7.4 Phase 1 Contamination Assessment and Preliminary Geotechnical Assessment prepared by Network Geotechnics

Report

Phase 1 Contamination Assessment & Preliminary Geotechnical Assessment

Proposed Re-zoning, Iluka Reserve, Kiama Downs NSW

Prepared for:

SET Consultants

No. 51 Graham Street
NOWRA NSW 2541

Prepared by:

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11 March 2016

Ref: G09/1967-Ar

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Document delivery

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Appendices

Executive Summary

SET Consultants commissioned Network Geotechnics Pty Ltd (NG) to carry out a Stage 1 Site Contamination Assessment in accordance with Contamination Land Management Act in order to lodge a Development Application for proposed re-zoning of land at the northern portion of Iluka Reserve, Kiama Downs. The investigation also included a preliminary geotechnical assessment.

The subject site is identified as the northern portion of Lot 34 in DP28122 and northern portion of Lot 243 in DP30200 bordering Riverside Drive, Kiama Downs in Kiama Municipal Council (KMC) Area. A plan of the site is included in Appendix B, Drawing No. G09/1967-1.

The objective of this investigation was to carry out a Stage I Contamination Assessment in order to assess the risks of site contamination from historical land usage and to assess the suitability of the site for the proposed rezoning.

The scope of work undertaken to achieve the objectives included:

- Review of regional geology;
- Review of historical aerial photographs and title records to facilitate identification of potential site contamination;
- Walk over assessment to identify site features affecting potential site contamination;
- Evaluation of findings and preparation of Stage I Contamination Assessment.

Based on Aerial Photographs and title records, the site has been generally used as open parklands for the public and possible farming from 1911 to 1958. Between years 1958 and 1963, the site has been generally vacant and owned by Central Coast Realty Pty Ltd. From 1963 to present, the site has been open to the public with a children's playground located north east section of the site. However the surrounding lands to the north, west and east had been part of a residential subdivision. An old creek line and a low lying sections to west and south west had been subject to filling for the development of the subdivision.

Based on the above the risk of site contamination is assessed to be medium to high. Fill materials up to 1.2m depths were encountered in this investigation and hence it is assessed that a targeted Stage 2 Contamination Assessment is recommended for the proposed residential subdivision in order to rule out contamination hot spots not smaller than 23m in diameter.

The targeted Stage 2 Contamination Assessment should include test pits excavated to about 2m depth and sampling of soils at the surface and at 0.5m depth intervals. Laboratory testing should include Heavy metals, Recoverable Hydrocarbons (TRH), Polynuclear Hydrocarbons (PAH), Polychlorinated Biphenyls (PCB), Pesticides/ herbicides and Asbestos. We are pleased to provide you with a proposal to undertake a targeted Stage 2 Contamination Assessment.

Due to the underlying fill deemed to be uncontrolled, in the absence of records to the contrary, the site is assessed as Class P in accordance with AS2870-2011 Residential Slabs and Footings. Footings should be designed based on engineering principals using parameters

discussed in the report. Footing design should be carried out in accordance with engineering principles.

However if the site is to be re-worked under controlled conditions in accordance with AS3798-2007 ‘Guidelines on earthworks for commercial and residential developments’, then the site may be reclassified as H1 or H2 (Highly Reactive), depending on the quality/ reactivity of fill materials used.

1.0 Introduction

SET Consultants commissioned Network Geotechnics Pty Ltd (NG) to carry out a Stage 1 Site Contamination Assessment in accordance with Contamination Land Management Act in order to lodge a Development Application for proposed re-zoning of land at the northern portion of Iluka Reserve, Kiama Downs. The investigation also included a preliminary geotechnical assessment.

The subject site is identified as the northern portion of Lot 34 in DP28122 and northern portion of Lot 243 in DP30200 bordering Riverside Drive, Kiama Downs in Kiama Municipal Council (KMC) Area. A plan of the site is included in Appendix B, Drawing No. G09/1967-1.

The investigation was undertaken in accordance with NG Proposal G09/1967 dated 20 October 2015.

2.0 Scope of Work

The objective of this investigation was to carry out a Stage I Contamination Assessment in order to assess the risks of site contamination from historical land usage and to assess the suitability of the subject site for the proposed rezoning.

The scope of work undertaken to achieve the objectives included:

- Review of regional geology.
- Review of historical aerial photographs and title records to facilitate identification of potential site contamination.
- Walk over assessment to identify site features affecting potential site contamination.
- Undertake a limited intrusive investigation involving 5 boreholes.
- Evaluation of findings and preparation of Stage I Contamination Assessment.

3.0 Site Identification

The site is located east of Riverside Drive, Kiama Downs. It should be noted that this investigation was confined to the northern section of Iluka Reserve. The site is bounded by:

- Lot 25 to 28 in DP28122 SP 84446 to the north,
- Lot 1 in DP509019 to the south,
- And Lots 45 to 48 in DP28122 to the east.

The subject site is located in Kiama Municipal Council area in Parish of Kiama and County of Camden.

4.0 Site History

4.1 Zoning

Council zoning plans (LEP 2011) identifies Lot 34 in DP28122 as partly R2 'Low Density Residential' (covering the northern portion of the site) and partly RE1 'Public Recreation' (covering the northern portion of the site).

4.2 Land use

The land is currently used as a park for the surrounding residents. The only structure on-site is a children's playground.

4.3 Council Re-Zoning

It is understood that the southern and north eastern portions of the site will be re-zoned as R2 'Low density Residential Zone' from the current zoning as RE1 'Public Recreation'.

4.4 Title Records

A record of ownership/leasing as can be inferred from title records is given in Table 1 below.

Table 1 - Historical Ownership

Date	Lot /DP Number	Volume/Folio	Remarks
29 October, 1834	Portion 15		Crown Grant to James Holt.
12 October, 1911	334a.3r.17p.	2191-42	William Mackey Gray Charles (Farmer)
28 June, 1922	60a.2r.33p.	3358-179 3358-180 3358-181	William James Jones (Farmer) 1/3 Share. Frederick Charles Jones (Farmer) 1/3 Share. Alfred Henry Jones (Farmer) 1/3 Share.
1 August, 1958		7792-3	Central Coast Realty Pty Ltd.
30 August, 1988	34/28122	9708-147	The Council of Municipality of Kiama (Current Owner).
19 August, 1963	243/30200	9567-22	The Council of Municipality of Kiama (Current Owner).

4.5 Aerial Photographs

Aerial photographs for Lot 34 in DP 28122 & Lot 243 in DP 30200 Riverside Drive, Kiama Downs were purchased from NSW Department of Lands. A summary of findings are presented in Table 2.

Table 2 - Summary of Aerial Photograph Review

Year of Photo	*Scale*	*Colour*	*Description*
1949	1:30000	Black & White	The site is completely covered with grasslands and the surrounding areas are partly rural properties and partly vacant.

1963	1:40000	Black & White	The site seems to be vacant with some residential dwellings to the northern and western side and a creek line running along the southern boundary of the site. There is an existing quarry to the south west of the site. Rural properties to the west of the site.
1974	1:40000	Black & White	Same as above, however there are more residential properties to the north and east.
1984	1:40000	Black & White	Same as above, however to the west of the site, there seems to have been some filling carried out and internal residential roads visible. The creek line is no longer visible, which may have been filled as a part of the development to the west of the site.
1993	1:25000	Colour	Same as above with more residential dwellings now built to the west, east and north of the site.
2005	Google Earth	Colour	Same as above, no changes.
2015	Google Earth	Colour	Same as above, no changes.

4.6 Historical Site Usage

Based on aerial photographs and title records, the site has been generally used as open parklands for the public and possible farming from 1911 to 1958. Between years 1958 and 1963, the site has been generally vacant and owned by Central Coast Realty Pty Ltd. From 1963 to present, the site has been open to the public with a children's playground located in the north east section of the site. However the surrounding lands to the north, west and east had been part of a residential subdivision. An old creek line and a low lying sections to west and south west has been subject to filling.

Based on title records and aerial photographs, the following historical uses could be identified:

Table 3 - Historical Land Use

1911 - 1958	Vacant & possible farming
1958 - 1963	Vacant.
1963 - 2015	Used for public open space with a children's playground. The subject site may have been subject to filling as a result of residential subdivision to the west of the site.

4.7 Previous Reports

A Preliminary Contamination Assessment of the southern potion of Iluka Reserve was previously carried out by Coffey Geotechnics Pty Ltd in 2014. This report found that the southern portion of Iluka Reserve had been extensively filled during the 1980s. The investigation found two locations with asbestos in the topsoil. The concentration of copper, zinc and benzo(a)pyrene was found to exceed the Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) in several samples from the fill material.

It is possible that the filling of the southern portion of Iluka Reserve may have encroached on the northern portion which is subject to this investigation.

4.8 Potential Contamination

The site history records available do not show the use of chemicals onsite. The following chemicals and waste may be associated with demolition of sheds/ dwellings and filling of land.

- Contamination such as heavy metals, hydrocarbons and asbestos associated with any imported fill.
- Possible asbestos contamination in crushed rock/ recycled products associated with filling of the old creek line.

5.0 Site Condition & Surrounding Environment

5.1 Topography

The site is located east of Riverside Drive, Kiama Downs. The site comprises one break in slope, as observed from the centre of the site, with south facing slopes of 15^{o} over a span of about 7m transition to a gentle 5^{o} south east facing slopes. The site is generally covered with grass overlying gravelly silty CLAY fill. The fill material may have been excess topsoil material placed from past construction jobs. There was a children's playground near the north eastern corner of the site.

5.2 Visible Signs of Contamination

During the site visit on 19 November 2015 five boreholes were drilled (BH1-BH5). Fill material was identified in all boreholes to a variable depth of 0.7m to 1.2m. The source of the fill is unknown. No signs of surface soils staining suggesting oil leakages were evident at the time of the investigation. The surface soils mainly contained gravelly CLAY fill.

5.3 Flood Potential

A flood study was not carried out for this investigation. The closest body of water is the Beach located about 300m to the east of the subject site.

5.4 Geology & Subsurface Profile

Geological maps for the area indicate the site to be underlain by Bumbo Latite Member 'P_{sgb}' comprising Aphanitic to Porphyritic Latite.

The subsurface profile encountered in the boreholes may be generalised as follows:

Table 4: Subsurface Profile Encountered

Layer/Description		Depth to Base of Layer
FILL:	gravelly silty CLAY, low to medium plasticity, dark greybrown, some fine to medium grained sands	0.7 – >1.3

FILL:	CONCRETE (Only in BH5)	1.2
RESIDUAL:	CLAY, high plasticity, grey mottled brown	1.6 – >2.0
ROCK:	LATITE, extremely weathered, orange/ grey	0.8 - >2.0

Groundwater was not encountered during drilling in of the boreholes. However, the depth to groundwater may change with the variation of environmental factors.

6.0 Fieldwork

Fieldwork carried out on 19 November 2015 comprised drilling 5 boreholes (BH1 to BH5) to depths ranging from 1.0m to 2.0m using a skid steer Dingo drill rig. Disturbed samples were placed in plastic bags/ buckets and sealed and transported to NG's Laboratory located in Mount Kuring-Gai for materials testing.

Field investigation was carried out by a Geotechnical Engineer from NG who selected borehole locations, carried out sampling and prepared borehole logs. Borehole locations are shown on Drawing No. G09/1967-1, included in *Appendix B* and the borehole logs are included in *Appendix C*.

7.0 Results & Discussion - Contamination

7.1 Summary of Desk Study

The site history records available do not show the use of chemicals onsite. The subject site has been generally vacant prior to 1960's with possible farming activities. In the past 50 years the site has been used as a public recreation area.

However, the site was found to contain fill to between 0.7m to 1.2m depth in the subject site. A previous report by Coffey Geotechnics found the southern portion of Iluka Reserve contained filling with fragments of asbestos found in the topsoil and copper, zinc and bezo(a)pyrene levels exceeding the EIL/ESL. It is likely that the fill identified on the southern portion of Iluka Reserve encroached on the northern portion of the reserve which is subject to this investigation. Therefore, the following chemicals and waste may be associated with the filling material placed:

- Contamination such as heavy metals, hydrocarbons and asbestos associated with any imported fill.

- Possible pesticides/ herbicides used as part potential farming activity in the past.

In general, there is assessed to be a medium to high risk of potential contamination as there was filling carried out in the past with unknown contaminants sources.

7.2 Borehole Logs & Visual Assessment

During the site inspection carried out on 19 November 2015 by NG staff, there was no visible staining of soil surfaces. There were no signs of oil/petroleum leakages. Samples recovered from boreholes did not have any obvious odours and discolouration.

7.3 Conclusion

Based on the above the risk of site contamination is assessed to be medium to high. Fill materials up to 1.2m depths were encountered in this investigation and hence it is assessed that a targeted Stage 2 Contamination Assessment would be required for the proposed residential subdivision in order to rule out contamination hot spots not smaller than 23m in diameter.

The targeted stage 2 Contamination Assessment should include test pits excavated to about 2m depth and sampling of soils at the surface and at 0.5m depth intervals. Laboratory testing should include Heavy metals, Recoverable Hydrocarbons (TRH), Polynuclear Hydrocarbons (PAH), Polychlorinated Biphenyls (PCB), Pesticides/ herbicides and Asbestos. We are pleased to provide you with a proposal to undertake a targeted Stage 2 Contamination Assessment.

8.0 Geotechnical Aspects

8.1 Laboratory Test Results

Laboratory field moisture content test results on two residual clay samples were 32.8% and 37.0%. Based on the above and Table 4 Laboratory Test Results, it is assessed the residual clay soils to be highly reactive. The laboratory results are included in *Appendix D* and are summarised as follows:

Table 4 Laboratory Test Results

Borehole No/ Depth (m)	Soil Description / Origin	LL (%)	PL (%)	PI (%)	LS (%)	FMC (%)
BH2 (1.5-1.9)	CLAY, brown-grey/ Residual	96	33	63	20	37.0
BH1 (1.3-1.7)	CLAY, brown-grey/ Residual	-	-	-	-	32.8

Note: LL (Liquid Limit), PL (Plastic Limit), PI (Plastic Index), FMC % (Field Moisture Content), LS (Linear Shrinkage)

Based on the test results a Shrink-Swell Index of 5.0% is assigned for residual CLAY. The fill is generally described as low to medium plasticity Gravelly CLAY and is assessed to not meet conventional engineered or controlled fill requirements. Dynamic Cone Penetrometer (DCP) tests carried out on residual clay indicated firm to stiff consistency and becoming very stiff below 1.5m depth.

Concrete was encountered and the borehole refused at 1.3m depth in BH5 indicating deeper filling in the south western portion of the site (bottom of existing slope).

8.2 Interim AS2870 Classification

Due to the underlying fill deemed to be uncontrolled, in the absence of records to the contrary, the site is assessed as Class P in accordance with AS2870-2011 Residential Slabs and Footings. Footings should be designed based on engineering principals using parameters discussed below. Footing design should be carried out in accordance with engineering principles.

However if the site is to be re-worked under controlled conditions in accordance with AS3798-2007 'Guidelines on earthworks for commercial and residential developments', than the site may be reclassified as H2 (Highly Reactive), depending on the quality/ reactivity of fill materials used.

The classifications and recommendations presented in this report are provided on the basis that the performance expectations set out in Appendix B of AS2870-2011 are acceptable and that future site maintenance complies with CSIRO Sheet BTF-18, a copy of which is attached in Appendix A. In particular, the site should be maintained in stable moisture conditions by providing adequate drainage.

8.3 Earthworks

Earthworks would be required for creation of level building pads for the proposed residential development. The following procedure is recommended:

- Strip topsoil, uncontrolled fill and other deleterious materials from the building foot prints and road subgrades.
- Exposed surface should be proof rolled with a static smooth wheeled roller not smaller than 10t. Any deflecting areas should be excavated and backfilled as indicated below.
- Place fill in not more than 250mm thick layers and compact to achieve a density ratio not less than 95% Standard Compaction.
- All filling should be in near horizontal layers not steeper than 8% (12H:1V).
- Density testing should be carried out under Level 1 testing as defined in AS3798-2007 Guidelines for Earthworks. The Geotechnical Testing Authority (GTA) undertaking testing should provide certification that testing has been carried out in accordance with the above requirements and AS3798.

8.4 Services

Excavation for installation of services can be carried out using conventional earthmoving equipment where excavation is limited to above 2m depth, and within clay/ fill. Such excavations are unlikely to cause disturbance to adjacent residences. However excavation of Latite rock may require the use of impact hammers.

9.0 Limitations

This report has been prepared for SET Consultants in accordance with NG's proposal dated 20 October 2015 (Ref. G09/1967) under NG's Terms of Engagement.

The report is provided for the exclusive use of SET Consultants for the specific development and purpose as described in the report. The report may not contain sufficient information for developments or purposes other than that described in the report or for parties other than SET Consultants.

The information in this report is considered accurate at the date of issue with regard to the current conditions of the site. The conclusions drawn in the report are based on interpolation

between boreholes or test pits. Conditions can vary between test locations that cannot be explicitly defined or inferred by investigation.

The report, or sections of the report, should not be used as part of a specification for a project, without review and agreement by NG, as the report has been written as advice and opinion rather than instructions for construction.

The report must be read in conjunction with the attached Information Sheets and any other explanatory notes and should be kept in its entirety without separation of individual pages or sections. NG cannot be held responsible for interpretations or conclusions from review by others of this report or test data, which are not otherwise supported by an expressed statement, interpretation, outcome or conclusion stated in this report. In preparing the report NG has necessarily relied upon information provided by the client and/or their agents.

Network Geotechnics Pty Ltd

Appendix A

Information Sheets

General Notes About This Report

INTRODUCTION

These notes have been prepared by Network Geotechnics Pty Ltd (NG) to help our Clients interpret and understand the limitations of this report. Not all sections below are necessarily relevant to all reports.

SCOPE OF SERVICES

This report has been prepared in accordance with the scope of services set out in NG's proposal under NG's Terms of Engagement, or as otherwise agreed with the Client. The scope of work may have been limited by a range of factors including time, budget, access and/or site constraints.

RELIANCE ON INFORMATION PROVIDED

In preparing the report NG has necessarily relied upon information provided by the Client and/or their Agents. Such data may include surveys, analyses, designs, maps and plans. NG has not verified the accuracy or completeness of the data except as stated in this report.

GEOTECHNICAL AND ENVIRONMENTAL REPORTING

Geotechnical and environmental reporting relies on the interpretation of factual information based on judgment and opinion and is far less exact than other engineering or design disciplines.

Geotechnical and environmental reports are for a specific purpose, development and site as described in the report and may not contain sufficient information for other purposes, developments or sites (including adjacent sites) other than that described in the report.

SUBSURFACE CONDITIONS

Subsurface conditions can change with time and can vary between test locations. For example, the actual interface between the materials may be far more gradual or abrupt than indicated and contaminant presence may be affected by spatial and temporal patterns.

Therefore, actual conditions in areas not sampled may differ from those predicted since no subsurface investigation, no matter how comprehensive, can reveal all subsurface details and anomalies.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions and thus the continuing adequacy of a geotechnical report. NG should be kept informed of any such events and should be retained to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

GROUNDWATER

Groundwater levels indicated on borehole and test pit logs are recorded at specific times. Depending on ground permeability, measured levels may or may not reflect actual levels if measured over a longer time period. Also, groundwater levels and seepage inflows may fluctuate with seasonal and environmental variations and construction activities.

INTERPRETATION OF DATA

Data obtained from nominated discrete locations, subsequent laboratory testing and empirical or external sources are interpreted by trained professionals in order to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions in accordance with any relevant industry standards, guidelines or procedures.

SOIL AND ROCK DESCRIPTIONS

Soil and rock descriptions are based on AS 1726 – 1993, using visual and tactile assessment except at discrete locations where field and / or laboratory tests have been carried out. Refer to the accompanying soil and rock terms sheet for further information.

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FURTHER ADVICE

NG would be pleased to further discuss how any of the above issues could affect a specific project. We would also be pleased to provide further advice or assistance including:

- Assessment of suitability of designs and construction techniques;
- Contract documentation and specification;
- Construction control testing (earthworks, pavement materials, concrete);
- Construction advice (foundation assessments, excavation support).

Abbreviations, Notes & Symbols

SUBSURFACE INVESTIGATION

METHOD

Borehole Logs		Excavation Logs	
AS#	Auger screwing (#-bit)	BH	Backhoe/excavator bucket
AD#	Auger drilling (#-bit)	NE	Natural exposure
B	Blank bit	HE	Hand excavation
V	V-bit	X	Existing excavation
T	TC-bit		
HA	Hand auger	**Cored Borehole Logs**	
R	Roller/tricone	NMLC	NMLC core drilling
W	Washbore	NQ/HQ	Wireline core drilling
AH	Air hammer		
AT	Air track		
LB	Light bore push tube		
MC	Macro core push tube		
DT	Dual core push tube		

SUPPORT

Borehole Logs		Excavation Logs	
C	Casing	S	Shoring
M	Mud	B	Benched

SAMPLING

B	Bulk sample
D	Disturbed sample
U#	Thin-walled tube sample (#mm diameter)
ES	Environmental sample
EW	Environmental water sample

FIELD TESTING

PP	Pocket penetrometer (kPa)
DCP	Dynamic cone penetrometer
PSP	Perth sand penetrometer
SPT	Standard penetration test
PBT	Plate bearing test
s_U	Vane shear strength peak/residual (kPa) and vane size (mm)
N*	SPT (blows per 300mm)
Nc	SPT with solid cone
R	Refusal

**denotes sample taken*

BOUNDARIES

——— Known

– – – – Probable

..... Possible

SOIL

MOISTURE CONDITION

D	Dry
M	Moist
W	Wet
Wp	Plastic Limit
Wl	Liquid Limit
MC	Moisture Content

CONSISTENCY		DENSITY INDEX	
VS	Very Soft	VL	Very Loose
S	Soft	L	Loose
F	Firm	MD	Medium Dense
St	Stiff	D	Dense
VSt	Very Stiff	VD	Very Dense
H	Hard		
Fb	Friable		

USCS SYMBOLS

GW	Well graded gravels and gravel-sand mixtures, little or no fines
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
SW	Well graded sands and gravelly sands, little or no fines
SP	Poorly graded sands and gravelly sands, little or no fines
SM	Silty sand, sand-silt mixtures
SC	Clayey sand, sand-clay mixtures
ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays
OL	Organic silts and organic silty clays of low plasticity
MH	Inorganic silts of high plasticity
CH	Inorganic clays of high plasticity
OH	Organic clays of medium to high plasticity
PT	Peat muck and other highly organic soils

ROCK

WEATHERING		STRENGTH	
RS	Residual Soil	EL	Extremely Low
XW	Extremely Weathered	VL	Very Low
HW	Highly Weathered	L	Low
MW	Moderately Weathered	M	Medium
DW*	Distinctly Weathered	H	High
SW	Slightly Weathered	VH	Very High
FR	Fresh	EH	Extremely High

**covers both HW & MW*

ROCK QUALITY DESIGNATION (%)

$$= \frac{\text{sum of intact core pieces} > 100\text{mm}}{\text{total length of section being evaluated}} \times 100$$

CORE RECOVERY (%)

$$= \frac{\text{core recovered}}{\text{core lIft}} \times 100$$

NATURAL FRACTURES

Type

JT	Joint
BP	Bedding plane
SM	Seam
FZ	Fractured zone
SZ	Shear zone
VN	Vein

Infill or Coating

Cn	Clean
St	Stained
Vn	Veneer
Co	Coating
Cl	Clay
Ca	Calcite
Fe	Iron oxide
Mi	Micaceous
Qz	Quartz

Shape

pl	Planar
cu	Curved
un	Undulose
st	Stepped
ir	Irregular

Roughness

pol	Polished
slk	Slickensided
smo	Smooth
rou	Rough

Soil & Rock Terms

SOIL

MOISTURE CONDITION

Term	Description
Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through the hand.
Moist	Feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	As for moist, but with free water forming on hands when handled.

For cohesive soils, moisture content may also be described in relation to plastic limit (W_P) or liquid limit (W_L). [>> much greater than, > greater than, < less than, << much less than].

CONSISTENCY

Term	c_u (kPa)	Term	c_u (kPa)
Very Soft	< 12	Very Stiff	100 - 200
Soft	12 - 25	Hard	> 200
Firm	25 - 50	Friable	-
Stiff	50 - 100		

DENSITY INDEX

Term	I_D (%)	Term	I_D (%)
Very Loose	< 15	Dense	65 – 85
Loose	15 – 35	Very Dense	> 85
Medium Dense	35 – 65		

PARTICLE SIZE

Name	Subdivision	Size (mm)
Boulders		> 200
Cobbles		63 - 200
Gravel	coarse	20 - 63
	medium	6 - 20
	fine	2.36 - 6
Sand	coarse	0.6 - 2.36
	medium	0.2 - 0.6
	fine	0.075 - 0.2
Silt & Clay		< 0.075

MINOR COMPONENTS

Term	Proportion by Mass coarse grained	fine grained
Trace	≤ 5%	≤ 15%
Some	5 - 2%	15 - 30%

SOIL ZONING

Layers	Continuous exposures
Lenses	Discontinuous layers of lenticular shape
Pockets	Irregular inclusions of different material

SOIL CEMENTING

Weakly	Easily broken up by hand
Moderately	Effort is required to break up the soil by hand

SOIL STRUCTURE

Massive	Coherent, with any partings both vertically and horizontally spaced at greater than 100mm
Weak	Peds indistinct and barely observable on pit face. When disturbed approx. 30% consist of peds smaller than 100mm
Strong	Peds are quite distinct in undisturbed soil. When disturbed >60% consists of peds smaller than 100mm

ROCK

SEDIMENTARY ROCK TYPE DEFINITIONS

Rock Type	Definition (more than 50% of rock consists of….)
Conglomerate	… gravel sized (> 2mm) fragments
Sandstone	… sand sized (0.06 to 2mm) grains
Siltstone	… silt sized (<0.06mm) particles, rock is not laminated
Claystone	… clay, rock is not laminated
Shale	… silt or clay sized particles, rock is laminated

STRENGTH

Term	Is50 (MPa)	Term	Is50 (MPa)
Extremely Low	< 0.03	High	1 – 3
Very Low	0.03 – 0.1	Very High	3 – 10
Low	0.1 – 0.3	Extremely High	> 10
Medium	0.3 – 1		

WEATHERING

Term	Description
Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident
Extremely Weathered	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded, in water. Fabric of original rock is still visible
Highly Weathered	Rock strength usually highly changed by weathering; rock may be highly discoloured
Moderately Weathered	Rock strength usually moderately changed by weathering; rock may be moderately discoloured
Distinctly Weathered	See 'Highly Weathered' or 'Moderately Weathered'
Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fresh	Rock shows no signs of decomposition or staining

NATURAL FRACTURES

Type	Description
Joint	A discontinuity or crack across which the rock has little or no tensile strength. May be open or closed
Bedding plane	Arrangement in layers of mineral grains of similar sizes or composition
Seam	Seam with deposited soil (infill), extremely weathered insitu rock (XW), or disoriented usually angular fragments of the host rock (crushed)
Shear zone	Zone with roughly parallel planar boundaries, of rock material intersected by closely spaced (generally < 50mm) joints and /or microscopic fracture (cleavage) planes
Vein	Intrusion of any shape dissimilar to the adjoining rock mass. Usually igneous

Shape	Description
Planar	Consistent orientation
Curved	Gradual change in orientation
Undulose	Wavy surface
Stepped	One or more well defined steps
Irregular	Many sharp changes in orientation

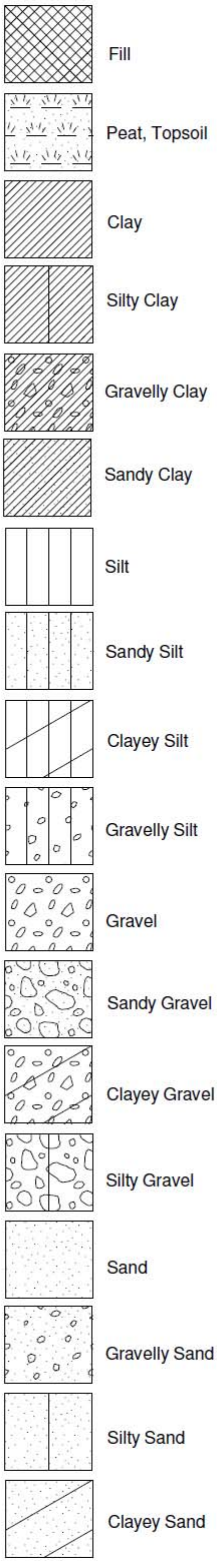
Infill or Coating	Description
Clean	No visible coating or discolouring
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	Visible coating ≤ 1mm thick. Ticker soil material described as seam

Roughness	Description
Polished	Shiny smooth surface
Slickensided	Grooved or striated surface, usually polished
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally < 1mm). Feels like fine to coarse sandpaper

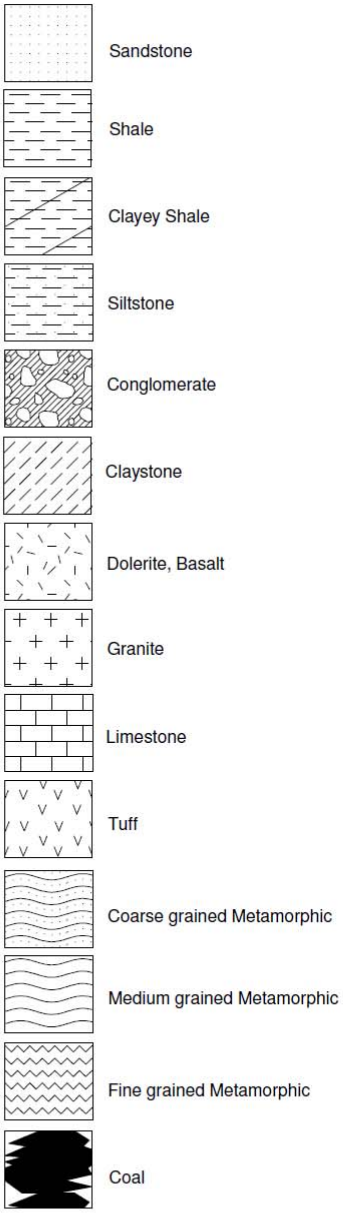
Note: soil and rock descriptions are generally in accordance with AS1726-1993 Geotechnical Site Investigations

Graphic Symbols Index

Soil

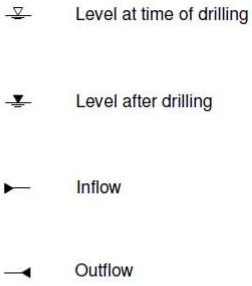


Rock



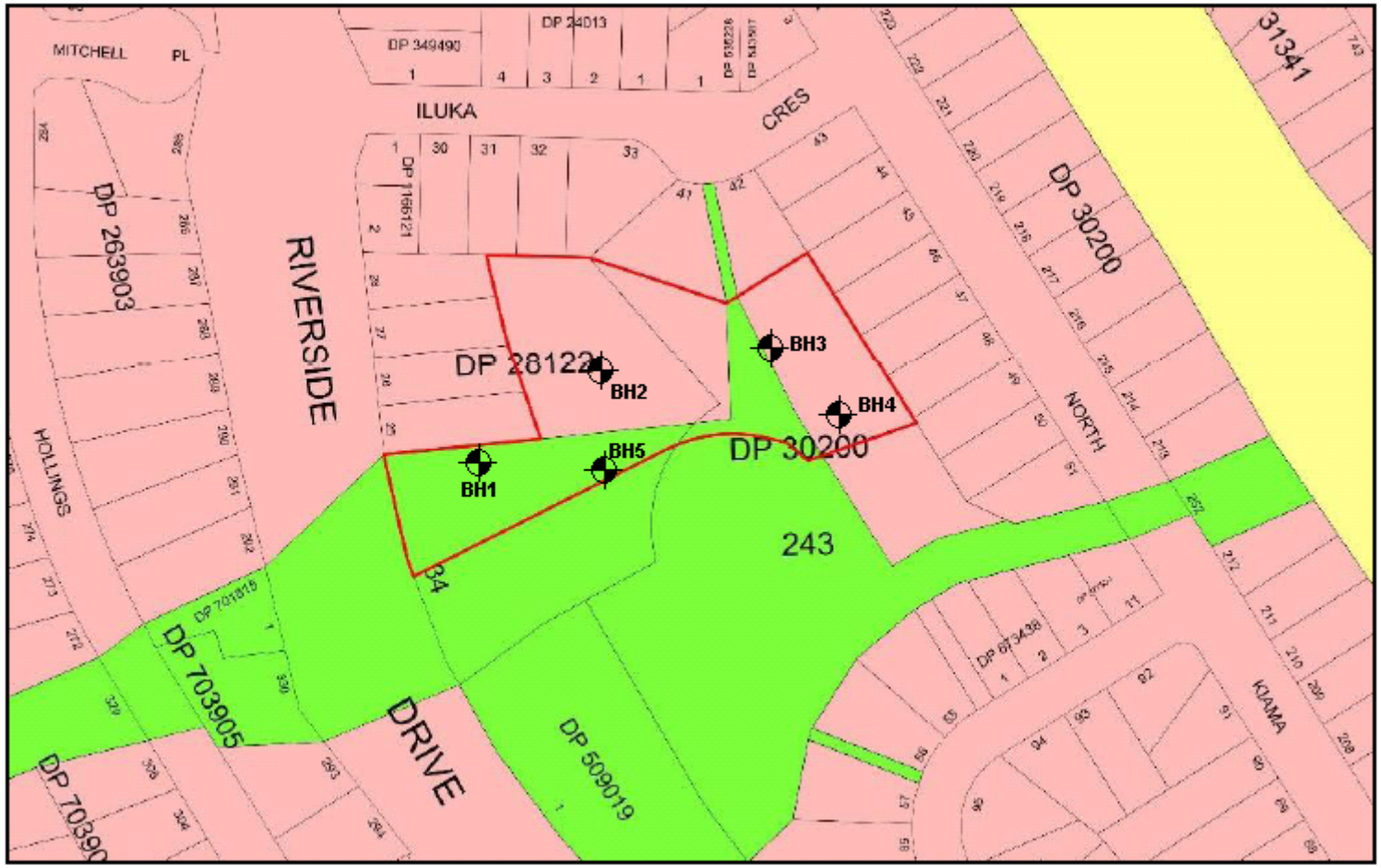
Other

Water Measurements



Appendix B

Site Plan and Test Locations



	LEGEND:		Scale: A4 - NOT TO SCALE	Client: SET CONSULTANTS	
⊕	APPROXIMATE BOREHOLE LOCATIONS	Network Geotechnics Pty Ltd *12/9-15 Gundah Road,* *MT KURING-GAI NSW 2080* *Tel: (02) 8438 0300* *Fax: (02) 8438 0310* *Email: engineering@netgeo.com.au*	Date: 17/12/2015	Project: PROPOSED RE-ZONING	
			Drawing: MA	Location: ILUKA RESERVE, KIAMA DOWNS	
			Drawing No: G09/1976-1	Sheet: 1 of 1	**SITE PLAN**

Appendix C

Borehole Logs

Network Geotechnics Pty Ltd

ACN 069 211 561

BOREHOLE LOG

Job No:	G09/1967
Hole No:	**BH1**
Sheet:	PAGE 1 / 1
Started:	19/11/15
Finished:	19/11/15
Logged:	MA
Checked:	VDS
RL Surface:	-
Datum:	-

Client: Set Consultants

Project: Proposed Re-Zonning of Land

Location: Iluka Reserve, Kiama Downs
GPS

Equipment Type: Truck Mounted Ezi - Probe Drill Rig

Borehole Diameter: 110mm (I.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
LB	None Encountered		0 1 3 4 3	1.0		CL/CI	Gravelly Silty CLAY low to medium plasticity, dark grey	≥Wp		TOPSOIL/FILL
			3 20+ 10 18 20+			CH	CLAY high plasticity, grey mottled brown			RESIDUAL
						-	Dark grey, LATITE, extremely weathered	-		ROCK
				2.0			BH1 Terminated at 1.8 m			

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Network Geotechnics Pty Ltd

ACN 069 211 561

BOREHOLE LOG

Job No:	G09/1967
Hole No:	**BH2**
Sheet:	PAGE 1 / 1
Started:	19/11/15
Finished:	19/11/15
Logged:	MA
Checked:	VDS
RL Surface:	-
Datum:	-

Client: Set Consultants

Project: Proposed Re-Zonning of Land

Location: Iluka Reserve, Kiama Downs
GPS

Equipment Type: Truck Mounted Ezi - Probe Drill Rig

Borehole Diameter: 110mm (I.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
LB	None Encountered		2 3 2 2 4			CL/CI	Gravelly Silty CLAY low to medium plasticity, dark grey	≥Wp		TOPSOIL/FILL
			4 3	1.0		CH	CLAY high plasticity, grey mottled brown	>Wp ≥Wp		RESIDUAL
			5 6 6 10							
				2.0			BH2 Terminated at 2 m			

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG LOGS.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 12/16/15

Network Geotechnics Pty Ltd

ACN 069 211 561

BOREHOLE LOG

Job No:	G09/1967
Hole No:	**BH3**
Sheet:	PAGE 1 / 1
Started:	19/11/15
Finished:	19/11/15
Logged:	MA
Checked:	VDS
RL Surface:	-
Datum:	-

Client: Set Consultants

Project: Proposed Re-Zonning of Land

Location: Iluka Reserve, Kiama Downs
GPS

Equipment Type: Truck Mounted Ezi - Probe Drill Rig

Borehole Diameter: 110mm (I.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
LB	None Encountered					CL/CI	Gravelly Silty CLAY low to medium plasticity, dark grey	≥Wp		FILL
			3			CI/CH	CLAY medium to high plasticity, grey mottled brown			RESIDUAL
			4							
			6	1.0						
			6							
			10							
			18							
			16							
						-	LATITE, extremely weathered, grey/orange	-		ROCK
				2.0			BH3 Terminated at 1.8 m			

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Network Geotechnics Pty Ltd

ACN 069 211 561

BOREHOLE LOG

Job No:	G09/1967
Hole No:	**BH4**
Sheet:	PAGE 1 / 1
Started:	19/11/15
Finished:	19/11/15
Logged:	MA
Checked:	VDS
RL Surface:	-
Datum:	-

Client: Set Consultants

Project: Proposed Re-Zonning of Land

Location: Iluka Reserve, Kiama Downs
GPS

Equipment Type: Truck Mounted Ezi - Probe Drill Rig

Borehole Diameter: 110mm (I.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
LB	None Encountered		2 6 20+ 6 20+			CL/CI	Gravelly Sandy CLAY low to medium plasticity, dark grey/orange	≤Wp		TOPSOIL/FILL
				1.0		-	LATITE, extremely weathered, orange/grey	-		ROCK
							BH4 Terminated at 1 m			
				2.0						

BOREHOLE LOG LOGS.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 12/16/15

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Network Geotechnics Pty Ltd

ACN 069 211 561

BOREHOLE LOG

Job No:	G09/1967
Hole No:	**BH5**
Sheet:	PAGE 1 / 1
Started:	19/11/15
Finished:	19/11/15
Logged:	MA
Checked:	VDS
RL Surface:	-
Datum:	-

Client: Set Consultants

Project: Proposed Re-Zonning of Land

Location: Iluka Reserve, Kiama Downs
GPS

Equipment Type: Truck Mounted Ezi - Probe Drill Rig

Borehole Diameter: 110mm (I.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
lb	None Encountered					CI	Gravelly Sandy CLAY medium plasticity, dark grey/brown			FILL
				1.0		-	CONCRETE			CONCRETE
							BH5 Terminated at 1.3 m			
				2.0						

BOREHOLE LOG LOGS.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 12/16/15

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Appendix D

Laboratory Test Results

ACN 069 211 561
Unit 12, 9-15 Gundah Road
Mt Kuring-Gai,,2080,AUSTRALIA
(02) 8438 0300
(02) 8438 0310
laboratory@netgeo.com.au

TEST REPORT

Client:	SET Consultants	Job No:	G09/1967	Sheet:	1 of 1
Client Address:	44 Manning St Kiama NSW 2533	Report No:	1		
Principal:					
Project:	Proposed Rezoning of Public Land	Tested By:	Cathy McDonald	Date:	20/11/2015
Location:	Illuka Reserve and Lot 38 Irvine St - Kiama				

Sample Procedure: AS1289.1.2.1 (Clause 6.5.3 - Power Auger Drilling)

MOISTURE CONTENT - AS1289.2.1.1

Sample Number	Test Pit or Borehole	Depth	Test Results
G51850	Borehole No: BH2	1.5-1.9m	37.0
G51851	Borehole No: BH1	1.3-1.7m	32.8
G51852	Borehole No: BH6	0.3-0.7m	31.8

REMARKS:

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

Mt Kuring-Gai Laboratory 1318

APPROVED SIGNATORY: Steven Waugh
DATE: 26/11/2015

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Mt Kuring-Gai,NSW,2080,AUSTRALIA
(02) 8438 0300
(02) 8438 0310
laboratory@netgeo.com.au

TEST REPORT

Client: SET Consultants
Project: Proposed Rezoning of Public Land
Location: Illuka Reserve and Irvine St - Kiama
TR Number :

Job Number: G09/1967
Report Number: 2
Issue No: 1

This report replaces all previous issues of the above report number.

Lot Number :
Lot Description :
Borehole No: BH2
Depth: 1.5-1.9m

Lab Number: G51850
Date Sampled: 19/11/2015
Sampling Procedure: AS1289.1.2.1 (Clause 6.5.3 - Power Auger Drilling)
Sample Description: Refer to Borehole logs

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289.3.1.2	%	96
Plastic Limit (W_P) AS1289.3.2.1	%	33
Plasticity Index (I_P) AS1289.3.3.1	%	63
Linear Shrinkage AS1289.3.4.1	%	20.0
LS Comments		-
Sample History:		Oven Dried
Preparation Method:		Dry
Shrinkage Mould Length(mm)		250

REMARKS:

Accredited for compliance with ISO/IEC 17025.

Mt Kuring-Gai Laboratory 1318

APPROVED SIGNATORY
Steven Waugh

DATE
26/11/2015

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(02) 8438 0310
laboratory@netgeo.com.au

TEST REPORT

Client: SET Consultants
Project: Proposed Rezoning of Public Land
Location: Illuka Reserve and Irvine St - Kiama
TR Number :

Job Number: G09/1967
Report Number: 2
Issue No: 1

This report replaces all previous issues of the above report number.

Lot Number :
Lot Description :
Borehole No: BH6
Depth: 0.3-0.7m

Lab Number: G51852
Date Sampled: 19/11/2015
Sampling Procedure: AS1289.1.2.1 (Clause 6.5.3 - Power Auger Drilling)
Sample Description: Refer to Borehole logs

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289.3.1.2	%	43
Plastic Limit (W_P) AS1289.3.2.1	%	30
Plasticity Index (I_P) AS1289.3.3.1	%	13
Linear Shrinkage AS1289.3.4.1	%	6.0
LS Comments		-
Sample History:		Oven Dried
Preparation Method:		Dry
Shrinkage Mould Length(mm)		250

REMARKS:

Accredited for compliance with ISO/IEC 17025.

Mt Kuring-Gai Laboratory 1318

APPROVED SIGNATORY Steven Waugh
DATE 26/11/2015