Acid Sulfate Soil Assessment

At

Lot 143 & 144 DP 715013

No 182 Salamander Way, Salamander Bay

For

St Philip's Christian Education Foundation

16 February 2022
5QS Ref: 211117

5QS™ CONSULTING GROUP

16 February 2022
5QS Ref: 211117

St Philip's Christian Education Foundation
C/- SHAC
224 Maitland Road
ISLINGTON NSW 2296

Attention: Elizabeth Brown

Re: Acid Sulfate Soil Assessment
Proposed School Buildings
No 182 Salamander Way, Salamander Bay

The following report presents the results of a limited geotechnical investigation undertaken at the above property.

If you have any further enquiries, please do not hesitate to contact the undersigned.

For and on behalf of
5QS Consulting Group

Peter Fennell
Principal

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5QS Consulting Engineers NSW/ACT is a division of C2F Pty Ltd ABN 48 137 633 124

Contents

Attachments

1. Drawing 211117/G1 Rev A
2. Engineering Logs
3. General Notes
4. Lime Types

Limited Geotechnical Investigation

Lot 143 & 144 DP 715013
No 182 Salamander Way, Salamander Bay

1. Introduction

At the request of Elizabeth Brown of SHAC, on behalf of St Philip's Christian Education Foundation, 5QS Consulting Group [5QS] has carried out a limited geotechnical investigation at the above properties.

The purpose of the investigation was to assess the risk of occurrence of acid sulfate soils [ASS] on the site within the area local to the footprint of a proposed infiltration trench for on-site stormwater disposal and to comment on the need for an ASS management plan.

For the purpose of the investigation, 5QS was provided with electronic copies of the following:

- Survey plan, prepared by Duggan Mather Surveyors, reference 2021115 TS1, dated 12 July 2021;
- Site plans for proposed development, prepared by SHAC, reference 4315, sheets DA1004 and DA1007, revision A, dated 18 June 2021; and
- Stormwater management plan, prepared by Northrop, reference DA-C04.01, revision A, dated 8 October 2021.

It is understood that proposed development on the property will comprise demolition of an existing building and construction of two new school buildings.

An infiltration trench is proposed near the southern boundary of Lot 144 in DP 715013.

The scope of this assessment included a desktop review of available published information, field work and preparation of this report. The following sections give the results of the assessment and comments on the above investigation scope.

This report should be read in conjunction with the attached 'General Notes'.

2. Site Description

The property, identified as Lot 143 and Lot 144 in DP 715013, [the site] occupies an area of approximately 4084 m^2 and is situated on the southern side of Salamander Way, Salamander Bay.

The site is bounded by Salamander Way to the north, by an existing childcare building and to the east, by the existing school facilities to the south, and by an existing church property to the west.

At the time of the investigation the site was partially occupied by brickwork school buildings and metal-clad demountable school buildings. Slopes on the site are near level with an embankment to the south of the proposed development sloping towards the south at approximately 9 % (5° slope angle).

Vegetation on the site comprised established grass cover, garden shrubs and a single mature tree.

Views of the site can be seen in photographs P1A to P3A. The approximate locations from where the photographs were taken are shown on attached Drawing 211117/G1 Revision A.

Photograph P1A – View towards south-east

Photograph P2A – View towards north-west

Photograph P3A – View towards north

3. Background Information

3.1 Acid Sulfate Risk Mapping

According to the Port Stephens 1:25 000 series acid sulfate soil [ASS] risk map [Ref 1], the site is situated in an area of aeolian plain at surface elevations in the order of 2 to 4 m to the Australian height datum (AHD) with a low probability of ASS occurrence between 1 m and 3 m below the natural ground surface.

4. Fieldwork

4.1 Methods

The field work, carried out by 5QS on 14 February 2022, comprised drilling of two boreholes by hand auger methods.

The approximate locations of the boreholes are shown on attached Drawing 211117/G1 Revision A.

4.2 Results

The boreholes at test locations BH1A and BH2A were excavated to depths of 2.3 m and 1.8 m, respectively. The boreholes were terminated due to collapse of saturated sandy soils below groundwater level.

The subsurface profile encountered at test location BH1A comprised sandy gravel filling to 0.1 m depth, overlying sand filling to 0.2 m depth, overlying silty sand filling to 1 m depth, overlying clay filling to 1.35 m depth, overlying natural silty sand to the limit of investigation at 2.3 m.

The subsurface profile encountered at test location BH2A comprised sandy clay filling to 0.5 m depth, overlying silty sand filling to 0.9 m depth, overlying sandy clay filling to 1.1 m depth, overlying natural sands to the limit of investigation at 1.6 m.

Standing groundwater was encountered at test locations BH1 and BH2 at 1.6 m and 1.5 m depth below existing surface level, respectively.

Engineering logs of the boreholes are provided in the attachments section of this report.

5. Acid Sulfate Soil Risk

5.1 Screening Testing

Samples of the soil profile were recovered from the boreholes and screened for the presence of actual and/or potential ASS in accordance with the procedures outlined in the NSW Acid Sulfate Soil Advisory Committee (ASSMAC) document, 'Acid Sulfate Soils Assessment Guidelines' [Ref 2].

The results of ASS screening are summarised in Table 1.

Table 1 – Summary results of ASS screening

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results			
			pH			Strength of Reaction [b]
			pH_F	pH_{FOX}	pH_F - pH_{FOX}	
BH1A	0.25	FILLING – silty sand	7.7	5.3	**2.4**	1
BH1A	0.50	FILLING – silty sand	7.4	4.8	**2.6**	1
BH1A	0.75	FILLING – silty sand	7.4	5.2	**2.2**	1
BH1A	1.00	FILLING – sandy clay	7.4	4.1	**3.3**	1
BH1A	1.25	FILLING – sandy clay	6.2	**2.4**	**3.8**	3
BH1A	1.50	Silty SAND	6.0	3.6	**2.4**	2
BH1A	1.75	Silty SAND	6.2	3.6	**2.6**	2
BH1A	2.20	Silty SAND	6.1	3.5	**2.6**	2
BH2A	0.50	FILLING – silty sand	6.1	5.1	**1.0**	1
BH2A	0.75	FILLING – silty sand	6.3	4.8	**1.5**	1
BH2A	1.00	FILLING – sandy clay	6.3	4.5	**1.9**	1
BH2A	1.25	SAND	6.1	4.7	**1.4**	1
BH2A	1.50	SAND	6.1	4.5	**1.6**	1
Guideline [c]		Sands to loamy sands	<4 [d]	<3 [e]	≥ 1 [e]	-
		Sandy loams to light clays				
		Medium to heavy clays & silty clays				

Notes to Table 1:

a Depth below ground surface

b Strength of Reaction
- 1 no or slight reaction
- 2 moderate reaction
- 3 high reaction
- 4 very vigorous reaction
- F bubbling/frothy reaction, indicative of organics
- H heat generated

c ASSMAC, 'Acid Sulfate Soils Assessment Guidelines' [Ref 2]

d For actual acid sulphate soils (AASS)

e Indicative value only for potential acid sulfate soils (PASS)

pH_{FOX} - soil peroxide pH test
pH_F - soil pH Test (1:5 soil:distilled water)
(1:4 soil:distilled water, following oxidation of soil with 30% H_2O_2)

3.00 indicate sample is potential ASS
3.00 indicate sample is actual ASS

5.2 Interpretation of Acid Sulfate Soil Risk

Based on the desktop review of published information, observations of subsurface conditions on site and the results of screening testing of site soils, it is interpreted that the soils encountered to a depth of 1 m **are neither potential acid sulfate soils [PASS]** nor **actual acid sulfate soils [AASS]**.

On the basis of the above comments, it is anticipated that no site-specific acid sulfate management plan is required provided the depth of excavation for the proposed infiltration trench is limited to a maximum depth of 1 m.

The screening testing results indicate that the filling material encountered at 1.25 m and the natural silty sand soils encountered below 1.5 m depth at test location BH1A may be PASS.

If excavations for the proposed infiltration trench are to be greater than 1 m depth, then chromium reducible sulfur testing would be required to determine whether AASS and/or PASS are present at depths greater than 1 m. If the excavations are proposed to extend greater than 1 m depth and the detailed testing indicates the presence of AASS and/or PASS then a site-specific acid sulfate management plan would also be required.

Excavation depths must be confirmed prior to commencement of any construction works at the property.

6. Comments on ASS Management

Acid sulfate soils [ASS] in their natural state pose little problem. One of the best forms of minimising ASS impacts is to **not disturb or modify the soils from their natural state, where practicable, and to transport no excavated materials off site**.

Project elements must be designed to minimise the depth of excavation where practicable. Excavations to depths below 1 m might intercept ASS materials.

The primary focus of all excavation work on this site should be to minimise ASS impacts by **not disturbing or modifying the soils from their natural state, where practicable, and to transport no excavated materials off the site**.

The following strategies to manage the impact of acid sulfate soils should be adopted:

- *Minimise ASS disturbance* by, where practicable, **not disturbing or modifying the soils from their natural state, and to transport no excavated materials off site.** Construction activities should, where practicable, aim to minimise the disturbance of the acid sulfate soils by limiting excavation extent and depth.
- *Limit the use of dewatering measures on the site unless essentially required*. Lowering the ground water table, for example, by spear point extraction or pumping from open pits or trenches, has the potential to expose ASS and cause them to oxidise, as well as generating acidic soil-water leachate. When the exposed soils again contact water, the products of ASS oxidation generate acid runoff. **No dewatering is to be carried out within the natural soil profile on this site without further detailed geotechnical assessment**.
- *Minimise air exposure time of excavated soils*. The length of time that excavated acid sulfate soils are exposed to air is to be minimised so as to reduce oxidation levels. **Progressive development of excavations and regular spraying of excavation are to be used to minimise exposure times**.
- *Dose excavated soils and the surfaces of site excavations using an acid-neutralising agent*. **Excavated ASS materials are to be dosed with Grade 1 Agricultural lime**, at a nominal rate of 5 kg per tonne of excavated soil, and mixed using appropriate methods to control generation and movement of acid runoff. The base and sides of excavations and trenches within ASS materials should be dosed with agricultural lime at a nominal rate of 1 kg/m^2.
- *Control the movement of leachate from oxidised ASS on the site*. Control all leachate movement using diversion and/or containment during site excavation work. **Excavation works are not to be undertaken during periods of wet weather or if wet weather is imminent**.
- *Monitor the process of neutralising acid products*. Excavated soils, groundwater and soil-water leachate that have been dosed with acid-neutralising agents are to be tested for pH level prior to re-use on site only.

It should be noted that there are health risks associated with the use of acid-neutralising agents such as lime which need to be addressed prior to site work. Contractors should undertake a risk assessment in relation to the use of lime and obtain a Material Safety Data Sheet for the particular lime-based materials that are proposed to be used.

For descriptions of lime types, refer to the information sheet in the attachments to this report.

If off-site disposal is required, additional testing may be needed to determine the waste classification in accordance with NSW EPA waste classification guidelines.

7. How to Use This Report

5QS Consulting Group [5QS] has prepared this report on a limited geotechnical investigation for a proposed school building at No 182 Salamander Way, Salamander Bay in accordance with the services proposal by 5QS dated 3 February 2022.

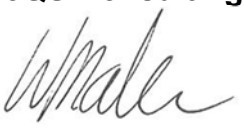
The following is a guide as to the intended scope and use of this report.

- This report has not been prepared for the purpose of informing design of any Class 2 development or mixed-use development with a Class 2 building component under the definitions of the Design and Building Practitioners Act 2020 and Regulation 2021.
- This report is provided for the exclusive use of St Philip's Christian Education Foundation for the purposes as described in the report. It may not be used or relied upon for other purposes or by a third party. 5QS can accept no responsibility for loss or damage arising out of the use of this report beyond its purpose as stated above, or incurred by any third party relying on the report without the express written consent of 5QS. In preparing this report 5QS has necessarily relied upon information provided by the client and/or their agents.
- The extent of testing associated with this assessment is limited to the borehole and DCP probe locations and variations in ground conditions may occur. The data from the test locations have been used to provide an interpretation of the likely subsurface profile at the site of the proposed development. The interpretation may or may not precisely represent the actual subsurface conditions at the site. 5QS should be contacted immediately if subsurface conditions are subsequently encountered that differ from those described in this report so that we can review and re-interpret the geotechnical model on the basis of the additional data.
- The scope of this investigation does not include any comment on the potential excavatability of the subsurface materials on site.
- Neither this report, nor sections from this report, should be used as part of a specification for a project without review and agreement by 5QS. This is because this report has been written as advice and opinion rather than instructions for construction.

- This report must be read in conjunction with all of the attachments.
- The recommendations provided in this report represent a summary of our technical advice. Please discuss the recommendations with the undersigned if you require any clarification.

For and on behalf of

5QS Consulting Group



William Maher
Professional Engineer

Reviewed

Peter Fennell
Principal

8. References

1. 'Port Stephens 1:25 000 acid sulfate soil risk map – Edition Two'
NSW Department of Land and Water Conservation (December 1997)

2. 'ASSMAC Acid Sulphate Soils Assessment Guidelines',
NSW Acid Sulphate Soil Management Advisory Committee (August 1998)

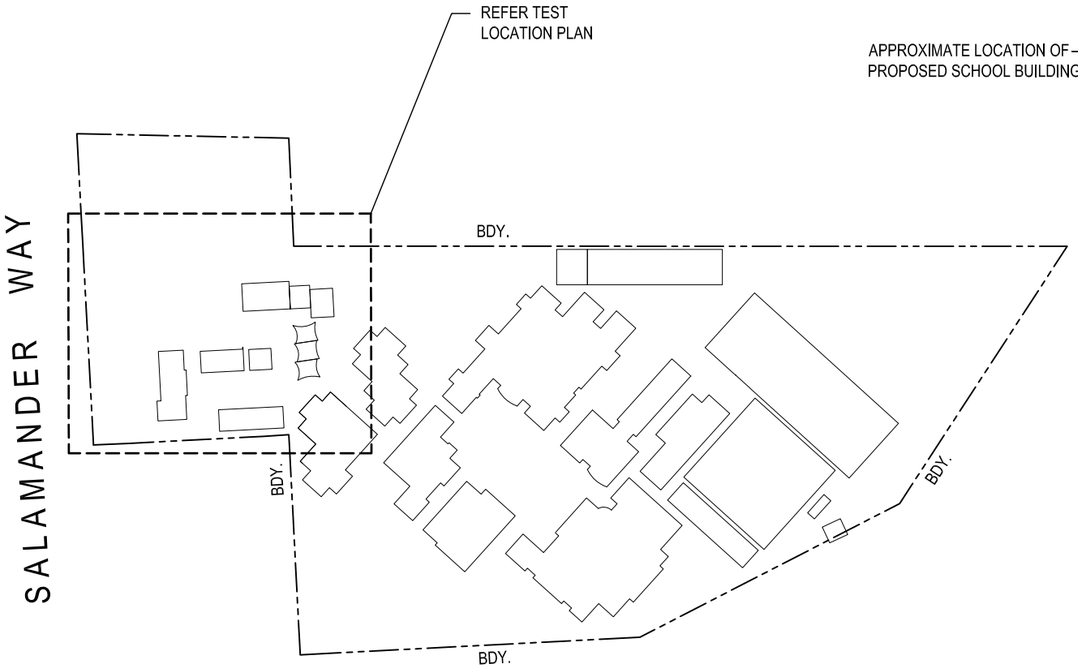
DRAWINGS DEVELOPED FROM
SITE PLAN

by: **SHAC**, *ref:* **4315**, *sheet* **DA1007,**
rev: **A**, *dated:* **18 June 2021.**

AND SURVEY PLAN

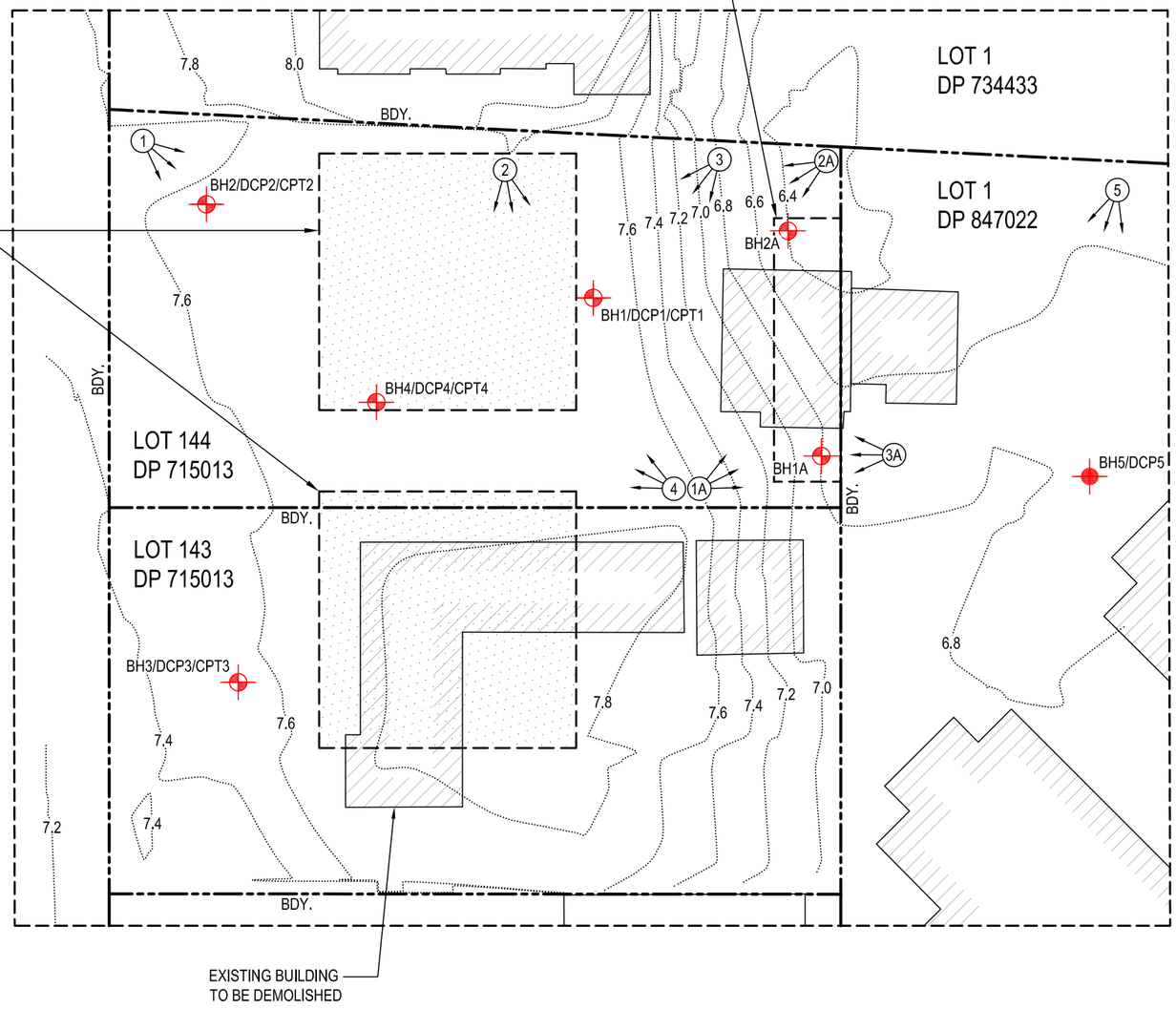
by: **Duggan Mather Surveyors**,
ref: **2021115 TS1**, *dated:* **12 July 2021**.

DIMENSIONS MAY NOT BE EXACT.
DO NOT SCALE OFF THESE DRAWINGS.



LOCALITY PLAN

SCALE 1:2000



TEST LOCATION PLAN

SCALE 1:500

LEGEND

- APPROXIMATE LOCATION OF PHOTOGRAPH
- BH/DCP — APPROXIMATE LOCATION OF BOREHOLE & DYNAMIC CONE PENETROMETER TEST
- BH/DCP/CPT — APPROXIMATE LOCATION OF BOREHOLE, DYNAMIC CONE PENETROMETER TEST & CONE PENETROMETER TEST

REV.	DATE	ISSUE DESCRIPTION	DESIGN	DRAWN	CHECKED
A	16.02.22	Additional boreholes added	-	WJM	WJM
-	29.10.21	Report Issue	-	RDP	WJM

Approved:

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TEST LOCATION PLAN
PROPOSED SCHOOL BUILDINGS
182 SALAMANDER WAY, SALAMANDER BAY
ST. PHILLIP'S CHRISTIAN COLLEGE

Drawing: 211117
Sheet: G1
Revision: A
Original Sheet Size: A3

ENGINEERING LOG

Location:	182 Salamander Way, Salamander Bay	Borehole No:	BH1A
Client:	St Phillip's Christian College, Port Stephens	Equipment:	Hand Tools†
Position:	See Test Location Plan - Drawing 211117/G1 - Rev A	Logged By:	WJM/RDP
Surface RL:	6.8 AHD*	Job No:	211117
Groundwater:	Standing groundwater level at 1.6m depth	Date:	14 Feb 2021

Depth in metres	Sample Type	Graphic Log	USCS	Material/Strata	Consistency Rel. Density	Moisture	Plasticity	Structure and Additional Comments
0.5	0.25 D 0.35		GW	FILLING - sandy gravel, angular gravel to 20mm size, brown, fine- to coarse-grained sand				
	0.5 D 0.6		SP	FILLING - sand, fine- to medium-grained, yellow				
1	0.75 D 0.85 1.0 D		SP	FILLING - silty sand, fine- to medium-grained, dark brown, wood chips				
	1.1 1.25 D		CL	FILLING - clay with sand, pale brown mottled dark grey			L	
1.5	1.35 1.5 D 1.6 1.75 D 1.85		SP	Silty SAND - fine- to medium-grained, dark grey				
2	2.2 D							
2.5	2.3			BH1A terminated at 2.3m depth depth due to borehole collapse in saturated soils, limit of investigation				
3								
3.5								
4								

Consistency Rel. Density: VS Fb, S VL, F L, St M, VSt D, H VD

Moisture: D, SM, M, W

Key

Water: seeping; free standing

Plasticity: NP Non Plastic; L Low; M Medium; H High

Moisture: D dry; M moist; W wet

Sampling Data: U50 undisturbed sample 50mm diameter; D disturbed sample; NC cone penetrometer; B bulk sample

Consistency: Relative Density — VS very soft; S soft; F firm; St stiff; VSt very stiff; H hard; VL very loose; L loose; M medium dense; D dense; VSt very dense

USCS Summary

GW GRAVEL, well graded
GP GRAVEL, poorly graded
GM Silty GRAVEL
GC Clayey GRAVEL
SW SAND, well graded
SP SAND, poorly graded
SM Silty SAND
SC Clayey SAND
ML Low plasticity SILT
CL Low plasticity CLAY
MH High plasticity SILT
CH High plasticity CLAY
OL, OH, Pt Organic soils

Comments

* Surface RL inferred from contours at 0.2m interval and spot heights to the Australian height datum [AHD] as shown on survey plan by Duggan Mather Surveyors, reference: 2021115 TS1, dated 12 July 2021

† 160mm diameter clay cutter to 0.4m depth, then 75mm auger to limit of investigation.

Refer to explanation sheet for description of terms and symbols used

ENGINEERING LOG

Location:	182 Salamander Way, Salamander Bay	Borehole No:	BH2A
Client:	St Phillip's Christian College, Port Stephens	Equipment:	Hand Tools†
Position:	See Test Location Plan - Drawing 211117/G1 - Rev A	Logged By:	WJM/RDP
Surface RL:	6.4 AHD*	Job No:	211117
Groundwater:	Standing groundwater level at 1.5m depth	Date:	14 Feb 2021

Drilling Information			Sampling Data			Profile Description				Structure and Additional Comments
Depth in metres	Progress	Water	Sample Type	Graphic Log	USCS	Material/Strata	Consistency Rel. Density	Moisture	Plasticity	
0.5			0.5 D 0.6		CL	FILLING - sandy clay, pale brown mottled grey and orange, fine- to medium-grained sand	VS Fb S VL F L St M VSt D H VD	D SM M W	L	
			0.75 D 0.85		SP	FILLING - silty sand, fine- to medium-grained, brown				
1			1.0 D		CL	FILLING - sandy clay, brown, fine- to medium-grained sand			L	
1.5		▽	1.1 1.25 D 1.35 1.5 D		SP	SAND - fine- to medium-grained, grey				
			1.6			BH2A terminated at 1.6m depth depth due to borehole collapse in saturated soils, limit of investigation				
2										
2.5										
3										
3.5										
4										

Key

Water: seeping; free standing

Plasticity
NP Non Plastic
L Low
M Medium
H High

Moisture
D dry
M moist
W wet

Sampling Data
U50 undisturbed sample 50mm diameter
D disturbed sample
NC cone penetrometer
B bulk sample

Consistency
Relative Density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
VL very loose
L loose
M medium dense
D dense
VSt very dense

USCS Summary

GW GRAVEL, well graded
GP GRAVEL, poorly graded
GM Silty GRAVEL
GC Clayey GRAVEL
SW SAND, well graded
SP SAND, poorly graded
SM Silty SAND
SC Clayey SAND
ML Low plasticity SILT
CL Low plasticity CLAY
MH High plasticity SILT
CH High plasticity CLAY
OL, OH, Pt Organic soils

Comments

* Surface RL inferred from contours at 0.2m interval and spot heights to the Australian height datum [AHD] as shown on survey plan by Duggan Mather Surveyors, reference: 2021115 TS1, dated 12 July 2021

† 160mm diameter clay cutter to 0.5m depth, then 75mm auger to limit of investigation.

Refer to explanation sheet for description of terms and symbols used

TERMS & SYMBOLS

Unified Soil Classification System (UCS)

COARSE-GRAINED SOILS More than half the material (by weight) is individual grains visible to the naked eye	GRAVELLY SOIL More than half of the coarse fraction is larger than 4.75mm	CLEAN GRAVEL Will not leave a stain on wet palm	Substantial amounts of all grain particle sizes	GW
			Predominantly one size or range of sizes with some intermediate sizes missing	GP
		DIRTY GRAVEL Will leave stain on wet palm	Non-plastic fines (to identify, see ML below)	GM
			Plastic fines (to identify, see CL below)	GC
	SANDY SOIL More than half of the coarse fraction is smaller than 4.75mm	CLEAN SAND Will not leave not leave a stain on wet palm	Wide range in grain size and substantial amounts of all grain particle sizes	SW
			Predominantly one size or range of sizes with some intermediate sizes missing	SP
		DIRTY SAND Will leave stain on wet palm	Non-plastic fines (to identify, see ML below)	SM
			Plastic fines (to identify, see CL below)	SC

	Ribbon	Liquid Limit	Dry crushing strength	Dilatancy reaction	Toughness	Stickiness	
FINE-GRAINED SOILS More than half the material (by weight) is individual grains not visible to the naked eye (< 0.074mm)	None	<50	None to slight	Rapid	Low	None	ML
	Weak	<50	Medium to high	None to very slow	Medium to High	Medium	CL
	Strong	>50	Slight to medium	Slow to medium	Medium	Low	MH
	Very Strong	>50	High to very high	None	High	Very high	CH
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture						OL, OH, Pt

Description and classification of soils and rock in accordance with AS1726 'Geotechnical Site Investigations'

Plasticity A2.4(b)

Symbol	Descriptive term	Liquid limit (%)
NP	Non plastic	-
L	of low plasticty	< = 35
M	of medium plasticity	> 35 < = 50
H	of high plastic	> 50

Moisture Condition A2.5(a)

'Dry' (D)	Cohesive soils; hard and friable or powdery, well dry of plastic limit. Granular soils; cohesionless and free-running
'Moist' (M)	Soil feels cool, darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
'Wet' (W)	Soil feels cool, darkened in colour. Cohesive soils usually weakened and free water forms on hand when handling. Granular soils tend to cohere.

Consistency terms - Cohesive soils TA4

Term	USS (kPa)	Field guide to consistency
Very soft	< = 12	Exudes between fingers when squeezed in hand
Soft	12 - 25	Can be moulded by light finger pressure
Firm	25 - 50	Can be moulded by strong finger pressure
Stiff	50 - 100	Cannot be moulded by fingers, can be indented by thumb
Vary stiff	100 - 200	Can be indented by thumb nail
Hard	> 200	Can be indented with difficulty by thumbnail

Consistency terms - Non-Cohesive soils TA5

Term	Density Index (%)
Very loose	< = 15
Loose	15 - 35
Medium dense	35 - 65
Dense	65 - 85
Very Dense	> 85

TERMS & SYMBOLS

Symbols

Soil


Asphaltic Concrete or Hotmix


Concrete


Topsoil


Fill


Peat, Organic Clays and Silts (Pt, OL, OH)


Clay (CL, CH)


Silt (ML, MH)


Sandy Clay (CL, CH)


Silty Clay (CL, CH)


Gravelly Clay (CL, CH)


Sandy Silt (ML)


Clayey Sand (SC)


Silty Sand (SM)


Sand (SP, SW)


Clayey Gravel (GC)


Silty Gravel (GM)


Gravel (GP, GW)


Loam

Rock


Claystone (massive)


Siltstone (massive)


Shale (laminated)


Sandstone (undifferentiated)


Sandstone, fine grained


Sandstone, coarse grained


Conglomerate


Limestone


Coal


Dolerite, Basalt


Tuff


Porphyry


Granite


Pegmatite


Schist


Gneiss


Quartzite


Talus


Alluvium

Inclusions


Rock Fragments


Organic Material


Ironstone Gravel, Laterite

Shale Breccia in Sandstone

Seams

Seam >0.1m thick

Seam 0.01m to 0.1m thick

General Notes

Introduction

These notes are supplied with all geotechnical reports from **5QS Consulting Group** and therefore may contain information not necessarily relevant to this report.

The purpose of the report is set out in the introduction section of this report. It should not be used by any other party, or for any other purpose, as it may not contain adequate or appropriate information in these events.

Engineering Reports

5QS Consulting Group engineering reports are prepared by qualified personnel and are based on information obtained, and on modern engineering standards of interpretation and analysis of that information. Where the report has been prepared for a specific design proposal the information and interpretation may not be relevant if the design proposal is changed. If the design proposal or construction methods do change, **5QS Consulting Group** request that it be notified and will be pleased to review the report and the sufficiency of the investigation work.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, the report must be regarded as interpretative, rather than a factual document, limited, to some extent, by the scope of information on which it relies.

5QS Consulting Group *cannot accept responsibility for problems which may develop if it is not consulted after factors considered in the report's development have changed.*

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, **5QS Consulting Group** cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will depend partly on bore spacing and sampling frequency.
- The actions of contractors responding to commercial pressures.

If these occur, **5QS Consulting Group** will be pleased to assist with investigation or advice to resolve the matter.

A Geotechnical Engineering Report May Be Subject To Misinterpretation

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, **5QS Consulting Group** should be retained to review the adequacy of plans and specifications relative to geotechnical issues.

Engineering Logs Should Not Be Separated From The Engineering Report.

Final engineering logs are developed by the Geotechnical Engineer based upon interpretation of field logs and laboratory evaluation of field samples. Only final engineering logs are included in geotechnical engineering reports. To minimize the likelihood of engineering log misinterpretation, *give contractors ready access to the complete geotechnical engineering report*.

Site Inspection

5QS Consulting Group will always be pleased to provide inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit, to full time engineering presence on site.

Change In Conditions

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions, which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time*.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and thus, the continuing adequacy of a geotechnical report. **5QS Consulting Group** should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, **5QS Consulting Group** requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed during construction, than at some later stage, well after the event.

Ground Water

Unless otherwise indicated the water levels given on the engineering logs are levels of free water or seepage in the test hole recorded at the given time of measuring. This may not accurately represent actual ground water levels, due to one or more of the following:

- In low permeability soils, ground water although present may enter the hole slowly, or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as indicated at the time of investigation.

Accurate confirmation of levels can only be made by appropriate instrumentation techniques and monitoring programs.

General Notes – Continued

Foundation Depth

Where referred to in the report, the recommended depth of any foundation, (piles, caissons, footings etc) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

Engineering Logs

Engineering logs presented in the report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify economically. In any case, the boreholes or test pits represent only a very small sample of the subsurface profile.

Interpretation of information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling and the possibility of other than straight line variations between the test locations.

Drilling Methods

The following is a summary of drilling methods currently used by **5QS Consulting Group**, and some comments on their use and application.

Continuous Sample Drilling: The soil sample is obtained by screwing a 75 or 100mm auger into the ground and withdrawing it periodically to remove the soil. This is the most reliable method of drilling in soils as the moisture content is unchanged and soil structure, strength, appearance etc. is only partially affected.

Test Pits: These are excavated using a backhoe or tracked excavator, allowing close examination of insitu soil if it is safe to descend into the pit. The depth of digging is limited to about 3 metres for a backhoe, and about 5 metres for an excavator. A potential disadvantage is the disturbance of the site caused by the excavation.

Hand Auger: The soil sample is obtained by screwing a 75mm Auger into the ground. This method is usually restricted to approximately 1.5 to 2 metres in depth, and the soil structure and strength is significantly disturbed.

Continuous Spiral Flight Augers: The soil sample is obtained by using a 90 – 115mm diameter continuous spiral flight auger which is withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays, and in sands above the water table. Samples, returned to the surface, are very disturbed and may be contaminated. Information from the drilling is of relatively lower reliability. SPT's or undisturbed sampling may be combined with this method of drilling for reasonably satisfactory sampling.

Hand Penetrometers

Hand Penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and recording the number of blows for successive 50mm increments of penetration.

Two, relatively similar tests are used:

1. Perth Sand Penetrometer (AS 1289.5.3.3) – A 16mm flat ended rod is driven with a 9kg hammer, dropping 600mm. This test was developed for testing the density of sands and is mainly used in granular soils and loose fill.

2. Cone Penetrometer/Scala Penetrometer (AS 1289.5.3.2) – A 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm. The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio (CBR) have been published by various road authorities.

Sampling

Sampling is carried out during drilling to allow engineering examination, and laboratory testing of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending on the amount of disturbance during drilling, some information on strength and structure.

Undisturbed samples are taken by pushing a think walled sample tube into the soils and withdrawing this with a sample of soil in a relatively undisturbed state contained inside. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Details of the type and method of sampling are given in the report.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 series, Methods of Testing Soils for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

Lime Types

Agricultural Lime

Agricultural lime products contain calcium and magnesium compounds that are capable of reducing / neutralising soil acidity. Agricultural limes are graded in terms of particle fineness and, therefore, speed of reaction with the soil. A term referred to as the effective neutralizing value (ENV) is the measure of fineness of lime.

Grade 1 Agricultural lime is specified with a minimum ENV of 80.

Hydrated Lime

"Hydrated lime" is a material, made from burnt lime, which consists essentially of calcium hydroxide or a combination of calcium hydroxide with magnesium oxide and magnesium hydroxide.

Burnt Lime

"Burnt lime" is a material made from limestone that consists essentially of calcium oxide or a combination of calcium oxide with magnesium oxide.

Quick Lime

“Quick Lime” is a material made from calcining limestone or shells, the heat driving off carbon dioxide and leaving lime. It is a white or grey caustic substance that develops great heat when treated with water, forming slaked lime.

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