GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL INVESTIGATION

FOR

TCON CONSTRUCTION PTY LIMITED

400 - 404 Cabramatta Road West, 2-18 Orange Grove Road and 6 Links Avenue, Cabramatta, New South Wales

Report No: 22/4221

Project No: 32073/7158D-G

December 2022

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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 development at 400 - 404 Cabramatta Road West, 2-18 Orange Grove Road and 6 Links Avenue, Cabramatta, New South Wales.

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

- Architectural Drawings for Stage 1: 'Proposed Staged Development at No. 400 – 404 Cabramatta Road, Cabramatta NSW', prepared by Designiche Pty Limited, Project No. 22020, Issue A, Drawing No. 01 to 30, dated 16.12.2022.
- Preliminary Architectural Drawings for Stage 2: 'Development Application Documentation Architectural Documentation For Stage 2 – Residential Flat Building', prepared by Aleksandar Projects, Project No. 21024, Revision A, Drawing No. DA00 to DA16, ADG01 to ADG04, dated 16/11/2022.

Based on the provided drawings, the proposed development will consist of two stages:

- Stage 1: Townhouses
- Stage 2: Residential Flat Building

Stage 1 comprises fifty-three townhouses divided into Blocks A to G, on grade car parking spaces, a common driveway, and a single level basement car park below Blocks C and E. Stage 2 comprises a six-storey residential flat building comprising 87 units with a double-level basement car park. Based on the drawings, the basements will require excavations of up to about 6.5 metres **BEGL** (Below Existing Ground Level).Because of the ground surface slope the basement excavation depth in the south-east portion of the site tapers to below 0.1 metres BEGL. . Additional locally deeper excavations may be required for footings or service trenches.

This purpose of this report was to provide preliminary geotechnical advice and recommendations on:

- Site conditions and regional geology
- Subsurface conditions,
- Site Classification to AS2870-2011 (soil reactivity),
- Excavation conditions and vibration control during rock excavation,
- Safe batter slopes,
- Retaining wall design parameters,
- Foundation design parameters,
- Pavement thickness design,

- Site preparation and re-grading including the re-use of site won materials and an earthworks specification, and
- Soil aggressiveness to buried steel and concrete in accordance with AS2870-2011 and AS2159-2009.

The investigation was undertaken in accordance with STS proposal P22-676 dated November 24, 2022.

2. GEOTECHNICAL INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of the drilling of nine (9) boreholes uniformly distributed across the site. The borehole locations were nominated by the Client and marked out with spray paint onsite. The boreholes were drilled using a utility mounted Edson RP70 drilling rig owned and operated by STS. Soils strengths were assessed by carrying out a Dynamic Cone Penetrometer (DCP) test adjacent to each borehole location. The borehole and DCP testing locations are shown on attached Drawing No. 22/4221.

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

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

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 soils for their aggressiveness, four (4) selected representative soil samples were tested to determine the following:

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

To assist with determining the Site Classification three (3) representative samples were collected to determine their Shrink/Swell Index.

To determine the CBR of the subgrade materials onsite, a 4-day soaked CBR compacted to 100% of the Maximum Dry Density was performed on three (3) representative samples.

Detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Sydney geological series sheet at a scale of 1:100,000 indicates that the site is underlain by Triassic Age Ashfield Shale of the Wianamatta Group. Rocks within this formation comprise black to dark-grey shale and laminite.

The site is irregular in shape with a total area of 1.535 hectares. At the time of the fieldwork, the site was vacant. A demountable office and shipping containers were observed at the northern most extent of the site. The existing ground surface slopes down approximately 30 degrees to the south. Site vegetation comprises trees and grass.

The site is bounded by Cabramatta Road West to the north, Orange Grove Road to the west, 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 in some parts of the site.

The subsurface conditions consist of fill, topsoil, natural silty clays, sandy clays, and weathered shale. Fill and topsoils were encountered to depths of 0.1 to 1.4 metres BEGL. Stiff, becoming very stiff with depth, natural silty clays and very stiff sandy clays underlie the topsoil and fill to depths of 1.3 to 2.5 metres BEGL. Weathered shale underlies the soils to the depths of auger refusal, 1.5 to 2.8 metres BEGL.

No groundwater was observed during the preliminary fieldwork. However, because the boreholes were drilled to a maximum depth of 2.8 metres, it is difficult to be definitive concerning the presence of groundwater prior to reaching the bulk excavation depths of 6 and 6.5 metres for the Stage 1 and Stage 2 basements, respectively. To determine the presence of groundwater within the bulk excavations additional boreholes will be required.

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.

To assist with determining the site classification, three shrink/swell tests were carried out on representative samples retrieved from the site. The detailed test report is attached and summarised in Table 5.1.

Table 5.1 – Shrink Swell Test Summary

Location	Depth (m)	Material Description	Shrink/Swell Index (% per ΔpF)
BH2	0.3 – 0.7	Silty CLAY: high plasticity, brown mottled pale grey, red, trace of gravel	4.0
BH3	0.2 – 0.5	Silty CLAY: medium to high plasticity, brown mottled pale grey, grey/red, trace of gravel	4.5
BH9	0.4 – 0.7	Sandy CLAY: fine to medium grained, medium plasticity, brown/pale grey	2.5

Because there are trees present, abnormal moisture conditions (AMC) prevail at the site. (Refer to Section 1.3.3 of AS2870-2011).

Because of the AMC and presence of over 400mm of fill, the site is classified a *Problem Site (P).* However, provided the recommendations given below are adopted and the fill is certified in writing as having been placed as controlled engineered fill, then the site may be reclassified as *Highly Reactive (H2).*

The fill appears to be placed as controlled engineered fill. However, no certification has been provided at the time of writing this report to confirm this.

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

5.2. Preliminary Excavation Conditions

Based on the subsurface conditions observed, bulk excavations for the basements on the site are expected to encounter topsoils, fill, silty clays, sandy clays, and weathered shale. Excavators without assistance should be able to remove the soils and some of the weathered shale.

Based on our local experience, medium strength shale and possibly high strength ironstone bands may be encountered prior to reaching the bulk excavation depth of 6.5 metres BEGL. The presence and the nature of this bedrock can be confirmed by carrying out additional cored boreholes, drilled below bulk excavation levels.

Excavators alone, without assistance, may not be able to remove a 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 infrastructure, 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 5.2.

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 5.2 - 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 or 600 kg rock hammer	100 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 considerations should be made to the impact of the proposed development upon neighbouring structures, roadways, and services. Basement excavation retention systems should be designed to limit lateral deflections.

Reference should be made to the TfNSW Technical Direction – Geotechnology (GTD) 2020/001, Version No.01, dated 2 July 2020, with regards to excavation/shoring adjacent to Cabramatta Road. This document outlines requirements for excavations adjacent to RMS infrastructure and includes the level of geotechnical investigation required, dilapidation surveying, instrumentation and monitoring during construction, trigger levels and contingency plans.

Instrumentation (e.g. inclinometers) and monitoring is typically required where the excavation exceeds 3 m in height (for cantilevered shoring walls) or 6 m in height (for anchored or propped shoring walls). A geotechnical monitoring plan may be required by RMS prior to construction of the Stage 2 building.

5.3. Excavation, Retention and Safe Batter Slopes

In the short term, dry cut slopes in the onsite soils should remain stable at an angle of 1(H) to 1(V). In the long-term dry cut slopes in the onsite soils formed at an angle of 2(H) to 1(V) should remain stable. Dry cut slopes in weathered shale formed at an angle of 1(H) to 1(V) should remain stable. Slopes cut at these angles would be subject to erosion unless protected by topsoil and diversion drains at the crest of the slopes. The above temporary batters should remain stable provided that all surcharge loads, including construction loads, are kept at a distance of at least 2h (where 'h' is the height of the batter in metres) from the crest of the batter. If steeper batters are to be used, then these must be supported by shotcrete and soil nail system, or the like, designed by a suitable experienced structural or geotechnical engineer.

Where space for temporary batters is not available, an engineered retention system will be required for the support of the entire depth of excavation. A soldier pile wall with shotcrete infill retention system is considered suitable for this site.

Excavations on the subject site 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.

5.4. Retaining Wall Design Parameters

The parameters used to proportion retaining wall support depend on whether the walls can be permitted to deflect. For walls, which cannot be permitted to deflect, an at rest earth pressure coefficient (Ko) of 0.6 should be adopted. For walls that can be allowed to deflect, an active earth pressure coefficient (Ka) of 0.4 should be adopted. A passive earth pressure coefficient (Kp) of 2.5 may be used for the silty clays and 4.5 for shale. A bulk density of 19 kN/m^3 may be used for the clays and 22 kN/m^3 for the weathered shale. If anchors or props are used for additional support a trapezoidal load distribution is to be used. As with all retaining walls, allowance must be made for ground surface slope, groundwater, and surcharge loads.

Additional cored boreholes are recommended to confirm the appropriate geotechnical parameters for an optimised shoring design.

5.5. Foundation Design Parameters

High level pad and/or strip footings founded in the stiff natural silty clays or fill certified in writing as being placed as controlled engineered fill, may be proportioned using an allowable bearing pressure of 100 kPa. For any high-level footings, the minimum depth of founding must comply with the requirements of AS2870-2011.

Should a higher bearing capacity be required, piles may be used to transfer the loads to the underlying very stiff natural materials, or weathered shale.

Piles founded in very stiff natural materials may be proportioned using an allowable bearing pressure of 300 kPa provided the 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.

The basement excavations are expected to encounter weathered shale at the maximum excavation depth of 6.5 metres BEGL and fill where the excavation depth tapers to below 0.1 metres BEGL. Due to the potential for differential settlements, we recommend that piles be used to ensure that the basements are uniformly founded within the weathered shale.

Footings or piles founded in weathered shale may be proportioned using an allowable bearing pressure of 700 kPa. For piled foundations, an allowable adhesion value of 70 kPa may be adopted for the portion of the pile shaft within the weathered shale. When piles are founded in weathered shale, the adhesion in the overlying soils must be ignored. An experienced geotechnical engineer should confirm appropriate founding levels and allowable bearing pressures during construction, based on assessment made during footing excavation or pier hole drilling.

If allowable bearing pressures greater than 700 kPa are required, an additional geotechnical investigation can be conducted which would include the coring of the shale bedrock to below bulk excavation depths, and subsequent laboratory testing and analysis to determine the shale quality. Once the shale quality has been determined, we will be able to recommend appropriate higher allowable bearing pressures.

To ensure the bearing values given can be achieved, care should be taken to ensure that the base of excavations is free of all loose material prior to concreting. It is recommended that all footing excavations be protected with a layer of blinding concrete as soon as possible, preferably immediately after excavating, cleaning, inspection, and approval.

Nearby footings founded at or near a crest of an excavation outside the basement outline should be founded below the zone of influence of the lower basement retaining walls, which may be taken as founding below a line drawn at 1 Vertical to 1 Horizontal from the base of the

retaining walls. Piles may be required. Specific geotechnical advice should be obtained for such footings taken into consideration the basement excavation and the quality of shale at the particular footing location.

5.6. Pavement Design

The results of the laboratory testing carried out on three (3) representative subgrade samples are summarised in Table 5.3.

Table 5.3 – Summary of CBR Test Results

Location	Depth (m)	Subgrade Material	CBR (%)
BH4	0.3 – 1.0	Silty CLAY: medium to high plasticity, brown	4.0
BH5	0.5 – 1.0	Silty CLAY: high plasticity, brown/pale grey, mottled pale grey, red and brown	3.5
BH8	1.2 – 1.8	Sandy CLAY: medium plasticity, fine to medium grained, brown	4.5

We have adopted a design CBR value of 3.5% for the design of the pavements in this site.

5.6.2 Flexible Pavement

For the on-grade driveways and carpark areas of the site, the flexible pavement thickness has been determined using the procedures given in Australian Roads Research Board (ARRB) "Sealed Local Roads Manual." We have assumed a 95% confidence level that the pavement will perform satisfactorily during its design life. In the absence of other traffic data, a design traffic loading of $5x10^5$ ESAs is considered appropriate for the site assuming that the driveways and car park are used for light vehicles.

For a design subgrade CBR value of 3.5%, the suggested pavement thickness is a recommended minimum of 440 mm, made up as follows:

Table 5.4 – Flexible Pavement Thickness Design

Material Type	Minimum Thickness (mm)
Surface Course	50
Base Course	100
Subbase Course	290
TOTAL	**440**

5.6.3 Construction

The designs given above assumed adequate provisions have been made for both surface and subsurface water.

The clay soils, which will make up the pavement subgrade, are reactive. They will therefore be susceptible to shrinkage and swelling due to moisture content changes. If these subgrade soils are permitted to dry following compaction, it is likely that shrinkage will occur, resulting in cracking. After placement of the pavement materials, the subgrade soils will moisten, resulting in swelling and partial loss of strength. It is therefore recommended that the subgrade be covered as soon as possible after completion of compaction to minimise the potential for evaporation and shrinkage to occur.

The subgrade materials should be compacted to a minimum density ratio of 100% of the Standard Maximum Dry Density (SMDD). Compaction should be verified by proof rolling and in-situ density tests. Base and subbase course materials should be compacted and tested to a minimum density ratio of 98% of the Modified Maximum Dry Density (MMDD). The level of compaction should be verified by in-situ density testing.

The long-term successful performance of the pavements is dependent on the satisfactory completion of the earthworks. To achieve this, the quality assurance programme should not be limited to routine compaction density testing only. Other important factors associated with the earthworks includes subgrade preparation, selection of fill materials, control of moisture content and drainage, etc.

All pavement materials used should comply with the Fairfield City Council requirements.

5.7. 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. Such excavation may need to be carried out with the excavation sides battered at an angle of no steeper than 1 Vertical to 1 Horizontal. The new fill 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, watered, and rolled until the cracks disappear.

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 95% of SMDD.

The existing fill materials onsite are considered suitable for re-use. The existing natural silty clays and sandy clays 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 the fill to confirm the above specifications are achieved in accordance with AS3798-2007 Table 8.1. We recommend that Level 1 control of fill compaction, as defined in AS3798-2007, be adopted on this Site.

We recommend that the engineered fill layers 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.

5.8. Soil Aggressiveness

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 5.5.

Table 5.5 – Soil Aggressiveness Summary

Sample No.	Location	Depth (m)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity (dS/m)	
						$EC_{1:5}$	EC_e
S1	BH1	0.3	5.2	200	610	0.318	2.9
S2	BH3	0.3	5.7	220	350	0.262	2.4
S3	BH5	0.3	6.2	20	20	0.032	0.3
S4	BH6	0.3	8.0	<10	<10	0.189	1.7

The soils on the site are cohesive and above the groundwater table. Therefore, soil conditions B are considered appropriate.

A review of the durability aspects indicates that:

- pH : minimum value of 5.2
- SO_4 : maximum value of 610 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of 220 mg/kg (ppm) < 5000 ppm
- ECe : maximum value of 2.9 dS/m

In accordance with AS2159-2009 the exposure classification for the onsite soils is mildly aggressive to concrete and non-aggressive to steel. In accordance with AS2870-2011 the soils are classified as A2.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that EC_e values of 0.3 to 2.9 dS/m are consistent with the presence of non and slightly saline soils.

6. FINAL COMMENTS

We recommend the following additional geotechnical work:

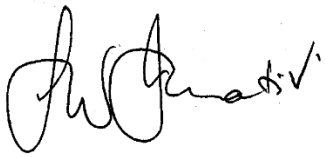
- Additional Geotechnical Investigation in the form of cored boreholes to confirm the depth and the quality of the Shale Bedrock across the site.

- Geotechnical Inspections of the exposed bearing surfaces for footings by an experienced geotechnical professional to verify the founding material and ensure the allowable pressure given has been achieved.
- Stability assessment of temporary batters and geotechnical inspection of unsupported excavations in bedrock (if required).
- Ongoing monitoring of groundwater seepage inflows into the bulk excavation.

STS recommends a meeting after the initial structural design has been completed to confirm our recommendations provided in this report has been correctly interpreted.

We also recommend a meeting at the commencement of construction to discuss the potential geotechnical issues should the subsurface conditions vary from those inferred above and geotechnical inspection requirements during the construction phase for the proposed development.

During construction, STS should be contacted to determine if any changes should be made to our recommendations for further advice.



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STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: December 2022
Client: TCON CONSTRUCTION PTY LIMITED		
GEOTECHNICAL INVESTIGATION **400-404 CABRAMATTA ROAD WEST, CABRAMATTA** **BOREHOLE AND PENETROMETER LOCATIONS**	Project No. 32073/7158D-G	
	Drawing No: 22/4221	

NOTES RELATING TO GEOTECHNICAL REPORTS

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.

Unforeseen 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 Information

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.

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CONSULTING GEOTECHNICAL ENGINEERS

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 1**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			FILL: SILTY CLAY: low plasticity, brown, gravel	CL	-	M
	S1 @ 0.3 m	0.5	SILTY CLAY: medium plasticity, brown mottled pale grey, red	CI	STIFF	M
		1.0			VERY STIFF	
		1.5	SILTY CLAY: high plasticity, pale grey	CH	VERY STIFF	M
		2.0	WEATHERED SHALE:		EXTREMELY LOW STRENGTH	
		2.5	AUGER REFUSAL AT 2.5 M ON WEATHERED SHALE			

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.:**	**BH 2**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1	
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT		

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			FILL: SILTY SAND: fine to medium grained sand, brown	SM	-	D
			SILTY CLAY: medium to high plasticity, brown mottled pale grey, red, trace of gravel	CI	VERY STIFF	M-D
	U50	0.5				
		1.0				
			SILTY CLAY: high plasticity, pale grey, mottle yellow	CH	VERY STIFF	M-D
		1.5				
		2.0				
			SILTY CLAY: medium plasticity, brown, trace of shale fragments	CL	VERY STIFF	M-D
		2.5				
			WEATHERED SHALE: brown/red		EXTREMELY LOW STRENGTH	D
			AUGER REFUSAL AT 2.8 M ON WEATHERED SHALE			

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.:**	**BH 3**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1	
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT		

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S2 @ 0.3 m		TOPSOIL: SILTY CLAY: low to medium plasticity, brown, trace of gravel	CL	-	M-D
	U50	0.5	SILTY CLAY: medium to high plasticity, brown mottled pale grey, grey/red, trace of gravel	CI/CH	VERY STIFF	M-D
		1.0				
		1.5	WEATHERED SHALE: brown		EXTREMELY LOW STRENGTH	D
			AUGER REFUSAL AT 1.8 M ON WEATHERED SHALE			
		2.0				
		2.5				

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: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 4**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			FILL: SILTY SAND: fine to medium grained sand	SM	-	M-D
	B	0.5	SILTY CLAY: medium to high plasticity,	CI/CH	STIFF	M-D
		1.0			VERY STIFF	
		1.5	WEATHERED SHALE: pale grey		EXTREMELY LOW STRENGTH	D
		2.0	grading to brown			
		2.5	AUGER REFUSAL AT 2.5 M ON WEATHERED SHALE			

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 5**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			FILL: GRAVEL: grey	GW	-	M
			FILL: SILTY CLAY: medium plasticity, brown, trace of gravel	CI	-	M
	S3 @ 0.3 m		SILTY CLAY: high plasticity, brown/pale grey, mottled pale grey, red and brown	CH	STIFF	M
		0.5				
	B				VERY STIFF	
		1.0				
		1.5	WEATHERED SHALE: pale grey		EXTREMELY LOW STRENGTH	D
		2.0	grading to pale red/brown			
		2.5	AUGER REFUSAL AT 2.4 M ON WEATHERED SHALE			

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 6**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S4 @ 0.3 m	0.5	FILL: SANDY CLAY: low to medium plasticity, fine to medium grained sand, gravel, glass, bricks, tiles	CI	APPEARS DENSE	D-M
		1.0	FILL: SILTY CLAY: high plasticity, brown/yellow	CH	APPEARS STIFF	D-M
		1.5	WEATHERED SHALE:		EXTREMELY LOW STRENGTH	D
		2.0	AUGER REFUSAL AT 1.5 M ON WEATHERED SHALE			
		2.5				

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: Edson RP70

Hole Diameter (mm): 100

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 7**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S5 @ 0.3 m		FILL: SAND: fine to medium grained sand, dark grey	SP	APPEARS DENSE	M-D
		0.5	FILL: SAND: fine to medium grained sand, pale grey brown, gravel and trace of gravel	SP	APPEARS DENSE	M-D
		1.0	WEATHERED SHALE: dark grey		EXTREMELY LOW STRENGTH	D
		1.5	AUGER REFUSAL AT 1.5 M ON WEATHERED SHALE			
		2.0				
		2.5				

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 8**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
		0.5	FILL: SAND: fine to medium grained sand, brown	SP	APPEARS DENSE	M-D
		1.0				
	B	1.5	SANDY CLAY: medium plasticity, fine to medium grained sand, brown	CI	VERY STIFF	M
		2.0				
		2.5	WEATHERED SHALE: brown		EXTREMELY LOW STRENGTH	D
			AUGER REFUSAL AT 2.7 M ON WEATHERED SHALE			

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Tcon Construction Pty Limited	Project: 32073/7158D-G	**BOREHOLE NO.: BH 9**
Project: 400-404 Cabramatta Road West, Cabramatta	Date : December 1, 2022	Sheet 1 of 1
Location: Refer to Drawing No. 22/4221	Logged: EJ Checked By: MT	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			FILL: SILTY SAND: fine grained sand, brown	SM	-	D
			SANDY CLAY: fine to medium grained sand, medium plasticity, brown/pale grey	SC	VERY STIFF	D-M
	U50	0.5				
		1.0				
			WEATHERED SHALE: brown/grey		EXTREMELY LOW STRENGTH	D
		1.5	AUGER REFUSAL AT 1.5 M ON WEATHERED SHALE			
		2.0				
		2.5				

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

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Edson RP70

Hole Diameter (mm): 100

Angle from Vertical (°):

Drill Bit: Spiral

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Dynamic Cone Penetrometer Test Report

Project: 400-404 CABRAMATTA ROAD WEST, CABRAMATTA
Client: TCON CONSTRUCTION PTY LIMITED
Address: 127 Water Street, Cabramatta West
Test Method: AS 1289.6.3.2

Project No.: 32073/7158D
Report No.: 22/4220
Report Date: 5/12/2022
Page: 1 of 2

Site No.	P1	P2	P3	P4	P5	P6
Location	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221
Date Tested	1/12/2022	1/12/2022	1/12/2022	1/12/2022	1/12/2022	1/12/2022
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level	Surface Level	Surface Level
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	4	9	10	6	4	4
0.15 - 0.30	3	10	6	5	6	8
0.30 - 0.45	3	9	8	4	4	10
0.45 - 0.60	3	8	10	6	4	14
0.60 - 0.75	4	5	8	6	6	19
0.75 - 0.90	7	6	6	10	7	22/R
0.90 - 1.05	6	8	4	12	7	
1.05 - 1.20	5	9	10	10	8	
1.20 - 1.35	6	10	13	14	10	
1.35 - 1.50	7	10	17	22/R	14	
1.50 - 1.65	7	11	22/R		22/R	
1.65 - 1.80	8	12				
1.80 - 1.95	13	14				
1.95 - 2.10	22/R	16				
2.10 - 2.25		20				
2.25 - 2.40		22/R				
2.40 - 2.55						
2.55 - 2.70						
2.70 - 2.85						
2.85 - 3.00						
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: EJ

Approved Signatory.....
Orlando Mendoza - Laboratory Manager

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Dynamic Cone Penetrometer Test Report

Project: 400-404 CABRAMATTA ROAD WEST, CABRAMATTA — Project No.: 32073/7158D

Client: TCON CONSTRUCTION PTY LIMITED — Report No.: 22/4220

Address: 127 Water Street, Cabramatta West — Report Date: 5/12/2022

Test Method: AS 1289.6.3.2 — Page: 2 of 2

Site No.	P7	P8	P9			
Location	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221	Refer to Drawing No. 22/4221			
Date Tested	1/12/2022	1/12/2022	1/12/2022			
Starting Level	Surface Level	Surface Level	Surface Level			
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	13	5	4			
0.15 - 0.30	18	7	5			
0.30 - 0.45	16	9	7			
0.45 - 0.60	19	12	9			
0.60 - 0.75	22/R	17	17			
0.75 - 0.90		19	22/R			
0.90 - 1.05		22/R				
1.05 - 1.20						
1.20 - 1.35						
1.35 - 1.50						
1.50 - 1.65						
1.65 - 1.80						
1.80 - 1.95						
1.95 - 2.10						
2.10 - 2.25						
2.25 - 2.40						
2.40 - 2.55						
2.55 - 2.70						
2.70 - 2.85						
2.85 - 3.00						
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

Approved Signatory.....

Technician: EJ — Orlando Mendoza - Laboratory Manager

E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by STS Geotechnics Pty Ltd (STS) in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-1981, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

(a) Soil Name and Classification Symbol

The USC system is summarised in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).

- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms “some” and “trace” as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - medium to high plasticity	H

(b) Grading

"Well graded" Good representation of all particle sizes from the largest to the smallest.

"Poorly graded" One or more intermediate sizes poorly represented

"Gap graded" One or more intermediate sizes absent

"Uniformly graded" Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as "rounded", "sub-rounded", "sub-angular" or "angular".

Particle **form** can be "equidimensional", "flat" or elongate".

Surface texture can be "glassy", "smooth", "rough", pitted" or striated".

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black White Grey Red
Brown Orange Yellow Green
Blue

These may be modified as necessary by "light" or "dark". Borderline colours may be described as a combination of two colours, eg red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

*E1.3 **S**oil Condition*

(a) Moisture

Soil moisture condition is described as "dry", "moist" or "wet".

The moisture categories are defined as:
Dry (D) - Little or no moisture evident. Soils are running.
Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 - 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 - 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 - 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 - 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2\ c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q_c (MPa)	DENSITY INDEX (%)
Very Loose	0 - 3	0 - 2	0 - 15
Loose	3 - 8	2 - 5	15 - 35
Medium Dense	8 - 25	5 - 15	35 - 65
Dense	25 - 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample
Lens - discontinuous with lenticular shape
Pocket - irregular inclusion
Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

“Residual Soil” - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

“Colluvium” - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

“Landslide Debris” - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

“Alluvium” - Material which has been transported essentially by water. usually associated with former stream activity.

“Fill” - Material which has been transported and placed by man. This can range from natural soils which have been placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicted by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes “O” or “H” depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an “organic material” by classification.

Coal and lignite should be described as such and not simply as organic matter.

APPENDIX B – LABORATORY TEST RESULTS

STS GEOTECHNICS PTY LTD
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STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Shrink Swell Index Report

Project: 400-404 CABRAMATTA ROAD WEST, CABRAMATTA
Client: TCON CONSTRUCTION PTY LIMITED
Address: 127 Water Street, Cabramatta West
Test Method: AS 1289.7.1.1

Project No.: 32073
Report No.: 22/4240
Report Date: 12/12/2022
Page: 1 of 1

Sampling Procedure: AS 1289.1.3.1 Clause 3.1.3.2 - Thin Walled Sampler

STS / Sample No.		7158D-L/1	7158D-L/2	7158D-L/3			
Sample Location		Borehole 2 Refer to Drawing No. 22/4221	Borehole 3 Refer to Drawing No. 22/4221	Borehole 9 Refer to Drawing No. 22/4221			
Material Description		Silty Clay, red brown/grey, trace of sand	Silty Clay, yellow brown/ grey red	Silty Sandy Clay, orange brown/grey			
Depth (m)		0.3 - 0.7	0.2 - 0.5	0.4 - 0.7			
Sample Date		1/12/2022	1/12/2022	1/12/2022			
Shrink	Moisture Content (%)	22.9	18.5	13.6			
	Soil Crumbling	Nil	Nil	Nil			
	Extent of Cracking	Open Cracks	Nil	Fine Cracks			
	Strain (%)	4.3	3.6	0.9			
Swell	Moisture Content Initial (%)	22.2	16.9	13.1			
	Moisture Content Final (%)	28.2	24.1	21.1			
	Strain (%)	5.7	8.9	7.4			
Inert Inclusions (%)		<25	<15	<20			
Shrink Swell Index (%)		**4.0**	**4.5**	**2.5**			

Remarks:

Approved Signatory.....

Technician: DH

Orlando Mendoza - Laboratory Manager

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2243629**	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	: 30055/32073/32068	Date Samples Received	: 02-Dec-2022 14:35
Order number	: ----	Date Analysis Commenced	: 06-Dec-2022
C-O-C number	: ----	Issue Date	: 07-Dec-2022 18:36
Sampler	: MBE/EJ/KS		
Site	: 2022-397		
Quote number	: EN/222		
No. of samples received	: 8		
No. of samples analysed	: 8		

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.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	30055/8686	30055.8687	32073/S1	32073/S2	32073/S3
			Sampling date / time	01-Dec-2022 00:00	01-Dec-2022 00:00	01-Dec-2022 00:00	01-Dec-2022 00:00	01-Dec-2022 00:00
Compound	CAS Number	LOR	Unit	ES2243629-001	ES2243629-002	ES2243629-003	ES2243629-004	ES2243629-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.1**	**6.2**	**5.2**	**5.7**	**6.2**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**481**	**102**	**318**	**262**	**32**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**10.6**	**16.6**	**20.2**	**14.0**	**10.8**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**350**	**200**	**610**	**350**	**20**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**----**	**----**	**200**	**220**	**20**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	32073/S4	32068/S1	32068/S2	----	----
			Sampling date / time	01-Dec-2022 00:00	01-Dec-2022 00:00	01-Dec-2022 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2243629-006	ES2243629-007	ES2243629-008	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**8.0**	**9.8**	**10.6**	**----**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**189**	**131**	**212**	**----**	**----**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**13.9**	**9.0**	**16.5**	**----**	**----**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	**40**	**170**	**----**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	**10**	<10	**----**	**----**

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@smectesting.com.au

California Bearing Ratio Determination Report

Project: 400-404 CABRAMATTA ROAD WEST, CABRAMATTA
Client: TCON CONSTRUCTION PTY LIMITED
Address: 127 Water Street, Cabramatta West
Test Method: AS 1289.6.1.1,5.1.1,2.1.1
No. of Days Soaked: 4

Project No.: 32073
Report No.: 22/4275
Report Date: 14/12/2022
Page: 1 of 1
Compactive Effort: Standard
Target Compaction (%): 100
Surcharge (Kg): 4.5

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

STS / Sample No.		7158D-L/1	7158D-L/2	7158D-L/3			
Sample Location		Borehole 4 Refer to Drawing No. 22/4221	Borehole 5 Refer to Drawing No. 22/4221	Borehole 8 Refer to Drawing No. 22/4221			
Material Description		Silty Sandy Clay, red brown	Silty Sandy Clay, red brown	Silty Sandy Clay, red brown			
Depth of Sample (m)		0.3 - 1.0	0.5 - 1.0	1.2 - 1.8			
Sample Date		1/12/2022	1/12/2022	1/12/2022			
Oversize on Wet Basis +19mm (%)		0.0	0.0	0.0			
Field Moisture Content (%)		13.9	18.7	15.6			
Optimum Moisture Content (%)		20	21.1	18.9			
Maximum Dry Density (t/m³)		1.70	1.70	1.73			
Dry Density (t/m³)	Before Soaking	1.70	1.68	1.75			
	After Soaking	1.68	1.65	1.73			
Relative Compaction (%)	Before Soaking	99.8	98.9	101.3			
	After Soaking	98.5	97.5	99.9			
Moisture Content (%)	Before Soaking	20.5	21.2	19.1			
	After Soaking	22.6	23	21.3			
Moisture Ratio Before Soaking (%)		102.5	100.5	101.0			
Moisture Content after test (%)	Top 30mm	21.7	23.1	21.5			
	Entire Depth	20.3	22.5	19.8			
Swell after Soaking (%)		1.3	1.4	1.4			
CBR Value (%)		**4.0**	**3.5**	**4.5**			
Penetration (mm)		**2.5**	**2.5**	**5.0**			

Remarks: +19mm material excluded from test

Approved Signatory.....

Technician: AW

Orlando Mendoza - Laboratory Manager