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Report

Lot Classification
Proposed Residential Subdivision Development
Part Lot 1 DP 1144668, Nos 86 to 94 Andromeda Drive, Cranebrook NSW

Prepared for
Trustee of the Roman Catholic Diocese of Parramatta
C/-RPS Australia (Asia Pacific) Pty Ltd
Suite 2, 55 East Parade
SUTHERLAND NSW 2232

Ref: JT14758A-r4
May 2015

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11th May 2015

Our Ref: JT14758A-r4

Trustee of the Roman Catholic Diocese of Parramatta
C/- RPS Australia (Asia Pacific) Pty Ltd
Suite 2, 55 East Parade
SUTHERLAND NSW 2232

Attention: Ms Katrina Griffin

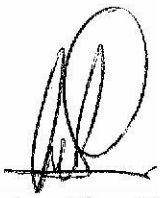
Dear Madam

Re: Lot Classification Report
Proposed Residential Subdivision Development
Part Lot 1 in DP 1144668, Nos 86 to 94 Andromeda Drive, Cranebrook

We are pleased to submit our lot classification report for the proposed residential subdivision development at the above address.

Should you have any queries, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd



Solern Liew CPEng (NPER)
Director

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1. INTRODUCTION

This report presents the results of a lot classification contamination assessment and geotechnical investigation for the rear eastern half portion of the site referred as Lot 1 in DP 2255668, Nos 86 to 94 Andromeda Drive in Cranebrook (referred hereafter as Subject Site) as shown on Drawing No 1. The investigation was commissioned by Ms Katrina Griffin of RPS Australia (Asia Pacific) Pty Ltd, acting on behalf of The Trustee of the Roman Catholic Diocese of Parramatta.

We understand that the proposed development will include subdivision of the Subject Site into 21 residential allotments (Proposed lots 1 to 21) and construction of a residential access road. We also understand that there is a deep sewer main which runs across the rear of proposed Lots 9 to 19 about 10m from the rear boundary and there will be a Restriction on Use of Land under Section 88B instrument of the Conveyancing Act 1919.

GeoEnviro Consultancy have undertaken the following studies on the site and reference should be made to the following reports for details;

- Phase 1 Contamination Assessment and Geotechnical Investigation – Part Lot 1 DP 11446688, No 86-94 Andromeda Drive Cranebrook NSW" GeoEnviro Consultancy Pty Ltd ref JT14758A-r1 dated August 2014 (Reference 3)
- Additional Geotechnical Investigation Report – Sewer Main - Part Lot 1 DP 11446688, No 86-94 Andromeda Drive Cranebrook NSW" GeoEnviro Consultancy Pty Ltd ref JT14758A-r2 dated 25th October 2014 (Referenced 4)

The purpose of this investigation was to provide Lot Classification for proposed Lots 501 to 519, in accordance to AS2870-2011 "Residential Slabs and Footings".

2. BACKGROUND INFORMATION

2.1 Site Locality

Property Nos 86 to 94 is situated on the eastern side of Andromedia Drive Cranebrook and this property occupies Lot 1 in DP 1144668 with approximate dimensions of about 100m wide along the road frontage by 435m. The Northern Road forms the rear property boundary.

The property is occupied by the Corpus Christi Primary School which is managed by the Catholic Church with school and church buildings occupying the western front portion of the site.

The proposed development site (referred here after as the Subject Site) occupies the rear vacant portion of Lot 1. The Subject Site is roughly rectangular in shape with an approximate 115m frontage to The Northern Road by about 200m. Total site area is approximately 2.2ha. Refer to Drawing 1 for site locality.

2.2 Site Topography and Geological Setting

The site is situated on gently undulating terrain with the ground surface within the Subject Site slightly dipping to the west at angles less than 3 degrees. Based on the contour lines on the survey drawing provided the eastern boundary of the site is at approximate Reduced Level (RL) 59.6m Australian Height Datum (AHD) and the western boundary is at about RL 54.2m AHD.

The site is situated on low lying terrain. Based on the 1:100,000 soil landscape map of Penrith; the site is situated at the boundary between fluvial soil of the Richmond Soil Landscape Group and erosional soil of the Luddenham Soil Landscape Group.

The 1:100,000 geological map of Penrith, the site is underlain by gravel, Sand Silt and Clay of the Cranebrook Formation. Some shale outcrops belonging to the Bringelly Shale group may occur on the eastern portion of the site.

2.3 Site Conditions and Section 88B instrument

The site was the subject of geotechnical and environmental studies undertaken by GeoEnviro Consultancy Pty Ltd in 2014 (Reference 3 and 4).

At the time of the site inspection, the site consisted of vacant land with some trees along the northern boundary and in the south eastern corner of the site. There were some school buildings which once occupied the western portion of the Subject Site

We understand that there is a deep sewer main which runs across the rear of proposed Lots 9 to 19 about 10m from the rear boundary with invert level of sewer at about 5m below existing ground surface in proposed Lot 19 and increasing in depth to about 10m below existing ground surface in proposed Lot 9.

We also understand that there will be a Restriction on Use of Land under Section 88B instrument of the Conveyancing Act 1919. This restriction on use of land identified as Area 'H' on Drawing No 2 is detailed under Item 4 of the Section 88B instrument as follows;

> ***4. Restriction on the Use of Land (H) (Sydney Water Sewer Zone of Influence Building***
>
> ***Requirements Apply) numbered 4 in the abovementioned plan***
>
> - *No excavation or building operations shall commence or be undertaken within the restriction site unless plans documenting the proposed excavation or building work have been approved by Penrith City Council, or a Principal Certifying Authority, and approved by Sydney Water Corporation in accordance with Guidelines for Building Over /Adjacent to Sydney Water Water and Wastewater Assets", or Sydney Water's equivalent document applying at the date of application for such excavation or building.*
> - *The registered proprietor of the burdened lot must not erect or allow to be erected, a building or any part thereof within the restriction site, unless the footings of the building are designed by a suitably qualified civil or structural engineer.*

2.4 Recent Development

Subdivision development was carried out on the Subject Site and involved some minor site regrading on the western portion of the site involving;

- Stripping of topsoil
- Excavation of all uncontrolled fill where encountered to expose the natural clay.
- Proof rolling of the exposed ground surface to delineate any soft or heaving areas
- Excavation and removal of all soft and heaving areas and replacement with good quality fill.
- Placement and compaction of suitably compactable fill

GeoEnviro Consultancy carried out a testing program during the filling operations (in accordance with AS 3798-1996). A minimum of 95% Standard Maximum Dry Density (SMDD) was achieved in the density tests and where the tests did not achieve the minimum density ratio, the fill was reworked and recompacted to ensure the minimum density ratio is achieved. The density test results for the proposed subdivision were compiled in our Site Fill Testing report (Reference 5).

Based on our density test results, the compacted fill on the western portion of the site may be classified as "Controlled" fill in accordance with the definition outlined in AS 3798-2007 "Guidelines on earthworks for commercial and residential developments".

The remaining eastern portion of the site was predominantly undisturbed.

3. LOT CLASSIFICAITON INVESTIGATION

3.1 Fieldwork

The site investigation was carried out on the 28TH April 2015 by an engineer of this company and involved the excavation of 10 test pits (TP 1 to 10) using a rubber tyred backhoe.

The test pits were excavated through topsoil and fill into natural soil in one test pit into shale to depths varying from 1.65m to 1.85m below existing ground surface. To assess the strength of the clayey soil, hand penetrometer tests were carried out on the test pit walls.

To minimise site disturbance, the test pits were excavated at the front and rear of the proposed lots within the proposed building platform as shown on Drawing No 2. The test pit locations were approximated by offset measurements from boundary lines and survey pegs. The test pits were noted for ground water during and upon completion of the site investigation.

The test pits were observed for groundwater during and upon completion of the excavation. The field results together with details of the strata encountered are presented in Appendix A.

3.2 Laboratory Analysis

Two "Undisturbed" U_{50} soil samples and disturbed samples were taken from the site to our NATA accredited laboratory for the Shrink-Swell Index to assess the soil reactivity of the insitu soil to moisture variation and other soil properties.

The laboratory test results are attached in Appendix B of this report.

4. RESULTS OF THE INVESTIGATION

4.1 Subsurface Conditions

Reference should be made to the attached Table A in Appendix A for a summary of subsurface profiles encountered from the test pit investigation. The following is a summary of the subsurface profiles encountered in the test pits;

Topsoil and Topsoil/Fill

Topsoil was encountered on the ground surface in all test pits except TP 3 and 13 comprising predominantly of low liquid limit Gravelly Sandy Silt and Clayey Silt. The thickness of the topsoil and topsoil/fill were found to range from 150mm to 500mm.

Fill

Fill was not encountered in this investigation, however based on our previous investigation, some fill was encountered along the southern portion of the site and this fill is understood to be part of the backfill material for the sewer main.

The fill encountered in our previous boreholes (Reference 4) along the sewer main were found to depths ranging from 2.2m to 4.7m below existing ground surface and this fill consist predominantly of Silty Clay of medium plasticity with some Gravelly Silty Clay.

Some localised fill up to 0.9m thick comprising of Silty Clay, Gravelly Silty Clay, road base and sandstone gravel was also encountered in a few locations away from the sewer main trench (Reference 3).

Natural Soil

Natural soil was encountered in all test pits immediately underlying the topsoil and fill at depths ranging from 0.15m to 0.5m below existing ground surface.

The natural soil generally comprises of generally of medium to high plasticity Silty Clay with bands of gravels at lower depth in some test pits.

Based on the hand penetrometer test results, the natural soil was generally found to very stiff to hard.

Bedrock

With the exception of TP 4, bedrock was not encountered in all test pits which were taken to a maximum depth of 1.85m below existing ground surface. In TP 4, shale was encountered at about 1.3m below existing ground surface.

Groundwater

All test pits were found to be dry during and shortly after completion of the investigation. Some perched groundwater is likely to exist in the vicinity of the dams.

4.2 Laboratory Test Results

For details of the geotechnical laboratory test results, refer to Appendix D for the Laboratory Test certificates. The following is a summary of laboratory test results;

The results of Shrink-Swell Index are summarised in the table below;

Sample	Swell (%)	Shrinkage (%)	Shrink/Swell Index (%/pF)
TP 1 (0.5-0.7m)	0.2	2.4	1.4
TP 7 (0.7-0.9m)	3.7	4.8	3.7

The Shrink/Swell Index results indicate the natural soil to have a moderately to highly reactive to moisture variation.

5. SITE CLASSIFICATION

5.1 Principles of Site Classification

Most natural clay soils have sufficient bearing capacities to support typical residential loads. Most distress to residential structures occurs due to reactive soil movements rather than settlement movements.

AS2870 establishes a classification system whereby reactive sites are classified based on the reactive soil movements anticipated. Other foundation conditions such as the presence of fill material, may affect the site classification. Appendix D of this report provides a comprehensive explanation of site classification.

The purpose of the classification is to allow the design of an economical footing system which will limit cracking of footings, floor slabs and masonry walls to an extent normally considered acceptable. The performance expectations associated with the design guidelines are presented in Appendix A of AS 2870. It is fundamental when applying the following site classifications to residential footing design that these performance expectations are acceptable to the house owners

5.2 Site Classification

The site was found to be generally underlain by topsoil/fill over natural clayey soil in excess of 2.2m and shale is expected to be present at lower depths. The fill encountered on the wester portion of the site was density tested by GeoEnviro Consultancy Pty Ltd and therefore may be classified as "Controlled" fill under the definition of AS 3798-2007. The laboratory test indicates the insitu clayey soil to have a moderate to high reactivity.

Based on the foregoing information, we are of the opinion that Proposed Lots 1 to 21 may be classified as Class H1 (Highly Reactive) in accordance to AS2870-2011 "Residential Slabs and Footings". The above lot classification should take into consideration the following;

- Proposed Lots 9 to 19 are impacted by Restriction on Use of Land under Section 88B instrument of the Conveyancing Act 1919 and for details on footing design and recommendations, refer to Section 5.5 of this report.

- Some deepening of the footings through thick topsoil or localised insitu fill may be required and this may involve thickening of edge beams, short piers or mass concrete footings.

The foregoing recommendations have been made on the following assumptions;

1. The Lot Classification is applicable to the respective lots at the time of the subsurface investigation. The lot classification may be subject to change to take into account the effects of future site work in accordance to Clause 2.5.2 of AS2870-2011
2. The construction requirements of Section 6 of AS2870-2011 must be followed.
3. The recommendations for site maintenance as outlined in Appendix B of AS2870-2011 are adhered to.
4. The performance expectation set out in Table 2.2 and Appendix C of AS2870-2011 is acceptable.
5. The Lot Classification may be downgraded to Class 'H2' or 'P' in future if the respective lots are subject to abnormal moisture condition as outlined in Clause 1.3.3 of AS2870-2011

5.3 Design and Construction of Footings

Selection and design of suitable footing systems should be undertaken in accordance with AS2870. All footings must penetrate the topsoil and fill layer and be founded on natural soil profile of uniform bearing capacity.

Particular attention is directed to those clauses regarding site preparation for floor slabs. Where raft slab construction is proposed, all topsoil and any local fill should be removed from building areas prior to site works. Additional footing stiffening or other measures may be required if footing locations coincide with backfilled test pit locations.

Care should also be taken to ensure that even bearing is achieved particularly in the event where bedrock is present at shallow depths. If bedrock is encountered during footing excavation, the remaining building footings should be taken to same profile to reduce the potential effects of differential settlement.

5.4 Site Maintenance

The above classifications have been based on moisture variation caused by climatic and normal garden conditions. More severe moisture variations can be caused by other common factors, such as removing or planting of large trees. Guidelines to appropriate site maintenance are provided in Appendix D of this report. Future owners should make themselves aware of these maintenance procedures, since most damage to residential structures on reactive sites is due to poor site maintenance. Footings designed to AS2870 may not perform satisfactorily if sites are not properly maintained.

5.5 Restriction on Use of Land under Section 88B instrument

The southern portion of Proposed Lots 9 to 19 identified as Area 'H' in Drawing No 2 will be impacted by the Restriction on Use of Land under Section 88B instrument of the Conveyancing Act 1919.

As recommended in our previous report (Reference 4), all building works within the Area 'H' would need to consider special footing and construction requirements to avoid damage to the existing sewer main and this may include;

- Concrete encasement of the sewer main or construction of protection slab.
- Deepening of proposed house footings to below the zone of influence of the sewer main.
- Constructing building footings on bedrock.
- Avoid surcharging of construction equipment on the main.
- Limiting vibration from construction works

In order to ensure adequate bearing material for the proposed residential dwellings and reduce risk of damage to the existing sewer main from loads imposed by the proposed residential dwellings, we recommend the footings of the proposed residential dwelling on Proposed Lots 9 to 19 to be piered to at least 0.5m below the zone of influence of the sewer main.

The zone of influence of the sewer main may be taken as the 1 Vertical to 1 Horizontal line transecting the invert level of the sewer main. For bored piers taken a minimum depth of 0.5m into natural clay with a minimum depth of embedment of 5m, a safe bearing capacity of 450 kPa may be adopted. Refer to the attached Drawing No 2 for indicative cross section of footing arrangements.

6. LIMITATIONS

The interpretation and recommendations submitted in this report are based on data obtained from test pits excavated at discrete locations. There is no investigation which is through enough to determine all site conditions and anomalies, no matter how comprehensive the investigation program is as site data is derived from extrapolation of limited test locations. The natural and extent of variations between test locations may not become evident until construction.

In view of the above, the subsurface soil and rock conditions between the test locations may be found to be different or interpreted to be different from those expected. can also occur with varying groundwater conditions caused by climatic conditions. Site fill may also be encountered in between test pits locations. If such differences appear to exist, we recommend that this office be contacted without delay.

The statements presented in this document are intended to advise you of what should be your realistic expectations of this report and to present you with recommendations on how to minimise the risk associated with groundworks for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes into doing. GeoEnviro do not undertake to guarantee the work of the contractors nor relieve their responsibility to produce a complete product conforming to the requirements of the specification. Your attention is drawn to the attached "Explanatory Notes" in Appendix E. This document should be read in conjunction with our report.

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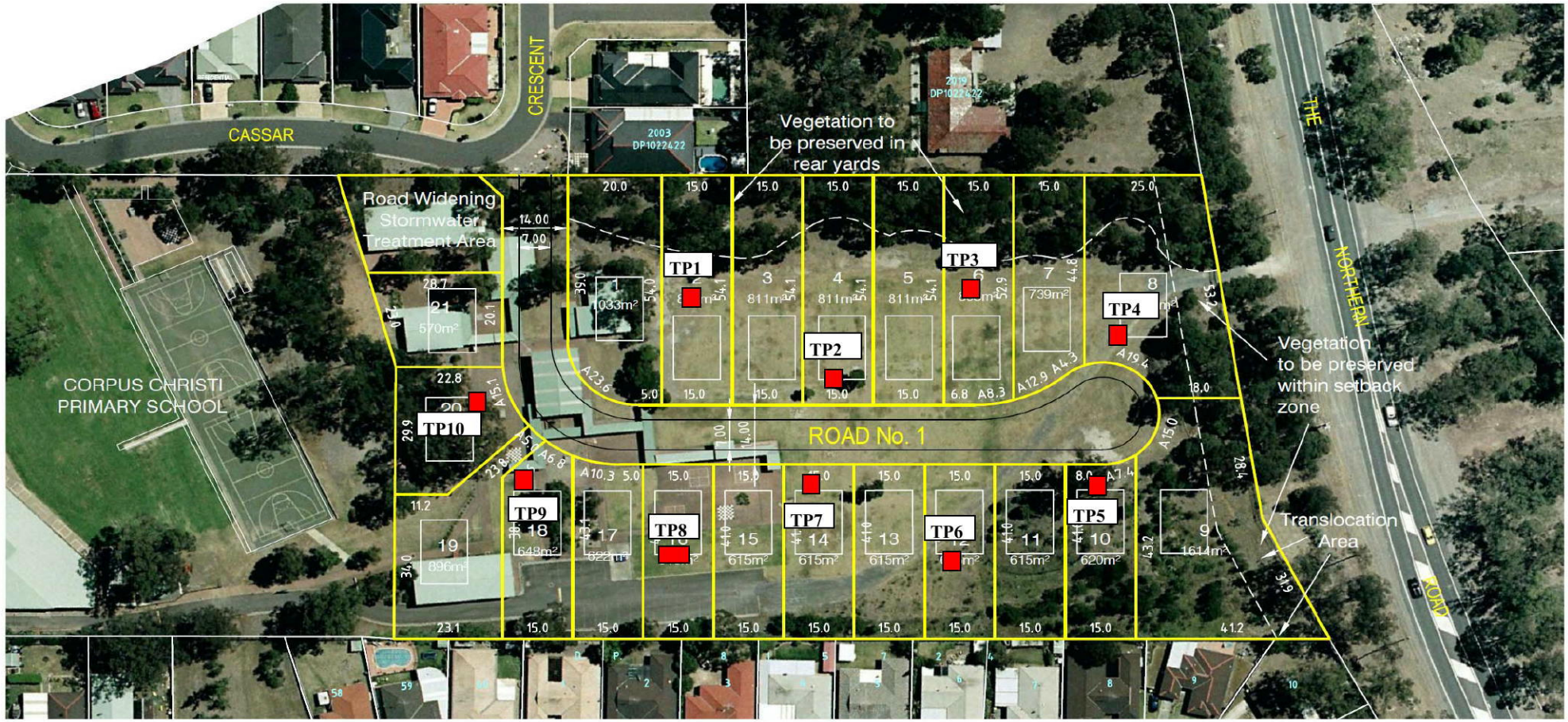
REFERENCES

1. *1:100,000 Geological Map of Penrith– Geological Series Sheet 9029-9129 (Edition 1) 1985*
2. *1:100,000 Soil Landscape Map of Penrith– Soil Conservation Service of NSW ; Sheet 9029-9129*
3. *Phase 1 Contamination Assessment and Geotechnical Investigation – Part Lot 1 DP 11446688, No 86-94 Andromeda Drive Cranebrook NSW" GeoEnviro Consultancy Pty Ltd ref JT14758A-r1 dated August 2014*
4. *Additional Geotechnical Investigation Report – Sewer Main - Part Lot 1 DP 11446688, No 86-94 Andromeda Drive Cranebrook NSW" GeoEnviro Consultancy Pty Ltd ref JT14758A-r2 dated 25th October 2014*
5. *Site Fill Report - Lot 1 DP 11446688, Andromeda Drive Cranebrook NSW" GeoEnviro Consultancy Pty Ltd ref JT14758B-r1 dated 11th March 2015*



Legend

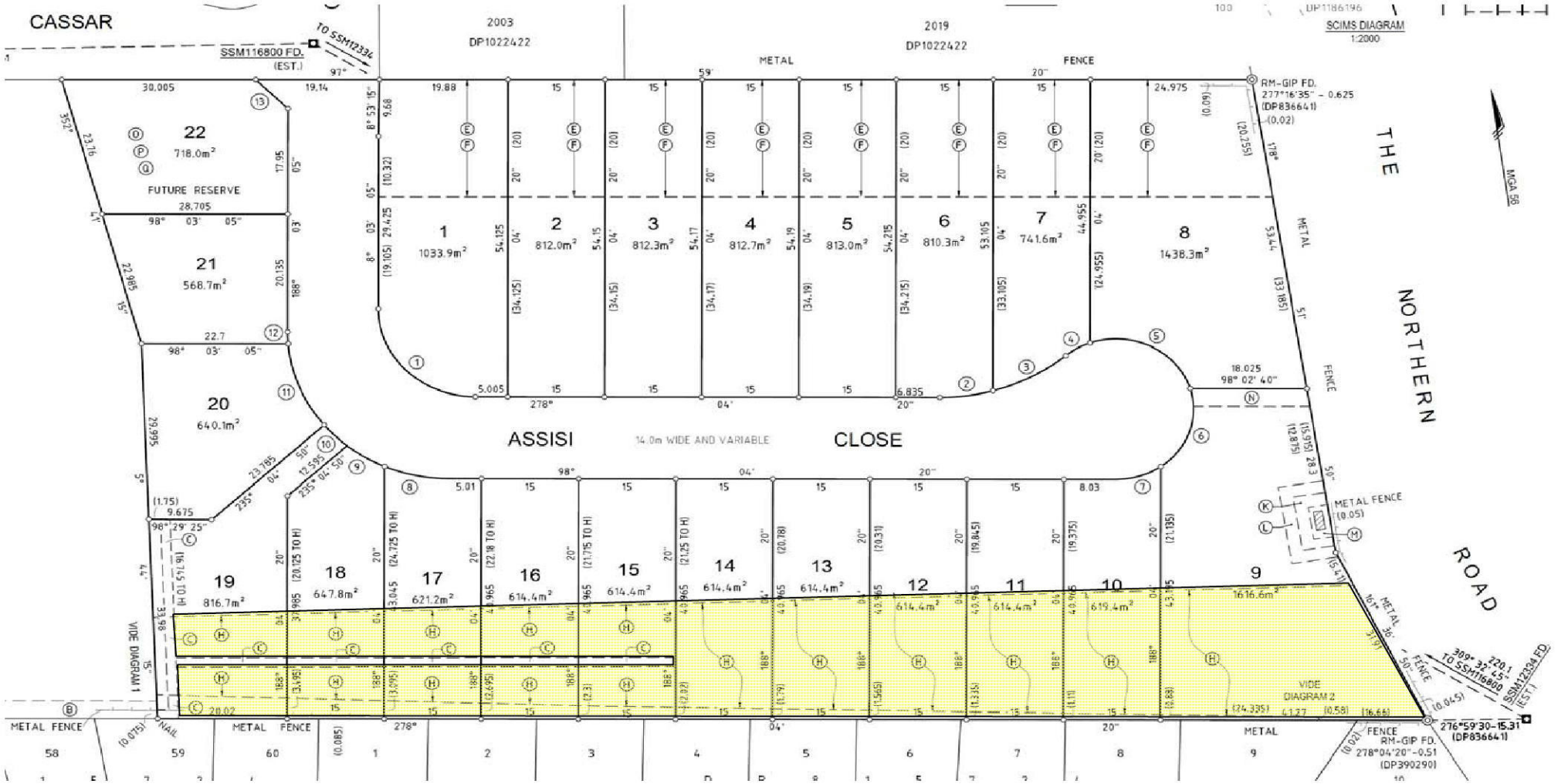
Test Pit

GeoEnviro Consultancy

Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia

Tel: (02) 96798733 Fax: (02) 96798744

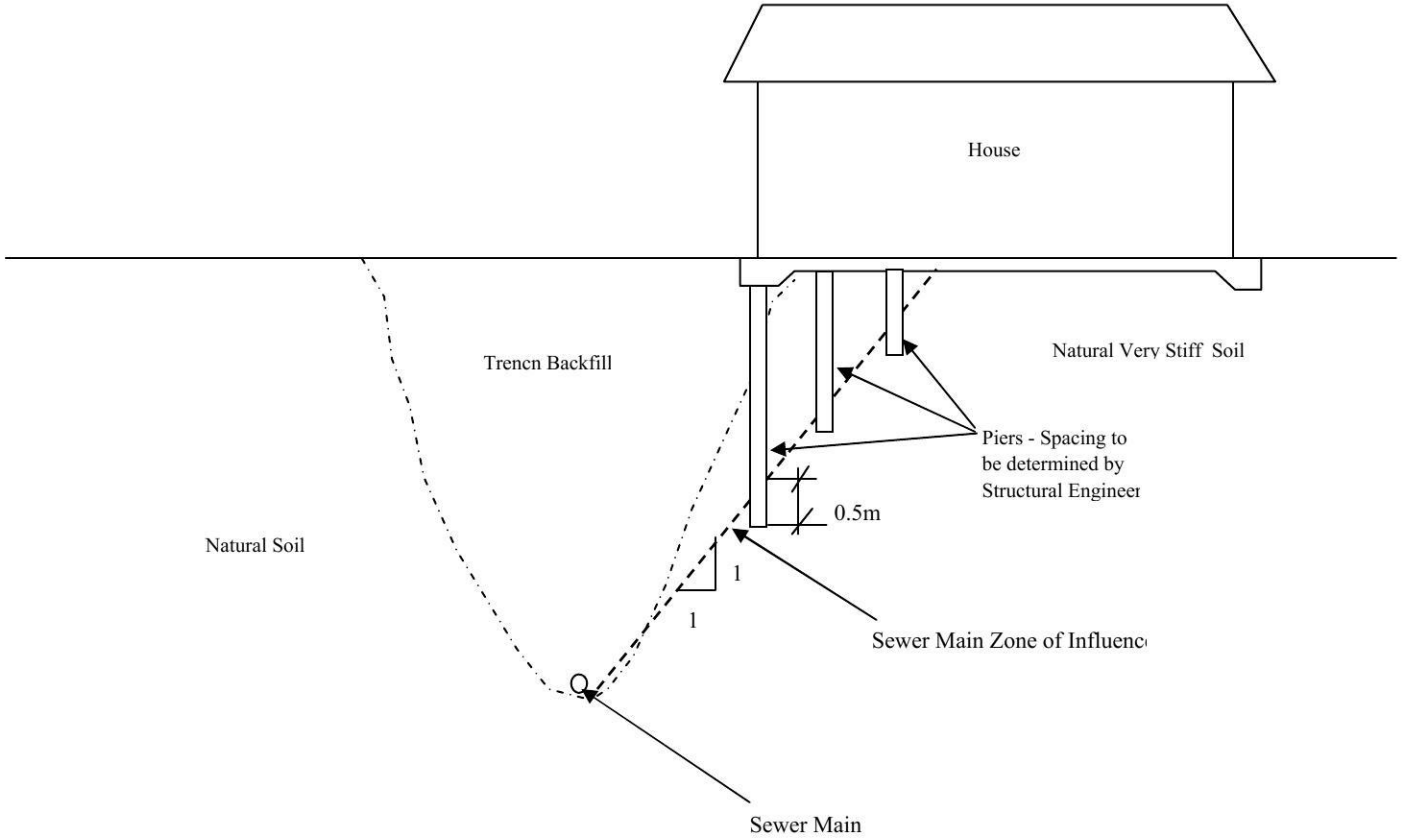
Drawn By: WW	Date: 28/04/15	RPS Australia (Asia Pacific) Pty Ltd	
Checked By: SL	Date: 28/05/15	Lot 1 DP 1144668 No 86-94 Andromeda Drive Cranebrook	
Revision By:	Date:	Test Pit Location Plan	
Scale: N.T.S.	A3	Project No: JT14758A	Drawing No: 1



Legend

H — Restriction on Use of Land under Section 88B instrument of the Conveyancing Act 1919.

GeoEnviro Consultancy Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 96798733 Fax: (02) 96798744	Drawn By: WW	Date: 28/04/15	RPS Australia (Asia Pacific) Pty Ltd Lot 1 DP 1144668 No 86-94 Andromeda Drive Cranebrook Restriction on Use of Land under Section 88B instrument Plan
	Checked By: SL	Date: 28/05/15	
	Revision By:	Date:	
	Scale: N.T.S.	A3	Project No: JT14758A / Drawing No: 2



NOTE: **The above footing arrangments apply to lots impacted by Section 88B instrument of the Conveyancing Act 1919 on Restriction of the Use of Land (H) (Sydney Water Zone of Influence Building Requirments Apply) as shown on Drawing no 2.**

GeoEnviro Consultancy
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Drawn By: WW	Date: 15/8/14	RPS Australia (Asia Pacific) Pty Ltd	
Checked By: SL	Date: 15/8/14	Lot 1 DP 1144668 No 86-94 Andromeda Drive Cranebrook	
Revision By:	Date:	Typical Cross Section of Pier and Sewer Zone of Influence	
Scale: N.T.S.	A3	Project No: JT14758A	Drawing No: 3

APPENDIX A

Table A: Summary of Test Pit Profile

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

Table A : Summary of Test Pit Profile

CLIENT: RPS — Job Number: JT14758A

PROJECT: Proposed New Residential Subdivision — Logged By: FA

LOCATION: Andromeda Dr, Cranebrook — Date: 28/04/2015

Test Pit Number	Lot Number	Depth (m) From	Depth (m) To	Material Description
7	14	0.0	0.02	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.02	0.25	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL
	U_{50} (0.7-0.9m)	0.25	1.00	(CH): Silty Clay: high plasticity, brown, moist, very stiff, PP = 400 KPa
		0.80	1.20	As above: but very stiff soil, PP = 550 KPa
		1.20	1.80	As above: but very stiff soil, PP = 650 KPa
8	16	0.0	0.05	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.05	0.40	Topsoil/Fill : Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL
		0.40	0.50	Topsoil Sandy Silt: black - dark grey, fine sand grained, moist
		0.50	0.80	(CI - CH): Silty Clay: medium to high plasticity, brown stained with orange, moist
		0.80	1.20	As above: but light brown
		1.20	1.75	As above: but grey-brown stained with orange, very stiff, PP = 450 - 480 KPa
9	18	0.0	0.02	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.02	0.20	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC < PL
		0.20	0.80	(CI - CH): Silty Clay: medium to high plasticity, dark brown stained with orange, moist, roots
		0.80	1.40	As above: but very stiff soil, PP = 340 KPa
		1.40	1.80	As above: but very stiff, PP = 500 KPa
10	20	0.0	0.02	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.02	0.20	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL, roots
		0.20	0.50	(CI - CH): Silty Clay: medium to high plasticity, brown, moist,
		0.50	1.40	(CH): Silty Clay: high plasticity, brown stained with orange, moist, fairly stiff, PP = 400 Kpa
		1.40	1.85	(CH): Silty Clay: high plasticity, grey-brown stained with orange, dry - moist, very stiff PP = 490 - 520 Kpa

Notes:
MC = Moisture Content.
PL = Plastic Limit.
PP = Pocket Penetrometer.

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
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Table A : Summary of Test Pit Profile

CLIENT: RPS — Job Number: JT14758A

PROJECT: Proposed New Residential Subdivision — Logged By: FA

LOCATION: Andromeda Dr, Cranebrook — Date: 28/04/2015

Test Pit Number	Lot Number	Depth (m) From	Depth (m) To	Material Description
1	2	0.0	0.02	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.02	0.20	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC < PL
	U_{50} (0.5-0.7m)	0.20	0.80	(Cl - CH): Silty Clay: medium to high plasticity, brown stained with orange, moist,
		0.80	1.20	As above: but fairly stiff soil
		1.20	1.60	(CH): Silty Clay: high plasticity, grey-brown stained with orange, moist, very stiff
		1.60	1.85	As above: but very stiff, PP = 600 KPa
2	4	0.0	0.03	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.03	0.25	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL
		0.25	0.50	(Cl - CH): Silty Clay: medium to high plasticity, brown stained with orange, moist, roots
		0.50	1.00	(Cl - CH): Silty Clay: medium to high plasticity, brown stained with grey and orange, moist
		1.00	1.30	As above: but very stiffl, PP = 350 KPa
		1.30	1.75	As above: but grey-brown stained with orange, very stiff, PP = 520 - 610 KPa
3	6	0.0	0.05	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.05	0.20	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL
		0.20	0.60	(Cl - CH): Silty Clay: medium to high plasticity, brown stained with orange, moist,
		0.60	1.10	(CH): Silty Clay: high plasticity, grey-brown stained with orange, moist, very stiff
		1.10	1.70	As above: but very stiffl, PP = 650 KPa
4	8	0.0	0.02	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.02	0.25	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL
		0.25	0.60	(Cl - CH): Silty Clay: medium to high plasticity, brown stained with orange, moist,
		0.60	0.95	(CH): Silty Clay: high plasticity, light brown stained with orange, moist, very stiff, PP = 400 Kpa
		0.95	1.30	As above: but grey-brown stained with orange, very stiff, PP = 600 KPa
		1.30	1.65	Shale: low to moderate strength, brown, moist
5	10	0.0	0.15	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC = PL, roots
		0.15	0.60	(Cl): Silty Clay: medium plasticity, brown stained with orange, moist
		0.60	1.10	(CH): Silty Clay: high plasticity, grey-brown stained with orange, moist, fairly stiff
		1.10	1.70	As above: but grey stained with orange, very stiff soil, PP = 650 KPa
6	12	0.0	0.02	Topsoil/Fill: Gravelly Sandy Silt: low liquid limit, grey, dry
		0.02	0.40	Topsoil: Clayey Silt / Silty Clay: low liquid limit, dark brown, MC > PL
		0.40	1.10	(CH): Silty Clay: high plasticity, grey-brown stained with orange, moist, very stiff
		1.10	1.80	As above: but grey stained with orange, very stiff, PP = 600 KPa

Notes:
MC = Moisture Content.
PL = Plastic Limit.
PP = Pocket Penetrometer.

APPENDIX B

Laboratory Test Results

GeoEnviro Consultancy Pty Ltd
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Tel: (02) 96798733 Fax: (02) 96798744

Test Results - Shrink/Swell Index

Client / Address: RPS Australia (Asia Pacific) Pty Ltd / BAULKHAM HILLS — Job No: JT14758A-r4

Project: Proposed Residential Subdivision Development — Date: 5/5/15

Location: Lot 1 in DP 1144668, Andromeda Drive, Cranebrook — Report No: R01A

Test Procedure: AS 1289 7.1.1

Sample Identification	TP 1 (0.5-0.7m)	TP 7 (0.7-0.9m)		
Sample Register No	SR 9513	SR 9514		
Sample Date	28-Apr-15	28-Apr-15		
Test Date	3-May-15	3-May-15		
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.4)	AS 1289 1.1, 1.2.1 (6.5.4)		
Test Results				
Test Procedure	AS 1289 2.1.1	AS 1289 2.1.1		
Moisture Content Initial % Final %	 18.5 22.5	 25.5 29.5		
Test Procedure	AS 1289 7.1.1	AS 1289 7.1.1		
Estimated UCS Before Test kPa After Test kPa	 >600 400	 300 150		
Swell % Shrinkage %	0.2 2.4	3.7 4.8		
Shrink/Swell Index %/pF	1.4	3.7		
Material Description	Silty Clay: brown	Silty Clay: red brown		

Remarks

Authorised Signatory _____ So Lern Liew Date 5/5/15

APPENDIX C

Summary of Lot Classification

Summary of Site Classification

Lot 1 DP 1144668 No 84-94 Andromeda Dr Cranebrook

LOT NO	CLASS
1	H1
2	H1
3	H1
4	H1
5	H1
6	H1
7	H1
8	H1
9*	H1
10*	H1
11*	H1
12*	H1
13*	H1
14*	H1
15*	H1
16*	H1
17*	H1
18*	H1
19*	H1
20	H1
21	H1

Note : * Lots 9 to 19 are impacted by Restriction on Use of Land under Section 88B instrument of the Conveyancing Act 1919 and for details on footing design and recommendations, refer to Section 5.5 of this report

APPENDIX D

A Brief Explanation of Site Classification

A BRIEF EXPLANATION OF SITE CLASSIFICATION

1. Introduction

The intention of the Australian Standard 2870-2011, "Residential Slabs and Footings" is to provide guidance on footing design for residential buildings with a particular emphasis on reactive clay sites. Footing design and construction involves the following steps:

- site classification
- selection of an appropriate footing system
- structural design
- construction in accordance with the required design details and construction methods
- proper site maintenance after construction

The classification assessed in this report is the first step in providing an economical footing system for a residence which will limit cracking of footings, floor slabs and masonry walls to an extent normally considered acceptable. (Performance expectations are explained in AS 2870- 2011). It is necessary that each subsequent step be diligently observed to achieve acceptable performance.

It is imperative when applying the site classifications presented in this report to residential footing design, that these performance expectations are acceptable to the home owner.

2. What is a Reactive Soil?

A reactive soil undergoes appreciable volume change when its moisture content changes. This causes ground surface movements which can result in fooling movements. The extent of ground movement that can occur depends on the clay mineralogy, the depth of clay in the soil profile, the depth of potential moisture variation in the soil and the change in soil suction that occurs from dry to wet soil conditions. AS2870 provides a classification system to quantify the range of ground surface movements anticipated (defined as having less than 5% chance of being exceeded in the design life of the structure).

3. How are Sites Classified in the Sydney Region

Experiment and observation within the Sydney Region indicates a high variability in the potential for reactive movements, which is not clearly related to soil association, terrain location or visual appearance and may not be accurately predicted by simple soil tests. Intense, complex and expensive testing is required at a site to accurately predict its potential for reactive behaviour. To avoid this, a simplified classification procedure for the Sydney region has been devised which is based on the depth of clay in the soil profile. This procedure is detailed in AS2870 – 2011.

4. What is a Class P Site?

Footing design may need to consider other factors beside reactive soils. Such factors include the presence of filling, the presence of compressible or collapsible soils, or the need to consider slope stability aspects. When these or other factors need to be considered the site may be classified P. The footing "solution" for Class P sites requires special engineering consideration. On many sites the "solution may the straight forward and may not necessarily incur major cost increases.

5. Filled Sites

The most common "problem" associated with residential lots is the presence of fill, compacted or otherwise, overlying the natural soils. If the fill is uncompacted, or if there are no records of adequate compaction, a piered footing system is usually adopted which penetrates the fill and found on natural ground.

AS2870 - 2011 indicates that a compacted fill site may be given a less severe classification than P if assessed in accordance with engineering principles. Subdivision developments often include areas of compacted filling which will usually have been required to have been compacted to the relevant Council Specifications. Adequately compacted filling will usually provide sufficient bearing capacity for residential footing loads, but the clay in the fill will also experience reactive soil movements. Depending on the moisture content at which the fill is placed and the compaction which has been achieved, reactive soil movements may exceed those experienced by the natural soil from which the fill has been derived. As a result, classification of compacted fill sites sometimes needs to be conservative.

6. Site Classifications should be Project Specific

Many Councils require that all lots within a new subdivision be classified prior to subdivision approval. This practice precludes a consideration of the impact of site preparation works on the classification. Sites which are not level are often cut and filled to provide a level platform for floor slab construction. AS2870 specifies that the classification shall be reconsidered if:

(a) the depth of cut exceeds 500mm, or
(b) the depth of compacted fill exceeds 400mm for clay (or 800mm for sand).

Where the classification provided in this report is carried out prior to the site development details being known it is a condition of this report that plans for future development of the block be reviewed by a geotechnical engineer to assess the impact of proposed site works and also the impact of work which may have occurred on adjacent sites since the date of this classification. Altering the site classification may be required in some cases.

7. Site Maintenance

The classifications presented in this report have been assessed for moisture variations caused by climatic and "normal" garden conditions. More severe moisture variation can be caused by other common factors, such as removing or planting trees, leaking plumbing, irrigation systems etc. Guidelines to appropriate site maintenance are provided in CSIRO 10-91 "A Guide to Home Owners on Foundation Maintenance and Footing Performance". Most Damage to residences on reactive sites is due to poor site maintenance. Footings designed to AS2870 may not perform satisfactorily if sites are not properly maintained.

APPENDIX E

Explanatory Notes
Important Information about your Environmental Site Assessment Report.

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 05m) 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:

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

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.