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Report

Site and Soil Assessment – Wastewater Disposal System Proposed Rural Residential Subdivision Development No 39 – 51 Devlin Road Castlereagh, NSW

Prepared for
Mr David Ballard & Barbara Hughes
C/- Vince Morgan Surveyors
PO Box 4156
PENRITH WESTFIELD NSW 2750

Ref: JG13757A
May 2013

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15th May 2013

Our Ref: JG13575A-r1

Mr David Ballard and Ms Barbara Hughes
C/- Vince Morgan Surveyors
PO Box 4156
PENRITH WESTFIELD NSW 2750

Attention: Mr Peter Warwick

Dear Sir

Re: Wastewater Feasibility Assessment
Proposed Rural Residential Subdivision
39-51 Devlin Road Castlereagh

Please find attached Site and Soil Assessment – Wastewater Disposal System report for the proposed residential subdivision development to be located at 39-51 Devlin Road Castelreagh.

Should you have any queries, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd

Solern Liew CPEng
Director

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1. INTRODUCTION

This report presents the results of a site and soil assessment for the proposed onsite wastewater disposal systems to be installed at the property at Nos 39 – 51 Devlin Road, Castlereagh as shown on Drawing No 1. The investigation was commissioned by Mr Peter Warwick of Vince Morgan Surveyors, acting on behalf of the property owners Mr David Ballard and Ms Barbara Hughes, following our fee proposal referenced PG13167A dated 22nd January 2013.

We understand that the site is roughly 4 hectares and the proposed development will include subdivision of the site into 2 rural residential lots, each about 2 hectares. As part of the proposed subdivision, on-site effluent disposal system is required to service each new allotment.

A wastewater feasibility report is required as part of the Development Application submission to Council.

The purpose of the investigation was to assess the surface and sub-surface conditions of the site. Based on the information obtained, an assessment on the ability of soil to absorb nutrients and recommendations on design parameters are provided for the proposed on-site effluent disposal system.

2. INVESTIGATION PROCEDURE

Fieldwork for the investigation was carried out on the 5th April 2013 by a geotechnical engineer from this company and consisted of drilling 6 boreholes (BH 1 to 6) using a hand auger. The boreholes were taken to refusal depths ranging from 0.4m to 1.3m below existing ground surface.

To assess the strength of the subsurface profile, Dynamic Cone Penetrometer (DCP 1 and 2) tests were carried adjacent to the BH 1 and BH 4 respectively. The approximate test locations are shown on Drawing No 1.

In order to assess the permeability of the sub-surface profile, percolation tests were carried out in the BH 1. The percolation tests were carried out in accordance with the procedures outlined in The Australian Standard, AS1547 – 2000 "On-site domestic-wastewater management" (Reference 1). The test principally involved drilling of the borehole to a depth of about 1m and a permeameter was used to monitor water level drop with time.

Two soil samples were taken from the boreholes (BH 1 [0.0-0.1m] and BH 4 [0.0-0.1m]) for laboratory testing, aimed at assessing the chemical properties of the soil. The soil samples were taken to Sydney Analytical Laboratories, a NATA accredited laboratory for the following analysis;

- Electrical Conductivity
- Cation Exchange Capacity
- Phosphorus Sorption/Index
- Exchangeable Sodium
- pH

Details of the subsurface strata encountered, together with factual field test results, are summarised on the Borehole Reports in Appendix A. The DCP test results are summarised on the DCP Test Reports in Appendix B. The laboratory test certificate is attached in Appendix C. Explanatory notes and graphic symbols used in the preparation of the borehole reports are attached in Appendix D.

3. SITE ASSESSMENT

3.1 Site Locality

The site is located on the northern side of Devlin Road at Castlereagh. The site consists of a large parcel of land and is roughly rectangular in shape with an approximate 135m at frontage and extends 163m towards the rear.

3.2 Geology

Based on the 1:100,000 Soil Landscape of Penrith, the site is underlain by Fluvial Soil of the Berkshire Park group (bp) consisting of heavy clays, sandy clays, ironstone nodule and large silcrete boulder in a sand/clay matrix.

Based on the 1:100,000 geological map of Sydney, the site is underlain by Londonderry Clay formation (Tl) comprising of clay, patches of ferruginized and consolidated sand.

3.3 Site Topography and Description

Ground surface within the site slopes down gently to the northwest at angles typically less than 2 degrees. The major portion of the property was densely populated with trees and bushes with the front quarter of the property predominantly cleared of vegetation with some scattered trees.

Ground surface in the cleared area was covered with thick grass. Some fill appeared to have been placed at the north eastern corner of the cleared portion of the site.

The relatively even and gentle sloping ground of the site suggests that the risk of mass movement and slope instability is low and therefore considered to pose minor limitation for land application of wastewater.

There is a residential dwelling at the front portion of the property on the south eastern corner.

3.4 Potential Flooding

The site is situated on gentle sloping ground and appeared well drained with no obvious signs of water logging areas. Surface runoff into the site is limited by the frontage road and bare ground surface.

Based on Google Earth, the site is at about 34m above sea level.

3.5 Site Exposure

The site is subject to high exposure to sun and wind due to absence of trees in the areas. Exposure to sun and wind promotes evaporation and evapotranspiration of plant uptake.

3.6 Groundwater

Our DCP tests which were taken to a refusal depth of about 0.4m to 1.3m and did not encounter free water and therefore ground water within the site is not expected to be present at shallow depths (less than 1m).

On this basis, applied wastewater is unlikely to directly enter into the groundwater system and polluting the receiving water.

4. SOIL ASSESSMENT

4.1 Subsurface Soil

Reference should be made to Appendix A of this report for details of the subsurface profile encountered. The borehole investigation encountered the followings;

- Topsoil comprising of fine to medium grained Silty Sand was encountered on ground surface in all boreholes with thickness varying from 100mm to 200mm.

- Beneath the topsoil in BH 1, there was a thin layer of fill about 200mm thick comprising of fine to medium grained Gravelly Sand.

- Natural soil profile comprising the interbedded layer of clay, sand and gravels were encountered immediately beneath the topsoil and fill. Based on the DCP test results, the natural soil was assessed to be very stiff. The natural soil was generally found to be dry to moist.

- All boreholes were terminated at refusal depths varying from 0.4m to 1.3m below existing ground surface on possibly gravelly sand profile.

- All boreholes were found to be dry during and at the completion of the investigation.

4.2 Soil Characteristics

Based on the permeability test results, the natural subsurface soil consists of Gravelly Sand at the upper 0.3m to 0.5m and Silty Clay and Gravelly Sandy Clay at lower depths.

Based on Environmental & Health Protection Guidelines (Reference 2), the Gravelly Sand has a soil permeability category of 2 and the underyling Silty Clay/Gravelly Sandy Clay has a soil permeability category of 5. A category 2 soil poses minor limitation for land application of wastewater whilst a category 5 soil poses moderate limitation.

4.3 Soil Chemistry

For details of the laboratory test results, refer to Appendix C. The following is a summary of the test results;

Sample	**BH 1 [0.0-0.1m]**	**BH 4 [0.0-0.1m]**
Electrical Conductivity (dS/m)	1.1	0.067
Exchangeable Sodium (%)	10.7	1.7
Cation Exchange Capacity ($cmol^+/kg$)	<1.0	4.5
Phosphorus Sorption	1.5	2.0

The above results were compared with recommended criteria outlined in Reference 2. The test results indicated the soil to have low electrical conductivity, hence low concentrations of soluble salts and desirable for vegetation growth. Based on the exchangeable sodium results, the soil was assessed to have a moderate sodicity hence moderate potential for structural degradation of soil.

The soil was assessed to have a moderate cation exchange capacity, hence able to retain some plant nutrients and therefore pose moderate limitation to land application.

The phosphorus sorption capacity was found to be low therefore the soil is not able to absorb phosphorus for plant intake and potentially leachable. This pose a major limitation to land application.

5. COMMENTS AND RECOMMENDATIONS

We understand that the proposed development will include subdivision of the site into two rural residential blocks each about 2 hectares. The wastewater guideline (Reference 1) suggests typical wastewater flow allowance for one person of 250 L/day, therefore for an average household of 4 persons, the estimated a maximum daily sewerage flow rate of 1000 L/day may be adopted in the design of the sewerage system.

There are a number of systems which may be considered suitable for the site as follows;

<u>Mechanical Aeration and Irrigation Systems</u>

There are a number of proprietary systems available (eg EnviroCycle, BioCycle, etc). These systems usually have a primary sedimentation unit, an aeration unit, a secondary sedimentation unit, a disinfection unit and a pump pit. Effluent enters the primary sedimentation unit and undergoes a settling process where the heavy solids undergo anaerobic digestion. The liquid overflow from the primary sedimentation unit passes into an aeration unit where the water is constantly circulated around a contact medium which has a large surface area to volume ratio. The medium sustains the growth of an attached bio-mass which, remains stationary.

Following aeration, the effluent is allowed to settle in a secondary sedimentation unit. Settled solids are periodically pumped back for further digestion. Liquid from the secondary sedimentation unit is disinfected and the water is irrigated automatically via a pressurised system. The advantages of these systems are the relatively high quality effluent, recycling of water for irrigation and a fully automatic system. It is expected that the following are typical for effluent after treatment;

	Raw Effluent	**Treated Effluent**
BOD_5	450 mg/kg	20 mg/kg
Suspended Solids	450 mg/kg	30 mg/kg
Feacal Coliforms	3×10^5 per 100mL	10 per 100mL
Oil and Grease	7 mg/kg	(7 mg/kg)
Nitrogen	45 mg/kg	30 mg/kg
Phosphorus	14 mg/kg	11 mg/kg
Free Residual Chlorine	-	0.5mg/kg
Conductivity	500 uS/cm	500 uS/cm

For effluent disposal by irrigation, a water balance of the site was considered in order to estimate area for irrigation. The main elements considered in the water balance are:

- Effluent applied from the aerated septic/irrigation system
- Precipitation
- Evapotranspiration by plant uptake
- Percolation of the subsurface soil
- Run-off from ground surface

In order to achieve equilibrium, the amount of effluent applied by the system, plus precipitation should be less than the evapotranspiration, plus a limited amount of percolation and surface run-off. A water balance computation was carried out using the following equation;

$$\text{Design Precipitation} + \text{Effluent Applied} = \text{Evapotranspiration} + \text{Percolation} + \text{Surface Run-off}$$

A water balance of the site was carried out based on rainfall data obtained from the Bureau of Meteorology. Median and mean rainfall between 1897 to 1999 were obtained from Windsor Fitzgerald Street (Site Number 067031) and mean monthly evaporation between 1972 and 1999 were obtained from Richmond-UWS Hawkesbury (Site Number 067021). The following climatic data was used in the water balance computation;

Period	**Mean Rainfall (mm)**	**Median Rainfall (mm)**	**Evaporation (mm)**
January	88.3	65.8	179.8
February	90.3	66.2	145.0
March	81.4	70.4	132.9
April	67.6	41.6	101.0
May	57.4	28.1	66.9
June	60.6	34.8	57.7
July	49.1	30.8	69.1
August	46.2	25.2	87.9
September	40.6	36.6	121.2
October	55.0	40.6	149.4
November	67.2	52.7	162.9
December	69.9	49.3	208.4
TOTAL	**777.6**	**751.5**	**1462.0**

For the system to operate effectively, we recommend the following;

1. A total irrigation area of 1405m^2 be provided for the effluent disposal. The irrigation area be divided into two zones and only one zone be applied with treated effluent at any one time with the other zone allowed for "resting". This method will prevent excess salt accumulation in the root zone and harmful long term environmental effects to the soil.

2. The insitu topsoil material was assessed to have moderate to major limitations to land application and importation of good quality topsoil material is recommended to promote plant growth.

3. Adequate buffer zones should be provided around the irrigation area to contain the effluent. As a guide, the following buffer zones should be adequate;

Features	**Recommended Buffer Distance**
Residential dwelling	15m
Site boundaries, driveways and sheds	6m upgradient
	3m downgradient
Dam	30m upgradient
	10m downgradient
Drainage Depression	20m

4. Appropriate vegetation should be planted to prevent aerosol sprays from coming into contact with people. Vegetation planted should have some tolerance to salinity.

5. Cut-off drains should be constructed on the uphill side of the irrigation area to divert surface runoff from the irrigation area. Irrigation should be evenly distributed across the entire area.

6. Erosion control measures should be in placed to reduce migration of silt downstream. This may include establishment of vegetation cover, hay-bales and bunding to reduce flow velocities

Membrane Filtration System

This system which is adopted by Novaclear uses membrane technology to filter solids and bacteria and works on a single tank system with three main chambers to treat wastewater as follows;

- Primary Aeration Chamber – This is the main receptor where raw effluent enters. The effluent is aerated on a cyclic basis to allow micro-organisms within the effluent to breakdown the organics and nutrients. Aeration is supplied to the primary chamber via a fine bubble diffuser. The pre-treated water is periodically transferred into the MBR chamber for further digestion and membrane filtration and the aim is to minimise build up of excess sludge.
- MBR Chamber – This chamber contains the membrane housing, membranes and diffuser assembly. Transfer of recycled water through the membranes to the recycled water chamber is controlled by a working level float. Primary disinfection to remove bacteria, viruses and contaminants is provided via the 0.2um pore size membranes.
- Recycled Water Chamber – This chamber contains a pump to supply to the irrigation system. A chlorinator for secondary disinfection is optional.

This system was claimed to produce the highest quality rating for recycled water and be operated with is a no chemicals or consumables.

Septic Tank and Amended Soil System

This system consists of a conventional septic tank and an amended soil zone for further treatment to improve effluent quality. After going through a settling process and anaerobic digestion in the septic tank, the effluent is diverted into a leach drain, or soak well system, where it disperses into a filter bed consisting of a mixture of soils and earthy material which is underlain by an impermeable membrane.

The filter medium physically absorbs and chemically reacts with contaminants in the wastewater, including nutrients (phosphorous and nitrogen) and decease causing organisms. The "purified" wastewater flows out of the system and removed by evapotranspiration (ie. grass and plant uptake).

The advantage of this system is the high removal efficiencies of BOD, suspended solid, nutrients and pathogens.

References:

1. *Australian Standard, AS 1547 – 2000 "On-Site Domestic-wastewater Management"*

2. *"On-Site Sewage Management for Single HouseHolds" - 1998, Environmental & Health Protection Guidelines*

N

Legend

- Borehole
- DCP

GeoEnviro Consultancy Pty Ltd Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 96798733 Fax: (02) 96798744	Drawn By: WW	Date: 2/05/2013	Vince Morgan Surveyors	
	Checked By: SG	Date: 2/05/2013	No. 39 - 51 Devlin Road, Castlereagh	
	Revision:SL	Date:3/05/2013	Test Location Plan	
	Scale: NTS	A4	Project No: JG13757A	Drawing No: 1

GeoEnviro Consultancy Pty Ltd
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Borehole Report

Borehole no: 1

Client: Vince Morgan Surveyors
Project: Proposed Rural Subdivision
Location: 39 - 51 Devlin Road, Castlereagh

Job no: JG13757A
Date: 29/04/2013
Logged by: WW

Drill Model and Mounting: Hand Auger
Hole Diameter: 100 mm
Slope: Vertical
Bearing: n/a
R.L. Surface:
Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth (m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetration	Structure and Additional Observations
HAND AUGER	NIL	DRY					Topsoil: Silty Sand, fine to medium grained, dark grey	M		2	Start DCP 1
										4	
							Fill: Gravelly Sand, fine to medium grained, grey			2	
						CH	Silty Clay: High plasticity, brown	MC		4	
				0.5				<=	St	3	
							As above: Brown mottled grey	PL	-Vst	2	
										1	
										2	
										2	
				1.0						2	
						CH	Sandy Clay: High plasticity, brown mottled grey	MC	H	3	
								<PL		7	
							End BH 1 at 1.2m			20	Bouncing
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 2

Client: Vince Morgan Surveyors
Project: Proposed Rural Subdivision
Location: 39 - 51 Devlin Road, Castlereagh

Job no: JG13757A
Date: 29/04/2013
Logged by: WW

Drill Model and Mounting: Hand Auger
Hole Diameter: 100 mm

Slope: Vertical
Bearing:n/a

R.L. Surface:
Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetration	Structure and Additional Observations
H.A	NIL	DRY					Topsoil: Silty Sand, fine to medium grained, dark grey	M			
						GW	Gravelly Sand: Fine to medium grained, brown,	M			
				0.5		CL	Gravelly Sandy Clay: Low plasticity, brown	D	Vst		
				1.0			End BH 2 at 0.7m				Hand Auger Refusal
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 6

Client: Vince Morgan Surveyors	Job no: JG13757A
Project: Proposed Rural Subdivision	Date: 29/04/2013
Location: 39 - 51 Devlin Road, Castlereagh	Logged by: WW

Drill Model and Mounting: Hand Auger	Slope: Vertical	R.L. Surface:
Hole Diameter: 100 mm	Bearing:n/a	Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetration	Structure and Additional Observations
HAND AUGER	NIL	DRY					Topsoil: Silty Sand, fine to medium grained, dark grey				
				0.5		CH	Silty Clay: High plasticity, brown As above: brown mottled grey	MC <= PL	Vst		
				1.0		CH	Sandy Clay: High plasticity, brown mottled grey As above: with gravels	MC <= PL	Vst		
				1.5			End BH 6 at 1.3m				Hand Auger refusal
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 3

Client: Vince Morgan Surveyors	Job no: JG13757A
Project: Proposed Rural Subdivision	Date: 29/04/2013
Location: 39 - 51 Devlin Road, Castlereagh	Logged by: WW

Drill Model and Mounting: Hand Auger	Slope: Vertical	R.L. Surface:
Hole Diameter: 100 mm	Bearing:n/a	Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetration	Structure and Additional Observations
H.A	NIL	DRY					Topsoil: Silty Sand, fine to medium grained, dark grey	D			
							Gravelly Sand: Fine to medium grained, pale brown				
				0.5		CH	Silty Clay: High plasticity, brown As above: Mottled light grey with ironstones	MC <= PL	Vst		
				1.0			End BH 3 at 0.7m				Hand Auger Refusal
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 4

Client: Vince Morgan Surveyors
Job no: JG13757A

Project: Proposed Rural Subdivision
Date: 29/04/2013

Location: 39 - 51 Devlin Road, Castlereagh
Logged by: WW

Drill Model and Mounting: Hand Auger | Slope: Vertical | R.L. Surface:

Hole Diameter: 100 mm | Bearing:n/a | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetration	Structure and Additional Observations
H.A	NIL	DRY					Topsoil: Silty Sand, fine to medium grained, dark grey			7	Start DCP 2
							Gravelly Sand: Fine to medium grained, brown	D	Vst	8	DCP Bouncing
				0.5			End BH 4 at 0.4m				Hand Auger Refusal
				1.0							
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 5

Client: Vince Morgan Surveyors
Job no: JG13757A
Project: Proposed Rural Subdivision
Date: 29/04/2013
Location: 39 - 51 Devlin Road, Castlereagh
Logged by: WW

Drill Model and Mounting: Hand Auger | Slope: Vertical | R.L. Surface:
Hole Diameter: 100 mm | Bearing:n/a | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Dynamic Cone Penetration	Structure and Additional Observations
H.A	NIL	DRY					Topsoil: Silty Sand, fine to medium grained, dark grey				
							Gravelly Sand: Fine to medium grained, brown	D	MD		
				0.5			End BH 4 at 0.4m				Hand Auger Refusal
				1.0							
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

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Dynamic Cone Penetration Test Report

Client/Address: Vince Morgan Surveyors (Penrith)	Job No: JG13757A
Project: Proposed Waste Waster Disposal System	Date: 10/5/13
Location: 39-51 Devlin Road Castlereagh	Report No: R01A

Test Procedure: AS 1289 1.1, 1.2.1, 6.3.2

Test Data

Test No: 1		Test No: 2		Test No:		Test No:	
Test Location: Refer to Drawing No 1		Test Location: Refer to Drawing No 1		Test Location:		Test Location:	
RL:		RL:		RL:		RL:	
Soil Classification: Refer to BH 1		Soil Classification: Refer to BH 4		Soil Classification:		Soil Classification:	
Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows
0.0-0.1	2	0.0-0.1	7	0.0-0.1		0.0-0.1	
0.1-0.2	4	0.1-0.2	8	0.1-0.2		0.1-0.2	
0.2-0.3	2	0.2-0.3	Bouncing	0.2-0.3		0.2-0.3	
0.3-0.4	4	0.3-0.4		0.3-0.4		0.3-0.4	
0.4-0.5	3	0.4-0.5		0.4-0.5		0.4-0.5	
0.5-0.6	2	0.5-0.6		0.5-0.6		0.5-0.6	
0.6-0.7	1	0.6-0.7		0.6-0.7		0.6-0.7	
0.7-0.8	2	0.7-0.8		0.7-0.8		0.7-0.8	
0.8-0.9	2	0.8-0.9		0.8-0.9		0.8-0.9	
0.9-1.0	2	0.9-1.0		0.9-1.0		0.9-1.0	
1.0-1.1	3	1.0-1.1		1.0-1.1		1.0-1.1	
1.1-1.2	7	1.1-1.2		1.1-1.2		1.1-1.2	
1.2-1.3	20	1.2-1.3		1.2-1.3		1.2-1.3	
1.3-1.4	Bouncing	1.3-1.4		1.3-1.4		1.3-1.4	
1.4-1.5		1.4-1.5		1.4-1.5		1.4-1.5	
1.5-1.6		1.5-1.6		1.5-1.6		1.5-1.6	
1.6-1.7		1.6-1.7		1.6-1.7		1.6-1.7	
1.7-1.8		1.7-1.8		1.7-1.8		1.7-1.8	
1.8-1.9		1.8-1.9		1.8-1.9		1.8-1.9	
1.9-2.0		1.9-2.0		1.9-2.0		1.9-2.0	
2.0-2.1		2.0-2.1		2.0-2.1		2.0-2.1	
2.1-2.2		2.1-2.2		2.1-2.2		2.1-2.2	
2.2-2.3		2.2-2.3		2.2-2.3		2.2-2.3	
2.3-2.4		2.3-2.4		2.3-2.4		2.3-2.4	
2.4-2.5		2.4-2.5		2.4-2.5		2.4-2.5	
2.5-2.6		2.5-2.6		2.5-2.6		2.5-2.6	
2.6-2.7		2.6-2.7		2.6-2.7		2.6-2.7	
2.7-2.8		2.7-2.8		2.7-2.8		2.7-2.8	
2.8-2.9		2.8-2.9		2.8-2.9		2.8-2.9	
2.9-3.0		2.9-3.0		2.9-3.0		2.9-3.0	

Remarks:

Weight:	9kg
Drop:	510mm
Rod Diameter:	16mm

c:\lab\report\R009

Form No. R009/Ver05/06/07

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Approved Signatory ________ Solern Liew Date 10/5/13

APPENDIX C

Laboratory Test Certificate

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

CERTIFICATE OF ANALYSIS 88599

Client:

Geoenviro Consultancy Pty Ltd
PO Box 1543, Macquarie Centre
North Ryde
NSW 2113

Attention: Solern Liew

Sample log in details:

Your Reference:	**JG13757A, Castlereagh**	
No. of samples:	2 Soils	
Date samples received / completed instructions received	08/03/13	/ 08/04/13

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.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	16/04/13	/ 16/04/13
Date of Preliminary Report:	Not Issued	

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

Rhian Morgan
Reporting Supervisor

ACCREDITED FOR TECHNICAL COMPETENCE

Miscellaneous Inorg - soil			
Our Reference:	UNITS	88599-1	88599-2
Your Reference	-------------	BH1	BH4
Depth	------------	0.0-0.1	0.0-0.1
Date Sampled		05/04/2013	05/04/2013
Type of sample		Soil	Soil
Date prepared	-	12/04/2013	12/04/2013
Date analysed	-	12/04/2013	12/04/2013
pH 1:5 soil: water	pH Units	7.2	6.4
Electrical Conductivity 1:5 soil:water	µS/cm	110	67
Chloride, Cl 1:5 soil:water	mg/kg	11	5
Sulphate, SO4 1:5 soil:water	mg/kg	22	2
Phosphorus Sorption (one point)		1.5	2.0

ESP/CEC			
Our Reference:	UNITS	88599-1	88599-2
Your Reference	-------------	BH1	BH4
Depth	------------	0.0-0.1	0.0-0.1
Date Sampled		05/04/2013	05/04/2013
Type of sample		Soil	Soil
Exchangeable Ca	meq/100g	0.2	3.0
Exchangeable K	meq/100g	<0.1	0.2
Exchangeable Mg	meq/100g	<0.1	1.2
Exchangeable Na	meq/100g	<0.1	<0.1
Cation Exchange Capacity	meq/100g	<1.0	4.5
ESP	%	10.7	1.7

MethodID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Ext-020	Analysis subcontracted to Australian Government - National Measurement Institute. NATA Accreditation No: 198
Metals-009	Determination of exchangeable cations and cation exchange capacity in soil based on Rayment and Lyons 2011.

QUALITYCONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			15/4/2013	[NT]	[NT]	LCS-1	12/04/2013
Date analysed	-			15/4/2013	[NT]	[NT]	LCS-1	12/04/2013
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	101%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	107%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	97%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	107%
Phosphorus Sorption (one point)			Ext-020	<1	[NT]	[NT]	LCS-1	98%

QUALITYCONTROL ESP/CEC	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	88599-2	3.0 || 2.4 || RPD: 22	LCS-1	97%
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	88599-2	0.2 || 0.2 || RPD: 0	LCS-1	101%
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	88599-2	1.2 || 0.87 || RPD: 32	LCS-1	95%
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	88599-2	<0.1 || <0.1	LCS-1	109%
Cation Exchange Capacity	meq/100g	1	Metals-009	<1.0	88599-2	4.5 || 3.5 || RPD: 25	[NR]	[NR]
ESP	%	1	Metals-009	<1.0	88599-2	1.7 || 1.7 || RPD: 0	[NR]	[NR]

QUALITYCONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	[NR]	[NR]
Date analysed	-	[NT]	[NT]	[NR]	[NR]
pH 1:5 soil:water	pH Units	[NT]	[NT]	[NR]	[NR]
Electrical Conductivity 1:5 soil: water	µS/cm	[NT]	[NT]	[NR]	[NR]
Chloride, Cl 1:5 soil:water	mg/kg	[NT]	[NT]	[NR]	[NR]
Sulphate, SO4 1:5 soil: water	mg/kg	[NT]	[NT]	[NR]	[NR]
Phosphorus Sorption (one point)		[NT]	[NT]	88599-2	93%

Report Comments:

Phosphate Sorption analysed by NMI. Report No.RN0966487.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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.

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 batched 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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

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

SAMPLE RECEIPT ADVICE

Client:

Geoenviro Consultancy Pty Ltd	ph: 9679 8733
PO Box 1543, Macquarie Centre	Fax: 9679 8744
North Ryde NSW 2113	

Attention: Solern Liew

Sample log in details:

Your reference:	**JG13757A, Castlereagh**
Envirolab Reference:	**88599**
Date received:	08/03/13
Date results expected to be reported:	**16/04/13**

Samples received in appropriate condition for analysis:	YES
No. of samples provided	2 Soils
Turnaround time requested:	Standard
Temperature on receipt	Cool
Cooling Method:	Ice Pack
Sampling Date Provided:	YES

Comments:

Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples.

Contact details:

Please direct any queries to Aileen Hie or Jacinta Hurst
ph: 02 9910 6200 fax: 02 9910 6201
email: ahie@envirolabservices.com.au or jhurst@envirolabservices.com.au

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Laboratory Test Request/Chain of Custody Record

Job Details
Job Number: JG13757A
Client: -
Project: Proposed Subdivision
Location: 39-51 Devlin Road, Castlereagh

Sample Date: 5/04/2013
Sampled By: W.W
Project Manager: SL
Store Location:

External Laboratory Details:
Laboratory name: Envirolab Services Pty Ltd
Address: 12 Ashley Street
Chatswood
Contact: Tania Notaris

Test Required (\) Test Performed(X)

	Sampling Details – Location	Depth (m) From	Depth (m) To	Sample Type Soil	Sample Type Water	Metals (As Cd Cr Cu Pb Zn Ni Hg)	OCP / PCB	Combination 5	Combination 12	Combination 5A	pH	EC	CEC/ESP	Cl / ~~SO4~~	Phosphorus Sorption	Keep Sample
1 -	BH 1	0.00	0.10	DG							\	\	\	\	\	
2 -	BH 4	0.00	0.10	DG							\	\	\	\	\	

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 88599
Date Received: 8/4/13
Time Received: 18:00
Received by: AW
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by

Laboratory	Name	Signature	Date
GeoEnviro Consultancy	William Wijaya	W.W	8/04/2013

Received By

Laboratory	Name	Signature	Date
ELS	A. Weir	[signature]	8/4/13

Legend
DB Disturbed Sample (Bulk, Plastic bag)
DS Disturbed Sample (Small, Plastic bag)
DG Disturbed Sample (Glass Jar)
STP Standard Penetration Test Sample
U50 Undisturbed Sample, 50mm Tube
U75 Undisturbed Sample, 75mm Tube
WG Water Sample, Amber Glass Jar
WP Water Sample, Plastic Bottle
Y Keep Sample
N Discard Sample

APPENDIX D

Graphic Symbols For Soil and Rock
Explanatory Notes

EXPLANATORY NOTES

Introduction

These notes have been provided to amplify the geotechnical report with regard to investigation procedures, classification methods and certain matters relating to the Discussion and Comments sections. Not all notes are necessarily relevant to all reports.

Geotechnical reports are based on information gained from finite sub-surface probing, excavation, boring, sampling or other means of investigation, supplemented by experience and knowledge of local geology. For this reason they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods
The methods the description and classification of soils and rocks used in this report are based on Australian standard 1726, the SSA Site investigation Code, in general descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions. Identification and classification of soil and rock involves to a large extent, judgement within the acceptable level commonly adopted by current geotechnical practices.

Soil types are described according to the predominating particle size, qualified by the grading or other particles present (eg sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	Less than 0.002mm
Silt	0.002 to 0.6mm
Sand	0.6 to 2.00mm
Gravel	2.00m to 60.00mm

Soil Classification	Particle size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2.00mm
Gravel	2.00mm to 60.00mm

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

Classification	Undrained Shear Strength kPa
Very Soft	Less than 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very Stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer test (CPT), as below:

Relative Dense	SPT 'N' Value (blows/300mm)	CPT Cone Value (q_c-Mpa)
Very Loose	Less than 5	Less than 2
Loose	5 - 10	2 - 5
Medium Dense	10 - 30	5 - 15
Dense	30 - 50	15 - 25
Very Dense	> 50	> 25

Rock types are classified by their geological names, together with descriptive terms on degrees of weathering strength, defects and other minor components. Where relevant, further information regarding rock classification, is given on the following sheet.

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

Disturbed samples taken during drilling provided information on plasticity, grained size, colour, type, moisture content, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin walled sample tube (normally know as U_{50}) into the soil and withdrawing a sample of the soil in a relatively undisturbed state. 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.

Field Investigation Methods
The following is a brief summary of investigation methods currently carried out by this company and comments on their use and application.

Hand Auger Drilling
The borehole is advanced by manually operated equipment. The diameter of the borehole ranges from 50mm to 100mm. Penetration depth of hand augered boreholes may be limited by premature refusal on a variety of materials, such as hard clay, gravels or ironstone.

Test Pits
These are excavated with a tractor-mounted backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3.0m for a backhoe and up to 6.0m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Care must be taken if construction is to be carried out near, or within the test pit locations, to either adequately recompact the backfill during construction, or to design the structure or accommodate the poorly compacted backfill.

Large Diameter Auger (eg Pengo)
The hole is advanced by a rotating plate or short spiral auger generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed, but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers and is usually supplemented by occasional undisturbed tube sampling.

Continuous Spiral Flight Augers
The hole is advanced by using 90mm - 115mm diameter continuous spiral flight augers, which are 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 are returned to the surface, or may be collected after withdrawal of the augers flights, but they are very disturbed and may be highly mixed with soil of other stratum.

Information from the drilling (as distinct from specific sampling by SPT or undisturbed samples) is of relatively low reliability due to remoulding, mixing or softening of samples by ground water, resulting in uncertainties of the original sample depth.

Continuous Spiral Flight Augers (continued)
The spiral augers are usually advanced by using a V - bit through the soil profile refusal, followed by Tungsten Carbide (TC) bit, to penetrate into bedrock. The quality and continuity of the bedrock may be assessed by examination of the recovered rock fragments and through observation of the drilling penetration resistance.

Non - core Rotary Drilling (Wash Boring)
The hole is advanced by a rotary bit, with water being pumped down the drill rod and returned up the annulus, carrying the cuttings, together with some information from the "feel" and rate of penetration.

Rotary Mud Stabilised Drilling
This is similar to rotary drilling, but uses drilling mud as a circulating fluid, which may consist of a range of products, from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg SPT and U_{50} samples).

Continuous Core Drilling
A continuous core sample is obtained using a diamond tipped core barrel. Providing full core recovery is achieved (which is not always possible in very weak rock and granular soils) this technique provides a very reliable (but relatively expensive) method of investigation. In rocks an NMLC triple tube core barrel which gives a core of about 50mm diameter, is usually used with water flush.

Portable Proline Drilling
This is manually operated equipment and is only used in sites which require bedrock core sampling and there is restricted site access to truck mounted drill rigs. The boreholes are usually advanced initially using a tricone roller bit and water circulation to penetrate the upper soil profile. In some instances a hand auger may be used to penetrate the soil profile. Subsequent drilling into bedrock involves the use of NMLC triple tube equipment, using water as a lubricant.

Standard Penetration Tests
Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils, as a means of determining density or strength and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289 "Methods of testing Soils for Engineering Purpose"- Test F31.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63Kg hammer with a free fall of 769mm. It is normal for the tube to be driven in three successive 150mm increments and the "N" value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rocks, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In a case where full penetration is obtained with successive blows counts for each 150mm of, say 4, 6, and 7 blows.

as 4, 6, 7
N = 13

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm.

as 15,30/40mm

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally the test methods is used to obtain samples in 50mm diameter thin walled samples tubes in clays. In these circumstances, the best results are shown on the bore logs in brackets.

Dynamic Cone Penetration Test
A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The cone can be continuously driven into the borehole and is normally used in areas with thick layers of soft clays or loose sand. The results of this test are shown as 'N_c' on the bore logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing and Interpretation
Cone penetrometer testing (sometimes referred to as Dutch Cone-CPT) described in this report, has been carried out using an electrical friction cone penetrometer and the test is described in Australian Standard 1289 test F5.1.

In the test, a 35mm diameter rod with cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig, which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130mm long sleeve, immediately behind the cone. Transducer in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart recorders. The plotted results in this report have been traced from the original records. The information provided on the charts comprises:

- Cone resistance - the actual end bearing force divided by the cross sectional area of the cone, expressed in Mpa.
- Sleeve friction - the frictional force on the sleeve divided by the surface area, expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percentage.

There are two scales available for measurement of cone resistance. The lower "A" scale (0-5Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main "B" scale (0-50Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative frictions in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and very soft clays, rising to 4% to 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (Mpa)} = (0.4 \text{ to } 0.6) \text{ N (blows per 300mm)}$$

In clays the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to} 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimate of modulus or compressibility values to allow calculation of foundation settlements. Inferred stratification, as shown on the attached report, is assessed from the cone and friction traces, from experience and information from nearby boreholes etc.

Cone Penetrometer Testing and Interpretation continued

This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties and where precise information or soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometer (AS1289)

Portable dynamic cone penetrometer tests are carried out by driving a rod in to the ground with a falling weight hammer and measuring the blows per successive 100mm increments of penetration.

There are two similar tests, Cone Penetrometer (commonly known as Scala Penetrometer) and the Perth Sand Penetrometer. Scala Penetrometer is commonly adopted by this company and consists of a 16mm rod with a 20mm diameter cone end, driven with a 9kg hammer, dropping 510mm (AS 1289 Test F3.2).

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedures are given on the individual report forms.

Engineering Logs

The engineering logs presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, however, this is not always practicable or possible to justify economically. As it is, the boreholes represent only a small sample of the total sub-surface profile. Interpretation of the information and its application to design and construction should take into account the spacing of boreholes, frequency of sampling and the possibility of other than "straight line" variations between the boreholes.

Ground water

Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all, during the investigation period.
- A localised perched water table may lead to a erroneous indication of the true water table.
- Water table levels will vary from time to time, due to the seasons or recent weather changes. They may not be the same at the time of construction as indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole if any water observations are to be made.

More reliable measurements can be made by installing stand pipes, which are read at intervals over several days, or weeks for low permeability soils. Piezometers sealed in a particular stratum may be interference from a perched water table or surface water.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal is changed, say to a twenty storey building. If this occurs, the company will be pleased to review the report and sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussions of geotechnical aspects and recommendations or suggestions for design and construction. However, the company 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.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

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, the company request immediate notification. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information trader Documents", published by the Institute of Engineers Australia. Where information obtained for this investigation is provided for tender purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or make additional copies of the report available for contract purpose, at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspect of work to which this report is related. This could range from a site visit to confirm that the conditions exposed are as expected, to full time engineering presence on site

Review of Design

Where major civil or structural developments are proposed, or where only a limited investigation has been completed, or where the geotechnical conditions are complex, it is prudent to have the design reviewed by a Senior Geotechnical Engineer.

GeoEnviro Consultancy Pty Ltd

Graphic Symbols For Soil and Rock

SOIL	ROCK
Fill	Shale
Topsoil	Sandstone
Gravel (GW , GP)	Siltstone,Mudstone,Claystone
Sand (SP, SW)	Granite, Gabbro
Silt (ML, MH)	Dolerite, Diorite
Clay (CL, CH)	Basalt, Andesite
Clayey Gravel (GC)	
	Other Materials
Silty Sand (SM)	Concrete
Clayey Sand (SC)	Bitumen, Asphaltic Concrete, Coal
Sandy Silt (ML)	Ironstone Gravel
Gravelly Clay (CL, CH)	Organic Material
Silty Clay (CL, CH)	
Sandy Clay (CL, CH)	
Peat or Organic Soil	