ACT Geotechnical Engineers Pty Ltd
ACN 063 673 530

5/9 Beaconsfield St, Fyshwick, ACT, 2600
PO Box 9225, Deakin, ACT, 2609
Ph: (02) 6285 1547

7 November 2023
Our ref: SA/C14825

Group One
Via email: ymajeed@groupone.com.au

Attention: Yaaman Majeed

PROPOSED SUBDIVISION – 456 & 474 PLUMPTON ROAD, WAGGA WAGGA, NSW

Preliminary Geotechnical Investigation Report

We are pleased to present our preliminary geotechnical investigation report, assessing the geotechnical conditions for the proposed subdivision at 456 & 474 Plumpton Road, Wagga Wagga, NSW.

The report outlines the methods and results of exploration, describes site subsurface conditions, interprets results of soil salinity testing, and provides preliminary advice for lot site classifications and sit earthworks such as excavation conditions, use of excavated material, controlled fill construction and the scope for future investigation.

Should you require any further information regarding this report, please do not hesitate to contact our office.

Yours faithfully,
ACT Geotechnical Engineers Pty Ltd

Suraj Aryal
Geotechnical Engineer
M.Eng(Civil) MIEAust

Reviewed by:

Jeremy Murray
Senior Geotechnical Engineer | Director
FIEAust CPEng Eng Exec NER RPEQ APEC Engineer IntPE(Aust)
Registered Professional Engineer of Queensland (RPEQ) #19719
NSW Professional Engineer Registration #PRE0001487

GROUP ONE

PROPOSED SUBDIVISION – 456 & 474 PLUMPTON ROAD, WAGGA WAGGA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

NOVEMBER 2023

GROUP ONE

PROPOSED SUBDIVISION – 456 & 474 PLUMPTON ROAD, WAGGA WAGGA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

NOVEMBER 2023

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GROUP ONE

PROPOSED SUBDIVISION – 456 & 474 PLUMPTON ROAD, WAGGA WAGGA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

NOVEMBER 2023

1 INTRODUCTION

At the request of Group One, ACT Geotechnical Engineers Pty Ltd carried out a preliminary geotechnical investigation for the proposed residential subdivision at 456 & 474 Plumpton Road (lot 22 & 23 of DP757246), Wagga Wagga, NSW.

It has been indicated that the project will comprise of rezoning the parcel of land to residential subdivision.

The scope of this report is:

(i) Identify subsurface conditions at the site.

(ii) Provide site classification to AS2870 "Residential Slabs & Footings".

(iii) Present laboratory test results of soil salinity testing

(iv) Advise on the impact of salinity and recommendation for mitigation, if required.

(v) Advise on excavation conditions and use of excavated material for controlled fill.

(vi) Advise on controlled fill construction.

(vii) Further Investigation

The recommendations contained within this report are based on the available investigation data.

2 SITE DESCRIPTION & GEOLOGY

Plate 1. General site condition during the site investigation.

The investigation site is located on Lot 22 & 23 of DP757246, Wagga Wagga NSW. The site is generally flat with some areas of minor falling slope ranging from 1° to 3° towards the east and covered by pasture grass. Plate 1 shows the general site condition during our investigation.

NSW Seamless Geology v2.3 documents the site to be underlain by Quaternary colluvium deposit comprising of poorly sorted, weakly cemented to unconsolidated colluvial lenses of polymictic conglomerate with medium – to very coarse-grained sand matrix; interspersed with unconsolidated clayey and silty red-brown sand layers, modified by pedogenesis. Plate 2 shows the NSW Seamless Geology extract for the site.

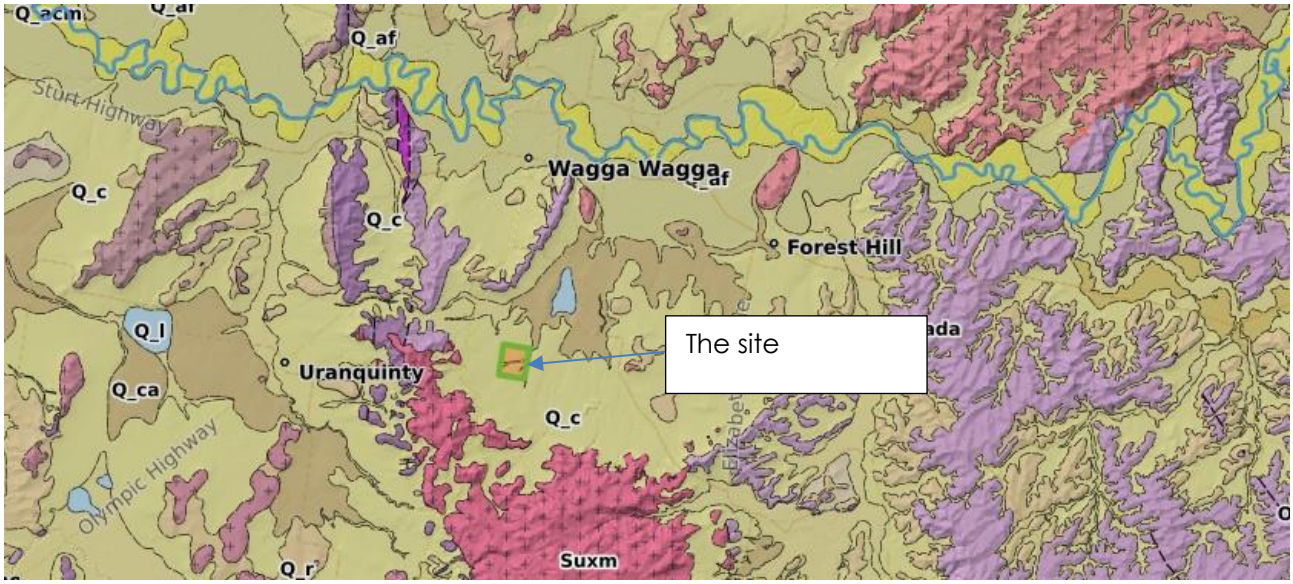

Plate 2. NSW Seamless Geology Extract

3 GROUND INVESTIGATION

The field investigation was carried out on 26 October 2023. Field investigation comprised of eight (8) boreholes drilled to the depth of 1.5m. From each borehole, one (1) sample was collected at depths ranging from 0.2m to 1.0m, for salinity testing in a NATA accredited laboratory.

Approximate borehole locations are show in Figure 1. The subsurface profiles were visually logged in general accordance with AS1726 – 2017 "Geotechnical Site Investigations" by an experienced geotechnical engineer. Borehole logs are presented in Appendix A.

Laboratory test results are presented in Appendix B.

Definitions of geotechnical engineering terms used on the borehole logs and in this report, including a copy of the USCS chart, are provided in Appendix C.

4 RESULTS OF GEOTECHNICAL INVESTIGIATON

4.1 Subsurface Conditions

Table 1 outlines the subsurface conditions found during our investigation and Table 2 outlines the depth of different geological profiles encountered in eight (8) investigation boreholes.

Table 1 –Subsurface Conditions

Geological Profile	Unit	Description
TOPSOIL	Unit 1: TOPSOIL	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to medium sand, trace root fibres. Dry.
SLOPEWASH	Unit 2: SLOPEWASH	Sandy Clayey SILT: low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-angular gravel. Dry. Medium dense to dense.
COLLUVIAL SOIL	Unit 3: Very Stiff to Hard Sandy CLAY	Sandy CLAY; medium to high plasticity, orange-brown/red-brown/yellow-brown, fine to coarse sand, (with fine to medium, rounded to sub-rounded ferruginous nodules). Moisture: dry of the plastic limit. Very stiff to hard consistency.

Table 2 – Geological profiles encountered in investigation boreholes

Unit	End of unit below ground level (m)							
	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8
Unit 1: TOPSOIL	0 - 0.1	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.1	0 - 0.15
Unit 2: SLOPEWASH	0.1 - 0.3	0.15 - 0.4	-	0.15 - 0.4	0.15 - 0.4	0.15 - 0.35	0.1 - 0.3	0.15 - 0.4
Unit 3: Very Stiff to Hard Sandy CLAY	0.3 - >1.5	0.4 - >1.5	0.15 - >1.5	0.4 - >1.5	0.4 - >1.5	0.35 - >1.5	0.3 - >1.5	0.4 - >1.5

4.1 Laboratory Test Results

Eight (8) samples were sent to a NATA accredited laboratory to test for texture/salinity classification. Lab results are presented below in Table 3.

Table 3 – Laboratory test results

Sample	Electrical 1: 5 Soil: Water Conductivity (µS/cm)	Texture Value	Texture	Ece (dS/m)	Class
BH1 0.5m – 0.7m	36	6.0	Heavy Clay	<2	Non-Saline
BH2 0.5m – 0.7m	16	6.0	Heavy Clay	<2	Non-Saline
BH3 0.6m – 0.8m	17	9.0	Clay Loam	<2	Non-Saline
BH4 0.3m – 0.5m	50	9.0	Clay Loam	<2	Non-Saline
BH5 0.2m – 0.4m	80	9.0	Clay Loam	<2	Non-Saline
BH6 0.4m – 0.6m	27	6.0	Heavy Clay	<2	Non-Saline
BH7 0.8m – 1.0m	59	7.0	Medium Clay	<2	Non-Saline
BH8 0.2m – 0.4m	120	9.0	Clay Loam	<2	Non-Saline

5 DISCUSSION & RECOMMENDATIONS

5.1 Site Classification

The colluvial soils at the site within the depth of suction change are highly reactive in terms of potential shrink-sell movements that may occur due to soil moisture changes. The characteristic ground surface movement "ys" as defined by AS2879 for the range of normal soil moisture conditions is estimated to be between 40mm to 60mm for the encountered subsurface profile described in section 4.1. Therefore, the residential lots are expected to mostly be **Class "H1"** (highly reactive) sites, however, this must be confirmed following the subdivision earthworks.

Normal moisture conditions are those caused by seasonal and regular climatic effects.

Should earthworks (cut or fill) be undertaken on the site, or other activities which may cause abnormal moisture conditions to impact the soils within or near the building envelope beyond those addressed herein, the site classification shall be reassessed.

5.2 Soil Salinity

Based on the lab test results, the site is **non-saline** and no mitigation measures are required for the site. Therefore, there are no salinity issues, and the site is suitable for a residential subdivision from a geotechnical and salinity perspective.

5.3 Excavation Conditions & Use of Excavated Material

The soils are readily diggable by backhoe and medium sized excavator to at least 1.5m depth; however, hard digging conditions due to rock fragments within the colluvial soil layer could be encountered.

The medium to high plasticity colluvial soil can be used in controlled fill construction of building platforms with some restrictions because of high plasticity, although rock particles should be broken down to <75mm size. The existing topsoil should not be used in controlled fill construction.

If imported fill is required, a suitable select fill material would include a low or medium plasticity soil such as clayey sand or gravelly clayey sand, containing between 25% and 50% fines less than 0.075mm size (silt and clay), and no particles greater than 75mm size.

5.4 Controlled Fill Construction

For construction of any new fill foundation platforms and road subgrades, it is recommended that:

- Areas be fully stripped of topsoil and slopewash, and if present any uncontrolled fill and moisture-affected soils. A general stripping depth of about 0.2m/0.4m is expected. Stripped foundations should be proof-rolled by a vibratory pad-foot roller of not less than 9 tons static mass to check for any weak or wet areas that would require replacement. No fill should be placed until a geotechnical engineer has confirmed the suitability of the foundation.

- Controlled fill comprising suitable site excavated or imported materials of not greater than 75mm maximum particle size, be compacted in not greater than 150mm layers to not less than 98%StdMDD at about OMC.

- Fill placement and control testing be overviewed and certified by a geotechnical engineer at Level 1 involvement of AS3798 – 1996 "Guidelines on Earthworks for Commercial & Residential Developments" (Reference 3).

5.5 Further Investigation

This investigation is of a preliminary nature in order to obtain basic geotechnical information on the site and to assess the suitability for residential development. Further geotechnical investigations would be required to obtain detailed information about the site.

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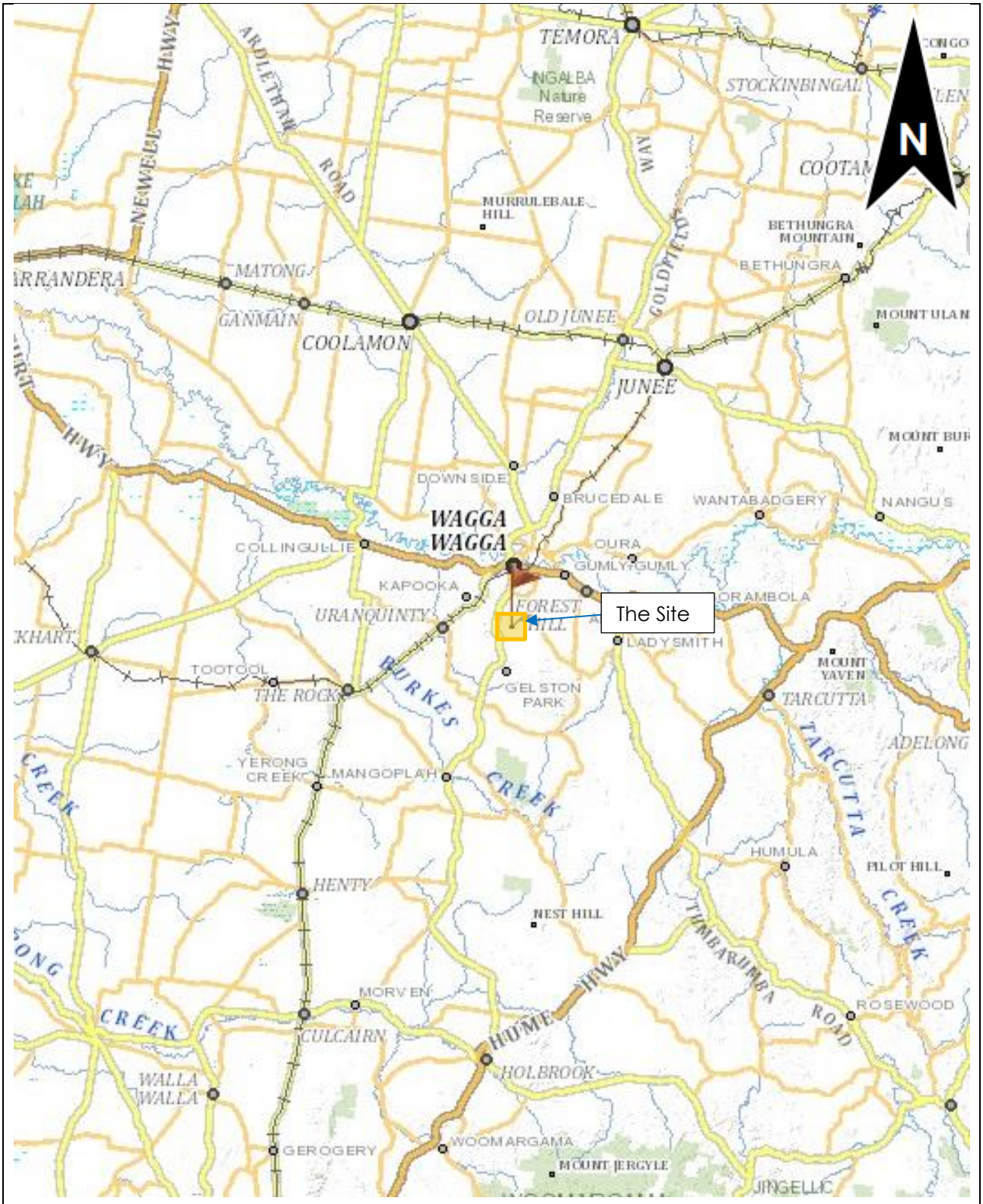
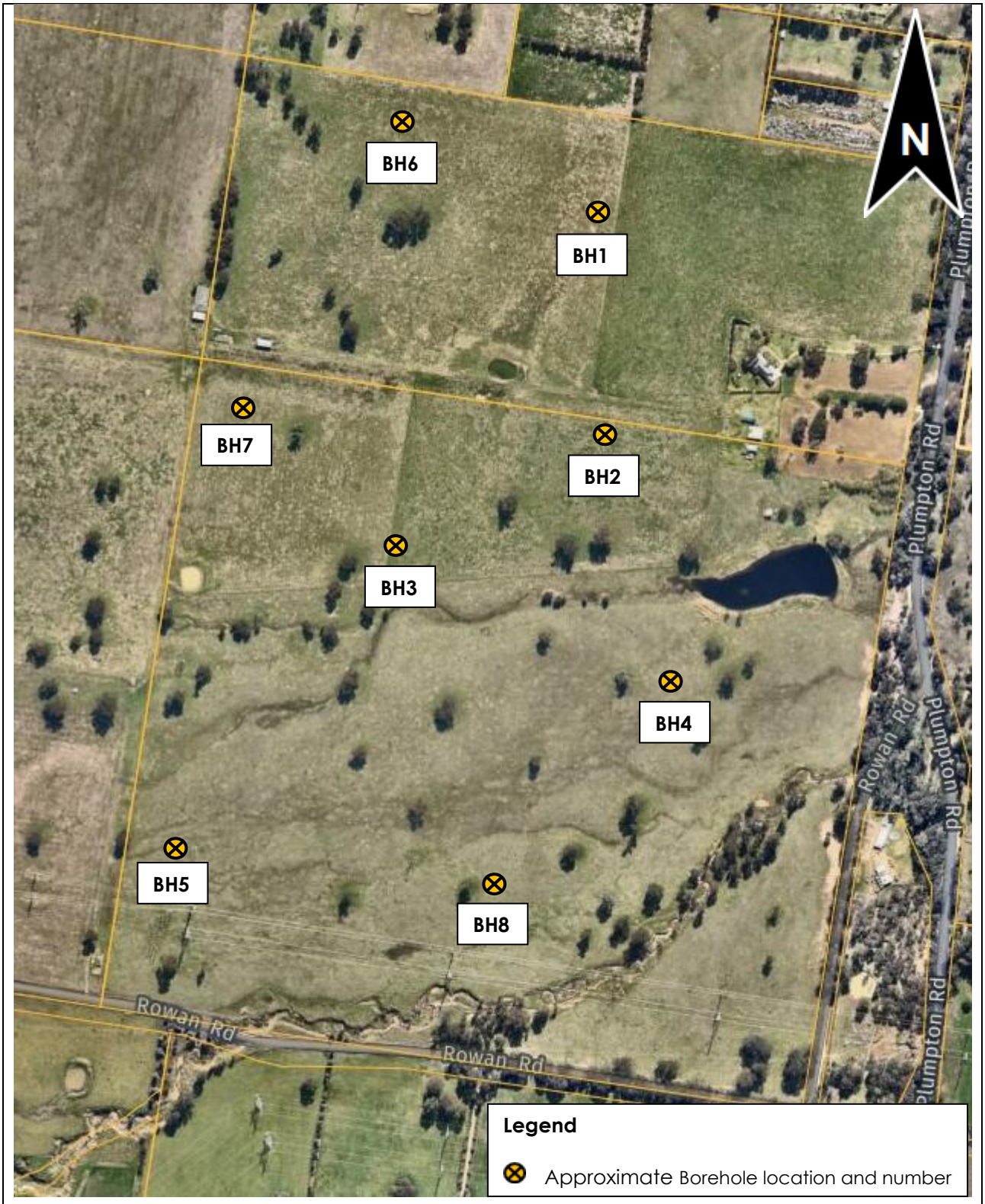


GROUP ONE
PROPOSED SUBDIVISION – 456 & 474 PLUMPTON ROAD, WAGGA WAGGA, NSW
SITE LOCALITY

ACT Geotechnical Engineers	C14825	FIGURE 1



GROUP ONE
PROPOSED SUBDIVISION – 456 & 474 PLUMPTON ROAD, WAGGA WAGGA, NSW
AERIAL IMAGE WITH APPROXIMATE BOREHOLES LOCATION

ACT Geotechnical Engineers	C14825	FIGURE 2

APPENDIX A
Borehole Logs

Borehole Log

Borehole No.	**BH1**
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.1		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.		DISTURBED SAMPLE	TOPSOIL
		0.3		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

ACT Geotechnical Engineers

ACT Geo Engineers

Borehole Log

Borehole No.	BH2
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.15		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.			TOPSOIL
		0.4		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard	DISTURBED SAMPLE	COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

ACT Geotechnical Engineers

ACT Geo Engineers

Borehole Log

Borehole No.	BH3
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.15		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to medium sand, trace root fibres. Dry.			TOPSOIL
		0.6		CI-CH	Sandy CLAY; medium to high plasticity, red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, yellow-brown mottled orange-brown, fine to coarse sand, with fine to medium, rounded to sub-rounded ferrugenous nodules. Moisture dry of the plastic limit.	Very Stiff to Hard	DISTURBED SAMPLE	
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

ACT Geotechnical Engineers

ACT Geo Engineers

Borehole Log

Borehole No.	**BH4**
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.15		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.		DISTURBED SAMPLE	TOPSOIL
		0.4		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

ACT Geotechnical Engineers

ACT Geo Engineers

Borehole Log

Borehole No.	BH5
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.15		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.		DISTURBED SAMPLE	TOPSOIL
		0.4		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

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Borehole Log

Borehole No.	**BH6**
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.15		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.		DISTURBED SAMPLE	TOPSOIL
		0.35		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

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Borehole Log

Borehole No.	**BH7**
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.1		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.		DISTURBED SAMPLE	TOPSOIL
		0.3		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

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Borehole Log

Borehole No.	**BH8**
Sheet	1 of 1
Job No.	C14825

CLIENT: Group One

PROJECT: Proposed Subdivision
456 & 474 Plumpton Road, Wagga Wagga, NSW

Location : See Figure 1

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : Push Tube
Hole Diameter : 50mm

Samples	Casing	Depth (Metres)	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
	Push tube	0.15		ML	TOPSOIL: Sandy SILT; low plasticity, dark brown, fine to meidum sand, trace root fibres. Dry.		DISTURBED SAMPLE	TOPSOIL
		0.4		ML	Sandy Clayey SILT; low plasticity, pale brown, fine to coarse sand, trace fine, rounded to sub-anguler gravel. Dry.	Medium Dense to Dense		SLOPEWASH
		1.0		CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled red-brown, fine to coarse sand. Moisture dry of the plastic limit.	Very Stiff to Hard		COLLUVIAL SOIL
		1.5			BOREHOLE TERMINATED AT 1.5m Target Depth			
		2.0						

Logged By : SA Date : 26/10/23 | Checked By : JM Date : 30/10/23

BOREHOLE/EXCAVATION LOG C14825 GINT.GPJ ACT GEO.GDT 3/11/23

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APPENDIX B
Laboratory Test Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 336647

Client Details

Client	ACT Geotechnical Engineers Pty Ltd
Attention	Jeremy Murray
Address	PO Box 9225, DEAKIN, ACT, 2600

Sample Details

Your Reference	**C14825 - 456 & 474 Plumpton Rd, Wagga Wagga**
Number of Samples	8 Soil
Date samples received	31/10/2023
Date completed instructions received	31/10/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	07/11/2023
Date of Issue	03/11/2023

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Diego Bigolin, Inorganics Supervisor

Authorised By
Nancy Zhang, Laboratory Manager

Texture and Salinity*						
Our Reference		336647-1	336647-2	336647-3	336647-4	336647-5
Your Reference	UNITS	BH1	BH2	BH3	BH4	BH5
Depth		0.5-0.7	0.5-0.7	0.6-0.8	0.3-0.5	0.2-0.4
Date Sampled		26/10/2023	26/10/2023	26/10/2023	26/10/2023	26/10/2023
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	02/11/2023	02/11/2023	02/11/2023	02/11/2023	02/11/2023
Date analysed	-	02/11/2023	02/11/2023	02/11/2023	02/11/2023	02/11/2023
Electrical Conductivity 1:5 soil:water	µS/cm	36	16	17	50	80
Texture Value	-	6.0	6.0	9.0	9.0	9.0
Texture	-	HEAVY CLAY	HEAVY CLAY	CLAY LOAM	CLAY LOAM	CLAY LOAM
ECe	dS/m	<2	<2	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE	NON SALINE	NON SALINE

Texture and Salinity*				
Our Reference		336647-6	336647-7	336647-8
Your Reference	UNITS	BH6	BH7	BH8
Depth		0.4-0.6	0.8-1.0	0.2-0.4
Date Sampled		26/10/2023	26/10/2023	26/10/2023
Type of sample		Soil	Soil	Soil
Date prepared	-	02/11/2023	02/11/2023	02/11/2023
Date analysed	-	02/11/2023	02/11/2023	02/11/2023
Electrical Conductivity 1:5 soil:water	µS/cm	27	59	120
Texture Value	-	6.0	7.0	9.0
Texture	-	HEAVY CLAY	MEDIUM CLAY	CLAY LOAM
ECe	dS/m	<2	<2	<2
Class	-	NON SALINE	NON SALINE	NON SALINE

Method ID	Methodology Summary
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
INORG-123	Determined using a "Texture by Feel" method.

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			02/11/2023	1	02/11/2023	02/11/2023		02/11/2023	[NT]
Date analysed	-			02/11/2023	1	02/11/2023	02/11/2023		02/11/2023	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	36	35	3	103	[NT]
Texture Value	-		INORG-123	[NT]	1	6.0	6.0	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

APPENDIX C
Definitions of Geotechnical Engineering Terms

DESCRIPTION AND CLASSIFICATION OF SOILS

The methods of description and classification of soils used in this report are based on the Australian Standard 1726 – 1993, Geotechnical site investigations. In general, descriptions cover the following properties – soil type, colour, secondary grain size, structure, inclusions, strength or density and geological description.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy clay) on the following basis:

Classification	**Particle Size**
Clay	Less than 0.002mm
Silt	0.002mm to 0.06mm
Sand	0.06mm to 2.00mm
Gravel	2.00mm to 60.00mm
Cobbles	60mm (63mm) to 200mm
Boulders	>200mm

Soils are also classified according to the Unified Soil Classifications System which is included in this Appendix. Rock types are classified by their geological names.

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The terms are defined as follows:

Consistency	**Shear Strength su(kPa) (Representative Undrained Shear)**	
Very soft	< 12	<2 (~SPT "N")
Soft	12 - 25	2-4
Firm	25 - 50	4-8
Stiff	50 – 100	8-15
Very Stiff	100 – 200	15-30
Hard	> 200	>30

Non-cohesive soils are classified on the basis of relative density, generally from the results of in-situ standard penetration tests as below:

Term	**Relative Density (%)**	**SPT Blows/300mm 'N'**
Very loose	< 15	<4
Loose	15-35	4-10
Medium dense	35-65	10-30
Dense	65-85	30-50
Very Dense	>85	>50

SAMPLING

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of soil or rock.

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

Undisturbed samples are generally taken by one of two methods:

1. Driving or pushing a thin walled sample tube into the soil and withdrawing with a sample of soil in a relatively undisturbed state.

2. Core drilling using a retractable inner tube (R.I.T.) core barrel.

Such samples yield information on structure and strength in additions to that obtained from disturbed samples 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.

PENETRATION TESTING

The relative density of non-cohesive soils is generally assessed by in-situ penetration tests, the most common of which is the standard penetration test. The test procedure is described in Australian Standard 1289 “Testing Soils for Engineering Purposes” Testing Soils for Engineering Purposes” – Test No. F3.1.

The standard penetration test is carried out by driving a 50mm diameter split tube penetrometer of standard dimensions under the impact of a 63 kg hammer having a free fall of 750mm.

The “N” value is determined as the number of blows to achieve 300mm of penetration (generally after disregarding the first 150mm penetration through possibly disturbed material). The results of these tests can be related empirically to the engineering properties of the soil.

The test is also used to provide useful information in cohesive soils under certain conditions, a good quality disturbed sample being recovered with each test. Other forms of in situ testing are used under certain conditions and where this occurs, details are given in the report.

DEFINITIONS OF ROCK, SOIL, AND DEGREES OF CHEMICAL WEATHERING

GENERAL DEFINITIONS – ROCK AND SOIL

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces.

Note: Since "strong" and "permanent" are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one.

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by such gentle mechanical means as agitation in water, can be remoulded and can be classified according to the Unified Soil Classification System. Three principal classes of soil recognized are:

Residual soils: soils which have been formed in-situ by the chemical weathering of parent rock. Residual soil may retain evidence of the original rock texture or fabric or, when mature, the original rock texture may be destroyed.

Transported soils: soils which have been moved from their places of origin and deposited elsewhere. The principal agents of erosion, transport and deposition are water, wind and gravity. Two important types of transported soil in engineering geology and materials investigations are:

Colluvium – a soil, often including angular rock fragments and boulders, which has been transported downslope predominantly under the action of gravity assisted by water. The principle forming process is that of soil creep in which the soil moves after it has been weakened by saturation. It may be water borne for short distances.

Alluvium – a soil which has been transported and deposited by running water. The larger particles (sand and gravel size) are water worn.

Lateritic soils: soils which have formed in situ under the effects of tropical weathering include all reddish residual and non residual soils which genetically form a chain of material ranging from decomposed rock through clay to sesqui-oxide rich crusts. The term does not necessarily imply any compositional, textural or morphological definition; all distinctions useful for engineering purposes are based on the differences in geotechnical characteristics.

ROCK WEATHERING DEFINITIONS

Extremely Weathered (EW)	Rock substance affected by weathering to the extent that the rock exhibits soil properties, i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered (HW)	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of the chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered (MW)	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered (SW)	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually by limonite, has taken place. The colour and texture of the fresh rock is recognisable.
Fresh (Fr)	Rock substance unaffected by weathering.

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the prominent degree of weathering first (e.g. EW-HW).

The various degrees of weathering do not necessarily define strength parameters as some rocks are weak, even when fresh, to the extent that they can be broken by hand across the fabric, and some rocks may increase in strength during the weathering process.

Fresh drill cores of some rock types, such as basalt and shale may disintegrate after exposure to the atmosphere due to slaking, desiccation, expansion or contraction, stress relief or a combination of any of these factors.

AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS

This classification system provides a standardised terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable. Where other rock types are encountered, such as in dykes, standard geological descriptions are used for rock types and the same descriptions as below are used for strength, fracturing and weathering.

Under this system rocks are classified by Rock Type, Strength, Stratification Spacing, Degree of Fracturing and Degree of Weathering. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc) where these are relevant.

ROCK TYPE DEFINITIONS

ROCK TYPE	DEFINITION
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments.
Sandstone:	More than 50% of the rock consists of sand sized (0.06 to 2mm) grains.
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated.
Claystone:	More than 50% of the rock consists of silt or clay sized particles and the rock is not laminated.
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated.

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

STRATIFICATION SPACING

Term	Separation of Stratification Planes
Thinly Laminated	< 6mm
Laminated	6mm to 20mm
Very thinly bedded	20mm to 60mm
Thinly bedded	60mm to 0.2m
Medium bedded	0.2m to 0.6m
Thickly bedded	0.6m to 2m
Very thickly bedded	> 2m

DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks.

Term	Description
Fragmented:	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter
Highly Fractured:	Core lengths are generally less than 20mm – 40mm with occasional fragments.
Fractured:	Core lengths are mainly 30mm – 100mm with occasional shorter and longer section.
Slightly Fractured:	Core lengths are generally 300mm – 1000mm with occasional longer sections and occasional sections of 100mm – 300mm.
Unbroken:	The core does not contain any fracture.

ROCK STRENGTH

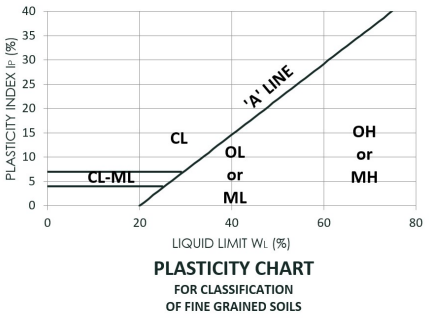
Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics.

Term	Point Load Index Is(50) MPa	Field Guide	Approx qu MPa*
Extremely Weak:	0.03	Easily remoulded by hand to a material with soil properties.	0.7
Very Weak:	0.1	May be crumbled in the hand. Sandstone is “sugary” and friable.	2.4
Weak:	0.3	A piece of core 150mm long x 50mm dia. May be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	7
Medium Strong:	1	A piece of core 150mm long x 50mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
Strong: (SW)	3	A piece of core 150mm long x 50mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very Strong (SW)	10	A piece of core 150mm long x 50mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely Strong (Fr)	>10	A piece of core 150mm long x 50mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	>240

The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ration to the point load index of 24:1. This ratio may vary widely.

Unified Soil Classification System (Metricated)
Data for Description Indentification and Classification of Soils

MAJOR DIVISIONS				DESCRIPTION				FIELD IDENTIFICATION					LABORATORY CLASSIFICATION				
				Group Symbol	Graphic Symbol	TYPICAL NAME	DESCRIPTIVE DATA						% [2] < 0.06mm	PLASTICITY OF FINE FRACTION			NOTES
COARSE GRAINED SOILS	More than 50% by dry mass, less than 60mm is greater than 0.06mm.	GRAVELS	More than 50% of coarse grains are greater than 2.0mm	GW		Well graded gravels and gravel-sand mixtures, little or no fines	Give typical name, indicate approximate percentages of sand and gravel, maximum size, angularity, surface condition and hardness of the coarse grains, local or geological name and other pertinent descriptive information, symbols in parenthesis. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics. EXAMPLE: Silty Sand, gravelly, about 20% hard, angular gravel particles, 10mm maximum size, rounded and sub angular sand grains coarse to fine, about 15% non-plastic fines with low dry strength, well compacted and moist in place, light brown alluvial sand, (SM)	Determine approximate percentages of material over 60mm size, maximum size, shape, surface texture, hardness of material, geological description. Identify on estimated percentage mass of the various fractions.	COARSE GRAINED SOILS	More than half of the material less than 60mm is larger than 0.06mm	0.06mm is about the smallest particle visible to the naked eye	GRAVELS AND SANDS	GRADATIONS	NATURE OF FINES	DRY STRENGTH	Group Symbol	Use the gradation curve of material passing 60mm for classification of fractions according to criteria given under 'Major Division'.	0-5	-	>4	Between 1 and 3	1. Identify Fines by the method given for fine grained soils. 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.06mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols eg SP-SM GW-GC
				GP		Poorly graded gravels and gravel-sand mixtures, little or no fines						GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	GW		0-5	-	Fails to comply with above		
		GRAVELLY SOILS		GM		Silty gravels, gravel-sand-silt mixtures						POOR	Predominantly one size or range of sizes			GP		12-50	Below 'A' line and Ip >7	-	-	
				GC		Clayey gravels gravel-sand-clay mixtures						GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	GM		12-50	Above 'A' line and Ip > 7	-	-	
		SANDS	More than 50% of coarse grains are greater than 2.0mm	SW		Well graded sands and gravelly sands, little or no fines								Fines are plastic (1)		GC		0-5	-	>6	between 1 and 3	
				SP		Poorly graded sands and gravelly sands, little or no fines						GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	SW		0-5	-	Fails to comply with above		
		SANDY SOILS		SM		Silty sand, sand-silt mixtures						POOR	Predominantly one size or range of sizes			SP		12-50	Below 'A' line or Ip < 4	-	-	
				SC		Clayey sands, sand-clay mixtures						GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	SM		12-50	Above 'A' line and Ip > 7	-	-	
														Fines are plastic (1)		SC						
FINE GRAINED SOILS	More than 50% by dry mass, less than 60mm is less than 0.06mm	Liquid Limit less than 50%		ML		Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, colour in wet condition, odour if any, local or geological name and r pertinent descriptive information, symbols in parenthesis. For undisturbed soil add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. EXAMPLE Clayey Silt, brown, low plasticity, small percentage of fine sand, numerous vertical root-holes, firm and dry in place, fill, (ML).		FINE GRAINED SOILS	More than half of the material less than 50mm is less than 0.06mm		SILT AND CLAY FRACTION									
				CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.						Fraction smaller than 0 20mm AS sieve size										
				OL		Organic silts and organic silty clays of low plasticity						DRY STRENGTH	DILATANCY	TOUGHNESS								
		Liquid Limit more than 50%		MH		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.						None to low	Quick to slow	None		ML		Below 'A' line				
				CH		Inorganic clays of high plasticity, fat clays.						Medium to high	None to very slow	Medium		CL		Above 'A' line				
				OH		Organic clays of medium to high plasticity.						Low to medium	Slow	Low		OL		Below 'A' line				
												Low to medium	Slow to none	Low to medium		MH		Below 'A' line				
												High to very high	None	High		CH		Above 'A' line				
												Medium to high	None to very slow	Low to medium		OH		Below 'A' line				
				Pt		Peat muck and other highly organic soils.		Readily identified by colour, odour, spongy feel and generally by fibrous texture								Pt*	*Effervescence with H2O2					



PLASTICITY CHART
FOR CLASSIFICATION OF FINE GRAINED SOILS

ACT Geotechnical Engineers

ACT Geotechnical Engineers Pty Lt
ACN 063 673 530

5/9 Beaconsfield Street, Fyshwick ACT 2609
PO Box 9225, Deakin ACT 2600
Ph: (02) 6285 1547

Limitations in the Use and Interpretation of this Geotechnical Report

Our Professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject development and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive borehole and test pit logs, cross- sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory bore holes, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory bore holes and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between conducting this investigation and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and the recommendations considering the changed conditions and time lapse.

The summary bore hole and test pit logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the test holes progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The bore hole and test pit logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at the other locations may differ from conditions occurring at these bore hole and test pit locations. Also, the passage of time may result in a change in the soil conditions at these test locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, bore holes or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report: nor can our company be responsible for any construction activity on sites other than the specific site referred to in this report.