

May 25, 2021
Project No. 30055/7593
Report No. 21/1554
SS/ms

SUMMARY SHEET

Client: McDonald Jones Homes
Address: Lot 381, 1048 Castlereagh Road, Castlereagh
Reference: 606395/016/01



SITE CLASSIFICATION	M	AS2870-2011
WIND CLASSIFICATION	N2	AS4055-2012
EXPOSURE CLASSIFICATION	A1	AS2870-2011

This summary sheet must be read in conjunction with the full report.

May 25, 2021

Project No. 30055/7593

Report No. 21/1554

SS/ms

SITE INVESTIGATION REPORT

Client: McDonald Jones Homes

Address: Lot 381, 1048 Castlereagh Road, Castlereagh

Proposed Development: Residential dwelling

Site Description

Approx. area (ha): 2.155

Approx. fall: 1 metre to the west, reasonable site drainage

Vegetation: Grass

Improvements: Vacant

Geology, Fieldwork Details and Subsurface Conditions

The Penrith geological series sheet at a scale of 1:100,000 shows the site is underlain by Quaternary Age Alluvial Soils. Soils within this formation comprise mainly sand, silt and clay.

Two boreholes were drilled and two Dynamic Cone penetrometer (DCP) tests were carried out on May 12, 2021 at the locations shown on Drawing No. 21/1554. The subsurface conditions encountered are shown on the attached borehole logs. Explanation sheets and notes relating to geotechnical reports are also attached.

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.

The subsurface conditions consist of topsoil overlying silty clays and weathered rock. The topsoil is present to a depth of 0.05 metres. Firm, becoming very stiff with depth, silty clays underlie the topsoil to depths of 1.8 and 1.9 metres. Weathered rock underlies the site to the depth of auger refusal, 2.0 and 2.1 metres.

No groundwater was observed in the boreholes during the fieldwork.

Wind Classification

The classification given below has been carried out in accordance with the guidelines set out in AS4055-2012 “Wind loads for housing”.

Region	A
Terrain Category	TC2.5
Topographic Classification	T1
Shielding	PS
Rating	N2

Laboratory Testing

In order to assist with determining the site classification, a shrink/swell test was carried out on a representative sample retrieved from the site. The detailed test report is attached and summarised below:

Location	Depth (m)	Material Description	Shrink/Swell Index (% per ΔpF)
BH1	0.8-1.0	Orange brown with grey silty clay	1.5

Site Classification

The classification has been prepared in accordance with the guidelines set out in the “Residential Slabs and Footings” Code, AS2870 - 2011.

Based on the subsurface conditions observed, the site is classified *Moderately Reactive (M)*, provided the recommendations given below are adopted. After cutting and filling the site classification remains unaltered.

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 details.

Foundation Design and Construction

Pad and/or strip footings founded in the stiff silty clays, underlying the topsoil and firm clays, may be proportioned using an allowable bearing pressure of 100 kPa. The minimum depth of founding must comply with the requirements of AS2870.

Piers founded in very stiff natural materials 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.

Footings and piers founded in the weathered rock may be proportioned using an allowable end bearing pressure of 700 kPa. An allowable adhesion of 70 kPa may be adopted for the portion of the shaft within the weathered rock.

During footing excavation or site preparation, weathered rock may be encountered at some locations. If this occurs, bucket piers or the like should be used to ensure all footings bear on materials of similar stiffness.

In order 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. Pier excavations should not be left open overnight. The possibility of groundwater inflow needs to be considered when drilling the piers and pouring concrete.

The site is considered suitable for slab on ground construction provided due regard is given to the ground surface slope.

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.

Soil Aggressiveness

The exposure classification for the concrete has been determined for the onsite soils. The exposure classification is obtained from Tables 5.1 and 5.2 of AS2870-2011. In regard to the electrical conductivity, the laboratory test results have been multiplied by the appropriate factor to convert the results to EC_e .

Detailed test reports are attached and summarised below, together with the exposure classification.

Sample No.	Electrical Conductivity (dS/m)		pH	Sulfate (ppm)	Exposure Classification
	$EC_{1:5}$	EC_e			
S1/7593	0.020	0.2	6.3	10	A1

The minimum concrete strength and reinforcement cover required for the various exposure classifications are given in Tables 5.3 and 5.4 of AS2870-2011 (see attached).

Additional Comments

Attention is drawn to Appendix B of AS2870 - 2011 regarding the need to properly maintain the foundations. Surface drainage should be provided to avoid the possibility of water ponding near the building and the finished ground surface should fall at least 50 mm over a distance of one metre away from the building.

If excavations for rainwater or detention tanks are to be made within 6 metres of the building foundations, advice should be sought regarding their effect on the foundations.

Placing absorption trenches on the high side of the property may create abnormal moisture conditions for the foundations (Refer to Section 1.3.3 of AS2870). This could have a negative effect on the foundation performance and more than likely alter the site classification provided above.

This report has been prepared assuming that no trees other than those noted will be present on the site. If future tree planting is planned, e.g. there is a landscaping plan, their effect on the foundation performance must be considered.

This report has been prepared assuming the site development will be limited to one or two storey residential buildings. The information and interpretation may not be relevant if the design proposal changes (e.g. to a five-storey building involving major cuts during the site preparation). If changes occur, we would be pleased to review the report and advise on the adequacy of the investigation.

Yours faithfully,

Slaiman Shirzai
Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: May 2021
Client: McDONALD JONES HOMES		
SITE INVESTIGATION LOT 381, 1048 CASTLEREAGH ROAD, CASTLEREAGH		Project No. 30055/7593
BOREHOLE AND PENETROMETER LOCATIONS		Drawing No: 21/1554

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.

TABLE 5.1 FROM AS2870-2011**EXPOSURE CLASSIFICATION FOR CONCRETE IN SALINE SOILS**

Saturated Extract Electrical Conductivity (EC _e), dS/m	Exposure Classification
<4	A1
4-8	A2
8-16	B1
>16	B2

NOTES:

1. Guidance on concrete in saline environments can be found in CCAA T56.
2. Exposure classifications are from AS3600.
3. The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (EC) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture to determine the saturated extract electrical conductivity (EC_e).
4. The division between a non-saline and saline soil is generally regarded as an EC_e value of 4 dS/m, therefore no increase in the minimum concrete strength is required below this value.

TABLE 5.2 FROM AS2870-2011**EXPOSURE CLASSIFICATION FOR CONCRETE IN SULFATE SOILS**

Exposure Conditions			Exposure Classification	
Sulfates (expressed as SO ₄)*			Soil Conditions A†	Soil Conditions B‡
In Soil ppm	In Groundwater ppm	pH		
<5000	<1000	>5.5	A2	A1
5000-10 000	1000-3000	4.5-5.5	B1	A2
10 000-20 000	3000-10 000	4-4.5	B2	B1
>20 000	>10 000	<4	C2	B2

* Approximately 100 ppm SO₄ = 80 ppm SO₃.

† Soil conditions A – high permeability soils (eg. Sands and gravels) that are in groundwater.

‡ Soil conditions B – low permeability soils (eg. Silts and clays) or all soils have groundwater.

TABLE 5.3 FROM AS2870-2011

MINIMUM DESIGN CHARACTERISTIC STRENGTH (f'_c)
AND CURING REQUIREMENTS FOR CONCRETE

Exposure Classification	Minimum f'_c MPa	Minimum Initial Curing Requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥ 50	
C2	≥ 50	

TABLE 5.4 – FROM AS2870-2011

MINIMUM REINFORCEMENT COVER FOR CONCRETE

Exposure Classification	Minimum Cover in Saline Soils* (mm)	Minimum Cover in Sulfate Soils† (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	‡	70
C2	‡	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30 mm.

† Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10 mm.

‡ Saline soils have a maximum exposure classification of B2 as per Table 5.1.

Client: McDonald Jones Homes		Project / STS No. 30055/7593		BOREHOLE NO.: BH 2		
Project: Lot 381, 1048 Castlereagh Road, Castlereagh		Date: May 12, 2021		Sheet 1 of 1		
Location: Refer to Drawing No. 21/1554		Logged: MB Checked By: SS				
W A T E R L E V E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			TOPSOIL: SILTY CLAY: brown, low plasticity, organics	CL	-	D-M
			SILTY CLAY: brown, low plasticity	CL	FIRM	D-M
		0.5			----- STIFF	
			SILTY CLAY: orange brown with grey, medium plasticity	CL	STIFF	D-M
					----- VERY STIFF	
		1.0				
			SILTY CLAY: grey with orange brown, low to medium plasticity	CL	VERY STIFF	D-M
		1.5				
			WEATHERED ROCK: grey		EXTREMELY LOW STRENGTH	D
		2.0				
			AUGER REFUSAL AT 2.1 M ON WEATHERED ROCK			
		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: 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: LOT 381, 1048 CASTLEREAGH ROAD, CASTLEREAGH

Project No.: 30055/7593

Client: MCDONALD JONES HOMES

Report No.: 21/1554

Address: 62 Norwest Boulevard, Baulkham Hills

Report Date: May 14, 2021

Test Method: AS 1289.6.3.2



Accredited for compliance with ISO/IEC
 17025 - Testing
 The results of the tests, calibrations and/or
 measurements included in this document are
 traceable to Australian/national standards
 NATA Accreditation Number 2750

Page: 1 of 1

Site No.	P1	P2			
Location	Refer to Drawing No. 21/1554	Refer to Drawing No. 21/1554			
Date Tested	12/5/2021	12/5/2021			
Starting Level	Surface Level	Surface Level			
Depth (m)	Penetration Resistance (blows / 150mm)				
0.00 - 0.15	2	2			
0.15 - 0.30	3	2			
0.30 - 0.45	3	3			
0.45 - 0.60	6	5			
0.60 - 0.75	10	9			
0.75 - 0.90	10	9			
0.90 - 1.05	16	11			
1.05 - 1.20	23+	14			
1.20 - 1.35	Refusal	23+			
1.35 - 1.50		Refusal			
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: MB

Orlando Mendoza - Laboratory Manager

STS Geotechnics Pty Ltd

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

**Shrink Swell Index Report**

Project: Lot 381, 1048 Castlereagh Road, Castlereagh
Client: McDonald Jones Homes
Address: 62 Norwest Boulevard, Baulkham Hills NSW 2153
Test Method: AS1289.7.1.1

Project No.: 30055/5077D-L
Report No.: 21/1559
Report Date: 17/05/2021
Page: 1 of 1

Sampling Procedure: AS 1289.1.3.1 Clause 3.1.3.2 - Thin Walled Sampler

STS / Sample No.		7593/1				
Sample Location		Borehole 1 Refer to Drawing No. 21/1554				
Material Description		Silty Sandy Clay, red brown with grey				
Depth (m)		0.80 - 1.00				
Sample Date		12/05/2021				
Shrink	Moisture Content (%)	20.1				
	Soil Crumbling	Nil				
	Extent of Cracking	Open Cracks				
	Strain (%)	2.4				
Swell	Moisture Content Initial (%)	18.8				
	Moisture Content Final (%)	21.5				
	Strain (%)	0.6				
Inert Inclusions (%)		<5				
Shrink Swell Index (%)		1.5				

Remarks:

Accredited for compliance with ISO/IEC
 17025 - Testing
 The results of the tests, calibrations and/or
 measurements included in this document are
 traceable to Australian/national standards
 NATA Accreditation Number 2750

Approved Signatory.....

Orlando Mendoza - Laboratory Manager

Technician: DH

CERTIFICATE OF ANALYSIS

Work Order	: ES2117966	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	Date Samples Received	: 13-May-2021 11:10
Order number	: ----	Date Analysis Commenced	: 17-May-2021
C-O-C number	: ----	Issue Date	: 18-May-2021 15:41
Sampler	: MB/TS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		



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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	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 Contact 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
∅ = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	30055/7593	30555/7594	30055/7595	30055/7596	30055/7599
				Sampling date / time	12-May-2021 00:00				
Compound	CAS Number	LOR	Unit		ES2117966-001	ES2117966-002	ES2117966-003	ES2117966-004	ES2117966-005
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.3	5.5	5.2	7.8	5.3
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		20	369	20	457	27
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		14.4	14.8	18.6	15.1	13.4
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		10	120	<10	210	10



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID		30060/1454	30060/1455	----	----	----
			Sampling date / time		12-May-2021 00:00	12-May-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2117966-006	ES2117966-007	-----	-----	-----	
				Result	Result	----	----	----	
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit	7.0	5.3	----	----	----	
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm	96	311	----	----	----	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%	16.4	14.7	----	----	----	
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg	70	40	----	----	----	

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 Soil 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 indicated 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.