Hunter Geotechnics
Pty Limited ABN 80 088 399 124

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Unit 2/8 Mathry Close
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ARD DEVELOPMENTS PTY LTD

PROPOSED RESIDENTIAL SUBDIVISION

LOT 22 DP 562824 & LOT 221 DP 823112

PRELIMINARY ASSESSMENT

FOR

ON-SITE EFFLUENT DISPOSAL

REPORT HGS 2154-1 **APRIL 2011**

Hunter Geotechnics
Pty Limited ABN 80 088 399 124

Email admin@huntergeotechnics.com.au

Unit 2/8 Mathry Close
Singleton NSW 2330
(PO Box 3003)
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HGS 2154-1 GP: gp
15th April 2011

ARD Developments Pty Ltd
PO Box 2063
SINGLETON NSW 2330

Attention: Dwight Geelan

Dear Sir,

Re: Proposed Residential Subdivision, Lot 21 in DP 562824 & Lot 221 in DP 823112 Retreat Road, Singleton: Preliminary Assessment for On-Site Effluent Disposal.

Find enclosed our report on geotechnical studies at the above site.

The report presents the results of field and laboratory testing and describes surface and subsurface conditions. Report assessment and recommendations cover on-site effluent disposal in accordance with AS1547-2000 "On-site Domestic Wastewater Management.

Please contact Richard Thompson or the undersigned if you require further assistance.

For and on behalf of
Hunter Geotechnics Pty Ltd

Gary Peake *BE (Civil), GCE, MIE Aust.*
Principal Geotechnical Engineer

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1.0 INTRODUCTION

As requested, Hunter Geotechnics Pty Ltd has carried out geotechnical studies associated with proposed residential subdivision of Lot 22 in DP 562824 and Lot 221 in DP 823112, Retreat Road at Singleton.

A preliminary site layout provided with our project brief indicates proposed development may include formation of about 35 residential lots each of about 0.8ha to be serviced by internal roads via Retreat Road, however the finalised layout will possibly change. Another lot of about 8ha accessed from Bridgeman Road will contain an existing residence within the western portion of the site. A Building Exclusion Zone is indicated within 20m of a creekline which drains south-east through the central portion of the site.

The aim of the study was to provide, for planning purposes, a preliminary assessment of site suitability and system type for onsite effluent disposal in accordance with AS1547-2000. A contour plan of the existing site, which includes a line showing the approximate location of the west boundary of proposed development, is shown on the attached Drawing HGS 2154-01.

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

2.0 FIELDWORK

Fieldwork carried out on 4th January 2011 comprised a walkover site inspection and fifteen boreholes (BH01 to BH15) drilled to depths of 0.3m to 1.4m with a mini-excavator equipped with 450mm diameter auger. The borehole locations were positioned as groups of three within five areas of varying topography (Areas A, B, C, D and E) across the site.

The fieldwork was carried out by our Principal Geotechnician who selected the borehole locations, carried out soil sampling and prepared field logs of the profiles encountered.

A Contour and Detail Plan by Le Mottee Group Pty Ltd (Ref. 5060DET-SH1, Sheet: 1 of 3, Date: 10/11/10) was used to interpolate approximate surface reduced levels at BH01 to BH15.

Borehole Logs with reduced levels including a subsurface diagram and description sheet of terms and symbols used are presented in Appendix A. Approximate borehole locations are shown on the above Drawing.

3.0 LABORATORY TESTING

Laboratory testing was carried out in accordance with the "Environmental & Health Protection Guidelines of Sewage Management" for a subdivision as follows:

- Bulk Density to aid assessment of plant growth restriction and permeability;
- Soil pH tests in $CaCl_2$ to aid assessment of soil conditions for vegetation growth;
- Electrical Conductivity (EC) and Textural Classification tests to determine Salinity (ECe) aid assessment of concentrations of soluble salts in the soil and their effect on vegetation growth;
- Sodicity (exchangeable sodium percentage) and Cation Exchange Capacity (CEC) to assess potential for structural degradation and ability to hold plant nutrients;

- Emerson aggregate (Class No.) to assess potential for soil dispersion and structural degradation;

- Phosphorus Sorption Capacity to assess ability of soil to immobilise excess phosphorus;

- Linear Shrinkage to aid soil classification.

The laboratory results are discussed in Section 5.0 and presented in Appendix B.

4.0 SITE CONDITIONS

4.1 Surface

Lots 22 and 221 combined occupy about 38ha near the north-east corner of the intersection of Retreat Road and Bridgman Road approximately 3km north of the New England Highway. The site has a frontage of about 400m to Bridgman Road and extends about 1000m to the east.

The site is situated within regionally undulating terrain and in particular occupies 10^{o} to 12^{o} south to west facing slopes of a northern hill and 7^{o} to 10^{o} generally north to east and locally south facing slopes of a southern ridge and western hill separated by a central gully (intermittent watercourse). The eastern end of the central gully is intersected by two smaller gullies (intermittent watercourses) that extend across Retreat Road. The watercourses were dry at the time of investigation. The site contains two existing dams. One is located on the 10^{o} to 12^{o} west facing slope of the northern hill and the other lies just outside the west boundary of proposed development.

Existing surface levels are indicated to range from about RL 145m AHD at the crest of the higher northern hill to RL 111m AHD at the lower eastern end of the central gully

Surface soils comprise mostly Clayey SILT and Gravelly Sandy SILT topsoil. Vegetation generally comprises a medium dense cover of trees along the southern ridge and within the eastern portion of the 10^{o} to 12^{o} south facing slope, cleared grassland within the western portion of the site and grassland with a scattering of trees within the balance of the site.

4.2 Subsurface

Singleton Geological Series Sheet 9132- IV-N (Edition 1) 1984 indicates the eastern boundary of the site to lie close to the approximate position of the *Darlington Anticline.* The western side of the anticline comprises *Maitland Group Branxton Formation (Pmb)* with overlying *Maitland Group Muree Sandstone (Pms)* and *Mulbring Siltstone (Pmm)* towards the west. Branxton Formation consists of silty sandstone, conglomerate lenses and erratics. Muree Sandstone consists of medium to coarse sandstone and pebbly conglomerate. Mulbring Siltstone consists of shale and siltstone.

Singleton Soil Landscape Series Sheet SI56-1 (Soil Conservation Service of NSW) indicates the site to be situated within the *Sedgefield Soloths (sf) Landscape* which is characterised by undulating low hills on Permian mudstone, sandstone, conglomerate, siltstone, shale and coal seams. Soils of this landscape typically consist of *Yellow Soloths* on upper to midslopes, *Yellow Solodics* on lower slopes and drainage lines and *Black Soloths* in areas of seepage. These soils are reported to have typically shallow depth, high salinity, low chemical fertility, and moderate to high erodibility and structural degradation hazards.

Subsurface conditions encountered on the **south facing 7° to 10° slope of the western hill at BH01 to BH03 (Area A)** are generalised as follows:

Layer	Description	Depth to Base of Layer (m)		
		BH01	**BH02**	**BH03**
TOPSOIL:	Clayey SILT, grey-brown	0.1	0.15	0.1
RESIDUAL:	Silty CLAY, low to medium & medium to high plasticity, dark brown to red-brown & grey-brown mottled red, M≤Wp	>1.1	>1.2	>1.2

Subsurface conditions encountered on the **north facing 7° to 10° slope of the southern ridge at BH04 to BH06 (Area B)** are generalised as follows:

Layer	Description	Depth to Base of Layer (m)		
		BH04	**BH05**	**BH06**
TOPSOIL:	Silty SAND & Sandy SILT, fine to medium grained, brown	-	0.15	0.1
SLOPEWASH:	Gravelly Sandy SILT & Silty Gravelly SAND, fine to coarse grained, pale brown, dry	0.25	0.4	0.35
RESIDUAL:	Sandy CLAY, medium plasticity, pale brown & orange-brown, fine to coarse sand, some fine to coarse gravel, M<Wp	>1.1	0.8	0.8
ROCK:	SANDSTONE, coarse grained, orange-brown	-	>1.2	>1.1

Subsurface conditions encountered on the **south facing 10° to 12° slope of the northern hill at BH07 to BH09 (Area C)** are generalised as follows:

Layer	Description	Depth to Base of Layer (m)		
		BH07	**BH08**	**BH09**
TOPSOIL:	Sandy SILT, Silty SAND & SILT, pale brown, dry	0.3	0.3	0.17
RESIDUAL:	Silty CLAY, low to medium plasticity, orange-brown & grey-brown mottled red-brown, M>Wp	>1.0	>1.2	1.2
ROCK:	SILTSTONE, extremely weathered, pale grey	-	-	>1.4

Subsurface conditions encountered on the **south facing upper 10° to 12° slope of the northern hill at BH10 to BH12 (Area D)** are generalised as follows:

Layer	Description	Depth to Base of Layer (m)		
		BH10	**BH11**	**BH12**
TOPSOIL:	Gravelly Sandy SILT, pale brown, fine sand, medium to coarse gravel	0.2	0.2	0.25
RESIDUAL:	Silty CLAY & Gravelly Sandy Silty CLAY, low to medium plasticity, orange-brown, M<Wp	-	>1.4	>1.4
ROCK:	SANDSTONE, fine grained, pale brown: Auger Refusal (R)	0.3R	-	-

Subsurface conditions encountered on the **west facing 10° to 12° slope of the northern hill at BH13 to BH15 (Area E)** are generalised as follows:

Layer	Description	Depth to Base of Layer (m)		
		BH13	**BH14**	**BH15**
TOPSOIL:	Gravelly Sandy SILT, grey-brown, fine sand, medium to coarse gravel, dry	0.28	0.4	0.2
RESIDUAL:	Gravelly Sandy CLAY & Sandy CLAY, low to medium plasticity, orange-brown, M≥Wp	>1.4	>1.2	>1.2

Groundwater was not encountered within the boreholes at the time of investigation however it is pointed out that groundwater levels and seepages may fluctuate with variations in rainfall, site drainage and other factors.

5.0 DISCUSSION & RECOMMENDATIONS

The results of our preliminary site and soil assessment indicate Areas A, B, C, D and E at BH01 to BH15 to be unsuitable for on-site effluent disposal by conventional surface, sub-surface or absorption systems.

Site features assessed as having major limitations comprise slope, landform and geology/regolith. Slopes are locally steep, landform includes dams and localised intermittent watercourses, and geology/regolith consists of major geological discontinuities associated with the various rock formations of the Darlington Anticline. These limitations represent run-off, erosion and groundwater pollution hazards.

Soil features assessed as having major limitations comprise localised shallow depth to bedrock, low soil permeability category, low pH and elevated sodicity. These features represent excessive runoff, restricted plant growth and potential for structural degradation hazards.

Proprietary sealed amended soil mound systems are considered best suited for this site. Amended soil mound systems comprise cells containing a leach drain, underlying impervious membrane and are filled with a soil treatment medium usually comprising an industrial by-product or soil that has a strong phosphorus sorption capacity. Vegetation is established over the mound/mounds. Effluent is first treated by a septic tank and then further treatment occurs during a flow within the cell in contact with amended soil. Effluent loss is by evapo-transpiration with reported low volume effluent escape over the perimeter bunds.

Amended soil mound systems generally have relatively high installation costs, however the advantages are that they occupy less area than conventional systems, can reportedly operate effectively in close proximity to creeks and watercourses/wetland areas, intermittent waterways, groundwater bores etc., and have generally low running costs. It should be noted that a pump will be required if fall to the disposal areas cannot be achieved.

An experienced Wastewater Systems Consultant should be able to provide further details and recommendations for appropriate amended soil mound systems if provided with a copy of this report.

We have completed a proforma “Onsite Effluent Disposal Preliminary Assessment”, a copy of this six page assessment including a copy of the results of a groundwater bore search is provided as Attachment A. Our preliminary assessment is for subdivision planning purposes. Assessment for on-site wastewater disposal should be verified by further inspection and possible testing when future building plans are available for individual lots.

For and on behalf of
Hunter Geotechnics Pty Ltd

Gary Peake *BE (Civil), GCE, MIE Aust.*
Principal Geotechnical Engineer

ATTACHMENT A

ONSITE EFFLUENT DISPOSAL PRELIMINARY ASSESSMENT

1 SITE EVALUATORS		
Company:	*Hunter Geotechnics Pty Ltd*	
Name(s):	*Gary Peake/Richard Thompson*	
Address:	*PO Box 3003, SINGLETON, NSW 2330*	
Ph:	*02 65721234*	fax: *02 65721572*
Date of field inspection:	*4/01/2011*	Date of Assessment/Report: 15/04/2011
Signature of Evaluator:		

2 SITE INFORMATION		
Address/locality of site:	*Lot 22 in DP 562824 & Lot 221 in DP 823112,* *Retreat Road, Singleton*	
Council area:	*Singleton*	
Owner/developer:	*ARD Developments Pty Ltd*	
ph:	*0412 611 206 (Mr Dwight Geelan)*	
Address:	*PO Box 2063, SINGLETON, NSW 2330*	
Size/shape/layout:	Site plans attached	*yes*
	Photographs attached	*yes*
Water supply: *Not known at this preliminary stage*		
Expected wastewater quantity (litres/day): *Not known at this preliminary stage*		
Local experience regarding neighbouring on-site sewage management systems installed in the locality?	*No*	

3 PRELIMINARY SITE ASSESSMENT
Climate: Are low temperatures expected (particularly below 15°C)? *Yes*
Where appropriate: Rainfall water balance attached? *no* Land application area calculation attached? *no* Wet weather storage area calculation attached? *no*
Flood potential: Land application area above 1 in 20 year flood level? *Yes* (assumed)* Electrical components above 1 in 100 year flood level? *Yes* (assumed)* **above building exclusion zone*
Exposure: *High sun and wind exposure [minor limitation]*
Slope: • *10^o to 12^o south to west facing slopes of the northern hill [**major limitation – surface irrigation**, moderate limitation – sub-surface & absorption system]* • *7^o to 10^o generally north to east and locally south facing slopes of the southern ridge and western hill [moderate limitation – all land application systems]*
Landform: *Side slopes [moderate limitation]* *Intermittent watercourses [**major limitation**]*
Run-on and upslope seepage: *Moderate – diversion possible [moderate limitation]*
Erosion potential: *Signs of erosion potential within watercourses [**major limitation**]* *Elsewhere, no signs of erosion potential present [minor limitation]*
Site drainage: *Signs of surface dampness within watercourses [**major limitation**]* *Elsewhere, no visible signs of surface dampness [minor limitation]*
Fill: *None observed [minor limitation]*

Groundwater:

Horizontal distance to groundwater well used for domestic water supply? *> 250m*
Relevant groundwater vulnerability map referred to? *yes*
Level of protection (I-VI)? *I (low)*
Bores in the area and their purpose? *Results of groundwater bore search indicate there are no registered bores within 250m of the site*

Buffer distances from wastewater:

Management system to:

Permanent waters (m)	*> 100m*
Other waters (m)	***<40m (locally) to dam & intermittent waterways [major limitation]***
Other sensitive environments (m)	*>250m*
Boundary of premises (m)	*>6m*
Swimming pools (m)	*>6m (none present)*
Driveways & Buildings (m)	*>6m*

Is there sufficient land area available for:

Application system (including buffer distances)? *Yes*
Reserve application system (including buffer distances)? *Yes*

Surface rocks:

<10% [minor limitation]

4 PRELIMINARY SOIL ASSESSMENT

Depth to bedrock or hardpan (m):

Area A (BH01 to BH03)	*>1.1m to >1.2m [minor limitation]*
Area B (BH04 to BH06)	*0.8m to >1.1m [**major limitation – absorption system**, moderate limitation – surface & subsurface irrigation]*
Area C (BH07 to BH09)	*1.2m [minor limitation]*
Area D (BH10 to BH12)	*0.2m to >1.4m [**major limitation – all systems]***
Area E (BH13 to BH15)	*>1.2m to >1.4m [minor limitation]*

Depth to high soil watertable (m): *Groundwater not encountered within the boreholes [minor limitation]*
Hydraulic loading rate (where applicable): Soil structure: *weakly pedal Topsoil Weakly pedal Slopewash (Area B) highly/moderately pedal Residual soil* Soil texture: *Light Medium Clay Topsoil Sandy Clay Residual soil (Medium Clay within Area A)* Permeability category: *6a (Area A)* ***[major limitation – all land application systems]*** *4a (Areas B, C, D & E) [minor limitation]* Other measures of soil permeability: - Design Loading Rate (DLR) for Mound Systems (mm/day): *8* Reasons for the DLR recommendation: *AS1547-2000*
Coarse fragments (%): *5-30 [minor to moderate limitation]*
Bulk density (g/cm^3): *Sandy Clay 1.4-1.6 [moderate limitation]*
pH_{CaCl} : *Areas A, B & E pH 4.63-4.79 (3 samples) [moderate limitation]* *Areas C & D pH 4.26 & 3.83 (2 samples) [**major limitation**]*
Electrical conductivity (dS/m): *EC topsoil 0.07 (1 test) x Multiplication Factor (MF) 10 = 0.7 [minor limitation]* *EC residual 0.04 to 0.2 (4 tests) x MF 9 = 0.36 to 1.8 [minor limitation]*
Exchangeable sodium percentage (ESP): *Areas A & D 6.01 & 5.9 (2 tests) [moderate limitation]* *Areas B, C & E 26.3, 30.7 & 21.7 (3 tests) [**major limitation**]*
Cation exchange capacity (cmol*/kg): *Areas A, B, C, D & E 6.2 to 12.64 [moderate to minor limitation]*

Phosphorus sorption index (kg/Ha):

Areas A, B, C, D & E *6370 to 12885 [minor limitation]*

Geology & soil landscape survey: *Singleton Geological Series Sheet 9132- IV-N (Edition 1) 1984*

Presence of discontinuities: *Darlington Anticline*
Presence of fractured subsoil: *none indicated*
Soil and Landscape map reference: *Singleton Soil Landscape Series Sheet SI56-1 (Soil Conservation Service of NSW)*

Dispersiveness: *Emerson Aggregate (SAR5):*

Class 2 (9 tests) *[moderate limitation]*

Class 5 (3 tests) *[minor limitation]*

5 SYSTEM SELECTION

Consideration of connection to a centralised sewerage system:
Approximate distance to nearest feasible connection point? *Unknown*
Potential for future connection to centralised sewerage? *Low*
Potential for future connection to reticulated water? *Unknown*

Type of land application system considered best suited to site:

Amended Soil Mound Systems consisting of cells containing a leach drain, underlying impervious membrane and filled with a soil treatment medium usually comprising an approved soil or industrial by-product which is high in iron and aluminium sesquioxides which have strong phosphorous adsorption capacity. Effluent treatment occurs during flow within cell in contact with amended soil. Effluent loss is by evapo-transpiration with reported low volume effluent escape over perimeter bunds.

Why?

The results of our preliminary site and soil assessment indicate Areas A, B, C, D and E at BH01 to BH15 to be unsuitable for on-site effluent disposal by conventional surface, sub-surface or absorption systems.

Site features assessed as having major limitations comprise slope, landform and geology/regolith. Slopes are locally steep, landform includes dams and intermittent watercourses, and geology/regolith consists of major geological discontinuities associated with the various rock formations of the Darlington Anticline. These limitations represent run-off, erosion and groundwater pollution hazards.

Soil features assessed as having major limitations comprise localised shallow depth to bedrock, low soil permeability category, low pH and elevated sodicity. These features represent excessive runoff, restricted plant growth and potential for structural degradation hazards.

Sites with major limitations are generally not suitable or require specialised design.

6 GENERAL COMMENTS

Are there any specific environmental and health constraints?

The restrictive site and soil features described above in Section 5 represent environmental and health constraints for the conventional methods of wastewater disposal at this site. A specialised method of disposal (Amended Soil Mound System) has been suggested.

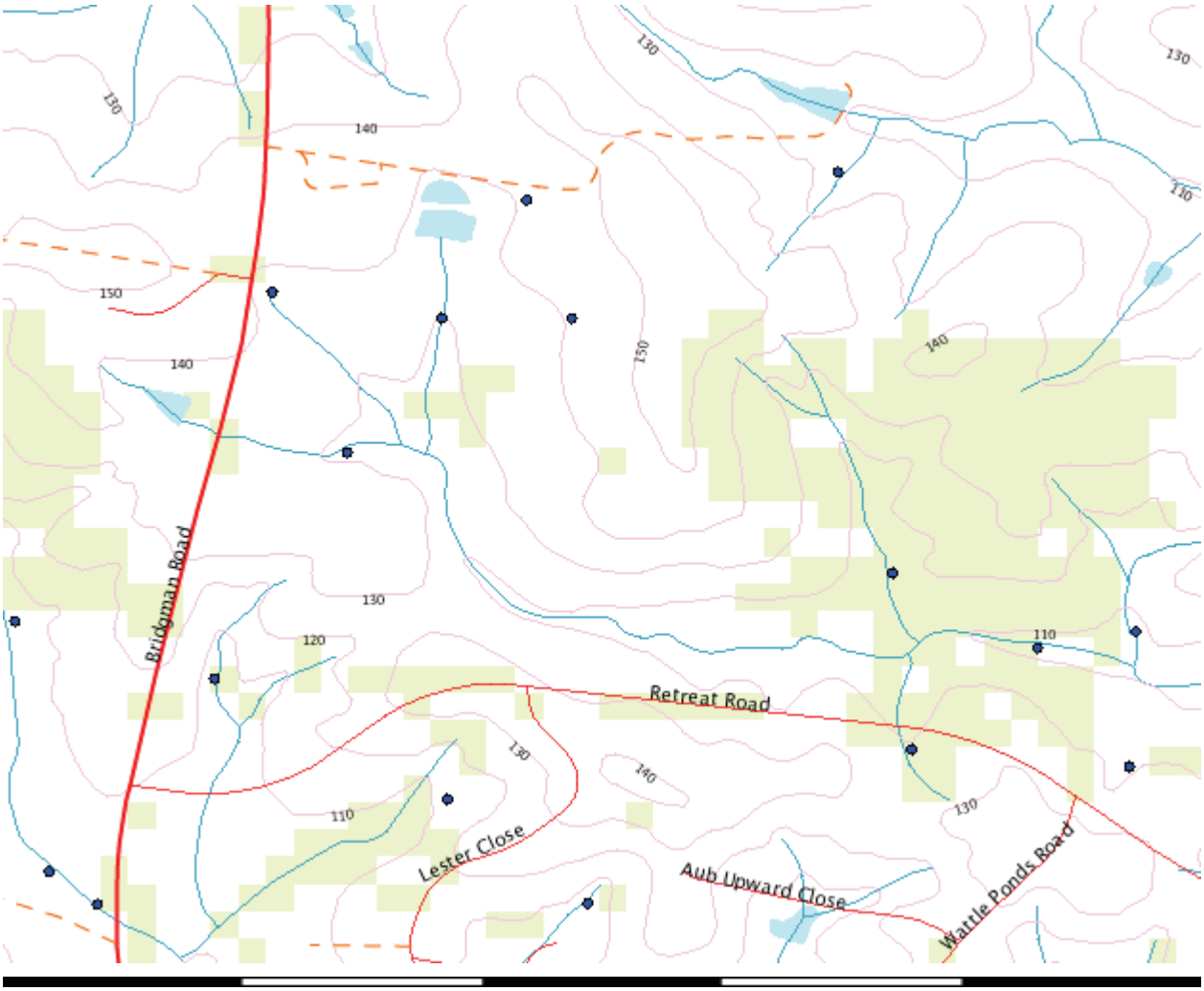
Disposal areas for the system should be constructed in accordance with Appendix 4.2A of AS1547-2000 "Onsite Domestic Wastewater Management" and preferably located in accordance with Table 5 in the "Environment and Health Protection Guidelines-Onsite Sewage Management for Single Households".

HGS 2145 ARD Developments

Proposed Residential Subdivision, Lots 22 & 221 DP 562824 & 823112 Retreat Road, Singleton NO
DOWNLOADABLE DATA IN CURRENT MAP

Map created with NSW Groundwater Works - http://nratlas.nsw.gov.au

Friday, March 25, 2011



0 1 Km

Legend

Symbol	Layer	Custodian
	Cities and large towns renderImage: Cannot build image from features	
Cowra	Populated places renderImage: Cannot build image from features	
	Towns	
	Groundwater Bores	
	Catchment Management Authority boundaries	
	Major rivers	

Topographic base map

Copyright © 2011 New South Wales Government. Map has been compiled from various sources and may contain errors or omissions. No representation is made as to its accuracy or suitability.

APPENDIX A

Borehole Logs (BH01 to BH15)

Subsurface Diagram

General Notes, Terms and Symbols Sheet

Hunter Geotechnics Pty Ltd
PO Box 7086
KARIONG NSW 2250
Telephone: 02 43401234
Fax: 02 43401234

BOREHOLE NUMBER BH01

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 131.5 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH01

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Clayey SILT, grey brown, dry, with grass roots	Laboratory Analysis	TOPSOIL
					CL	Silty CLAY, low to medium plasticity, dark brown to red brown, M<Wp, (stiff to very stiff)		RESIDUAL
		131.0	0.5				Laboratory Analysis	
		130.5	1.0					
						Borehole BH01 terminated at 1.1m		
		130.0	1.5					
		129.5	2.0					

Hunter Geotechnics Pty Ltd
PO Box 7086
KARIONG NSW 2250
Telephone: 02 43401234
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BOREHOLE NUMBER BH02

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 131 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH02

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Clayey SILT, brown, with grass roots		TOPSOIL
					CL-CH	Silty CLAY, medium to high plasticity, red brown, M=Wp, hard	PP=400kPa	RESIDUAL
		130.5	0.5					
		130.0	1.0					
						Borehole BH02 terminated at 1.2m		
		129.5	1.5					
		129.0	2.0					

Hunter Geotechnics Pty Ltd
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BOREHOLE NUMBER BH03

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 131 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH03

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Clayey SILT, dry, with grass roots		TOPSOIL
					CL-CH	Silty CLAY, medium to high plasticity, dark brown to red brown, M=Wp, very stiff to hard	PP=300 - 400kPa Laboratory Analysis	RESIDUAL
		130.5	0.5					
		130.0	1.0		CL-CH	Silty CLAY, medium to high plasticity, grey & pale grey-brown mottled red, M=Wp, very stiff	Laboratory Analysis PP=300kPa	
		129.5	1.5			Borehole BH03 terminated at 1.2m		
		129.0	2.0					

Hunter Geotechnics Pty Ltd
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BOREHOLE NUMBER BH04

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 119 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH04

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT, pale brown, medium to coarse gravel, dry	Laboratory Analysis	SLOPEWASH
					CL	Sandy CLAY, medium plasticity, pale brown & orange-brown, coarse sand to fine gravel with some coarse garvel & cobbles, M<Wp, hard	PP=>400kPa	RESIDUAL
		118.5	0.5					
		118.0	1.0				Laboratory Analysis	
						Borehole BH04 terminated at 1.1m		
		117.5	1.5					
		117.0	2.0					

Hunter Geotechnics Pty Ltd
PO Box 7086
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Telephone: 02 43401234
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BOREHOLE NUMBER BH05

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 123 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH05

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					SM	Silty SAND, fine to medium grained, brown, dry, (loose)		TOPSOIL
					SP-SM	Silty Gravelly SAND, fine to coarse sand & gravel, pale brown, dry		SLOPEWASH
		122.5	0.5		CL	Sandy CLAY, medium plasticity, orange & grey-brown, fine to coarse sand, some fine gravel, moist, (hard)		RESIDUAL
		122.0	1.0			SANDSTONE, coarse grained, orange-brown to brown		ROCK
		121.5	1.5			Borehole BH05 terminated at 1.2m		
		121.0	2.0					

BOREHOLE / TEST PIT HGS 2154.GPJ GINT STD AUSTRALIA.GDT 15/4/11

Hunter Geotechnics Pty Ltd
PO Box 7086
KARIONG NSW 2250
Telephone: 02 43401234
Fax: 02 43401234

BOREHOLE NUMBER BH06

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 121 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH06

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Sandy SILT, pale brown, fine sand, dry, with grass roots, (loose)	Laboratory Analysis	TOPSOIL
					SP-SM	Silty Gravelly SAND, pale brown, some coarse gravel, dry		SLOPEWASH
		120.5	0.5		CL	Sandy CLAY, medium plasticity, orange-brown, fine to coarse sand, some fine to coarse gravel, M<Wp, hard	PP=>400kPa	RESIDUAL
		120.0	1.0			SANDSTONE, pale brown & orange		ROCK
		119.5	1.5			Borehole BH06 terminated at 1.1m		
		119.0	2.0					

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BOREHOLE NUMBER BH07

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 126 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH07

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Sandy SILT, pale brown, dry, with grass roots	Laboratory Analysis	TOPSOIL
		125.5	0.5		CL	Silty CLAY, medium plasticity, red & grey brown, M>Wp, stiff	PP=>200kPa	RESIDUAL
		125.0	1.0			Borehole BH07 terminated at 1m		
		124.5	1.5					
		124.0	2.0					

BOREHOLE / TEST PIT HGS 2154.GPJ GINT STD AUSTRALIA.GDT 15/4/11

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BOREHOLE NUMBER BH08

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 123 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH08

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					SM	Silty SAND, fine grained, pale brown, dry, (loose)		TOPSOIL
		122.5	0.5		CL	Silty CLAY, low to medium plasticity, orange brown & grey brown & mottled red-brown, some fine sand, M>Wp, (stiff)	Laboratory Analysis	RESIDUAL
		122.0	1.0					
		121.5	1.5			Borehole BH08 terminated at 1.2m		
		121.0	2.0					

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BOREHOLE NUMBER BH09

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 126 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH09

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	SILT, grey brown, with grass roots		TOPSOIL
					CL	Silty CLAY, low to medium plasticity, M<W, (hard)		RESIDUAL
		125.5	0.5					
		125.0	1.0					
						SILTSTONE, extremely weathered, fine grained, pale grey		ROCK
		124.5	1.5			Borehole BH09 terminated at 1.4m		
		124.0	2.0					

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BOREHOLE NUMBER BH10

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 145 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH10

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT, pale grey brown & dark brown, dry, (loose)		ALLUVIAL
						SANDSTONE, fine grained, pale brown		ROCK
						Borehole BH10 terminated at 0.3m		Auger Refusal on Rock
		144.5	0.5					
		144.0	1.0					
		143.5	1.5					
		143.0	2.0					

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BOREHOLE NUMBER BH11

CLIENT ARD Developments Pty Ltd
PROJECT NAME Proposed Residential Subdivision
PROJECT NUMBER HGS 2154
PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 143 **DATUM** m AHD
DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---
EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01
HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.
NOTES No Groundwater Encountered at BH11

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT, pale brown, fine sand, medium to coarse gravel		TOPSOIL / SLOPEWASH
					CL	Silty CLAY, medium plasticity, orange brown mottled red-brown, some rounded gravel, M<Wp, (hard)		RESIDUAL
		142.5	0.5				Laboratory Analysis	
		142.0	1.0					
						Borehole BH11 terminated at 1.4m		
		141.5	1.5					
		141.0	2.0					

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BOREHOLE NUMBER BH12

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 142 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH12

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT, pale brown, fine sand, medium to coarse gravel		TOPSOIL
					CL	Gravelly Sandy Silty CLAY, low to medium plasticity, orange-brown, M<Wp, (firm to stiff)		RESIDUAL
		141.5	0.5					
		141.0	1.0					
						Borehole BH12 terminated at 1.4m		
		140.5	1.5					
		140.0	2.0					

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BOREHOLE NUMBER BH13

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 129.5 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH13

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT,pale grey, medium to coarse gravel, with grass roots		TOPSOIL
					CL	Gravelly Sandy CLAY, low to medium plasticity, orange-brown, fine to coarse gravel & sand, M=Wp, (stiff to very stiff)		RESIDUAL
		129.0	0.5				Laboratory Analysis	
		128.5	1.0					
						Borehole BH13 terminated at 1.4m		
		128.0	1.5					
		127.5	2.0					

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BOREHOLE NUMBER BH14

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 128 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH14

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT, pale brown, fine sand, medium to coarse gravel, dry, with grass roots	Laboratory Analysis	TOPSOIL
		127.5	0.5		CL	Sandy CLAY, medium plasticity, pale orange & brown, fine to medium sand, M>Wp, stiff	PP=200 - 150kPa	RESIDUAL
		127.0	1.0					
						Borehole BH14 terminated at 1.2m		
		126.5	1.5					
		126.0	2.0					

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BOREHOLE NUMBER BH15

CLIENT ARD Developments Pty Ltd **PROJECT NAME** Proposed Residential Subdivision

PROJECT NUMBER HGS 2154 **PROJECT LOCATION** Lots 22 & 221 Retreat Road, Singleton

DATE STARTED 4/1/11 **COMPLETED** 4/1/11 **R.L. SURFACE** 127.5 **DATUM** m AHD

DRILLING CONTRACTOR Dwight Geelan **SLOPE** 90° **BEARING** ---

EQUIPMENT Kubota 4.5 Tonne Excavator **HOLE LOCATION** Refer to Site Plan Drawing HGS 2154-01

HOLE SIZE 450mm **LOGGED BY** R.T. **CHECKED BY** G.P.

NOTES No Groundwater Encountered at BH15

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
AS					ML	Gravelly Sandy SILT, grey-brown, fine sand, medium to coarse gravel, dry, with grass roots		TOPSOIL
					CL	Sandy CLAY, low to medium plasticity, orange-brown to brown, fine sand, some medium gravel, M>Wp, firm to stiff	PP=150 - 230kPa	RESIDUAL
		127.0	0.5					
		126.5	1.0					
						Borehole BH15 terminated at 1.2m		
		126.0	1.5					
		125.5	2.0					

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SUBSURFACE DIAGRAM

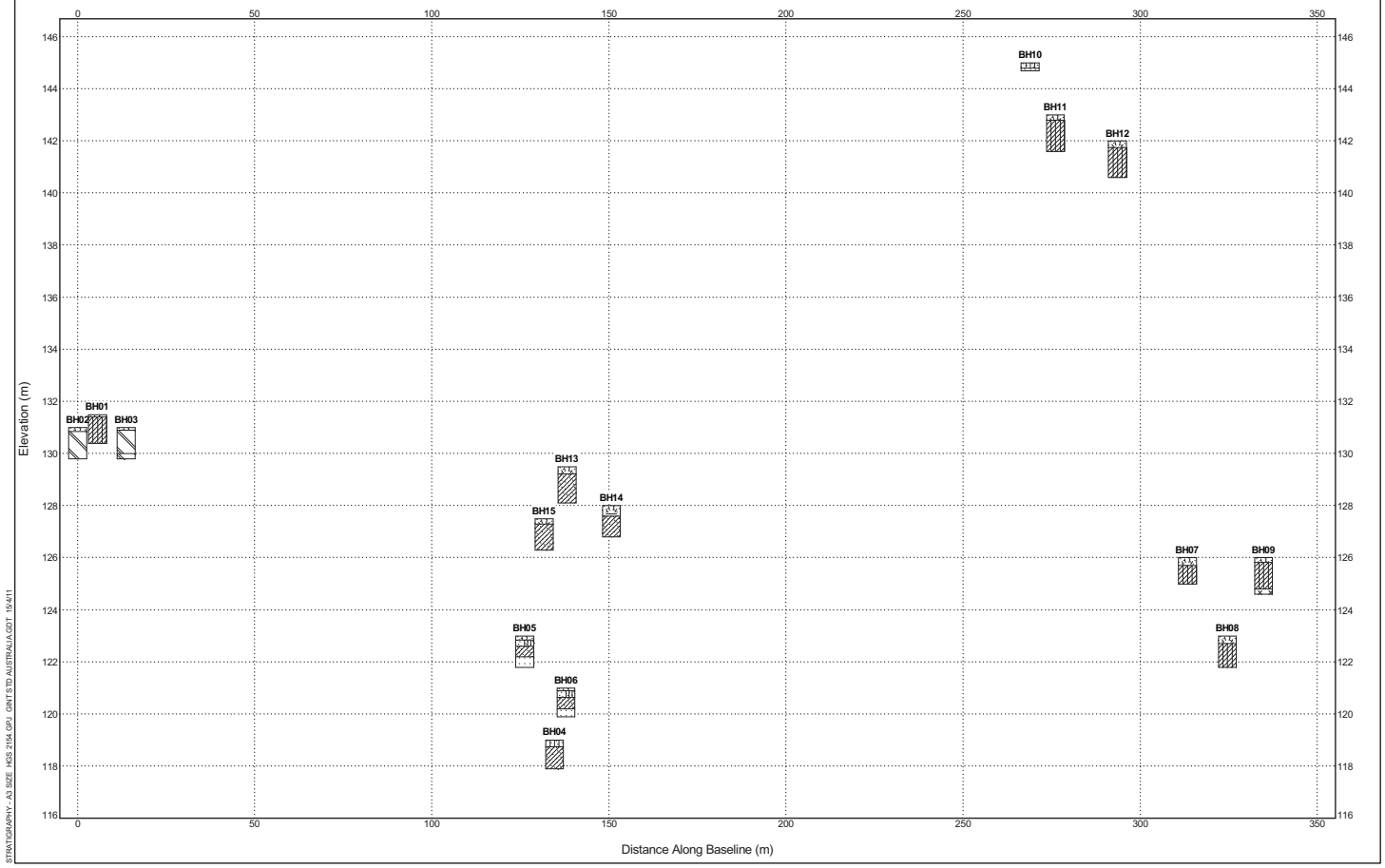
CLIENT ARD Developments Pty Ltd

PROJECT NUMBER HGS 2154

PROJECT NAME Proposed Residential Subdivision

PROJECT LOCATION Lots 22 & 221 Retreat Road, Singleton

- Topsoil
- USCS Sandy Silt
- Sandstone
- USCS Low Plasticity Silty Clay
- USCS Low Plasticity Sandy Clay
- Siltstone
- USCS Low to High Plasticity Clay
- USCS Poorly-graded Sand with Silt



STRATIGRAPHY - A3 SIZE - HGS 2154.GPJ - GINT STD AUSTRALIA.GDT - 16/4/11

General Notes Terms and Symbols

GENERAL
Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report may not be relevant for other phases of the project (e.g. construction), or where projects details change.

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 opposite for term and symbol definitions.

GROUNDWATER
The water levels indicated on the logs are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specific locations. Also, groundwater levels can vary with time due to seasonal or tidal fluctuations and construction activities.

INTERPRETATION OF RESULTS
The discussion and recommendations in the accompanying report are based on extrapolation / interpolation from data obtained at discrete locations. The actual interface between the materials may be far more gradual or abrupt than indicated. Also, actual conditions in areas not sampled may differ from those predicted.

CHANGE IN CONDITIONS
Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

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FURTHER ADVICE
We would be pleased to further discuss how any of the above issues could affect your specific project. We would also be please to provide further advice or assistance including.

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

SOIL DESCRIPTIONS

Consistency		Qu (kPa)
VS	Very Soft	<25
S	Soft	25 – 50
F	Firm	50 – 100
St	Stiff	100 – 200
VSt	Very Stiff	200 – 400
H	Hard	>400
Fb	Friable	- -

Density Index		I_D (%)
VL	Very Loose	< 15
L	Loose	15 – 35
MD	Medium Dense	35 – 65
D	Dense	65 – 85
VD	Very Dense	> 85

Moisture Condition

D	Dry	M	Moist	W	Wet
W_P	Plastic Limit	W_L	Liquid Limit		

ROCK DESRIPTIONS

Weathering		Structure	Spacing
RS	Residual Soil	Thinly laminated	< 6 mm
XW	Extremely Weathered	Laminated	6 – 20 mm
HW	Highly Weathered	Very Thinly bedded	20 – 60 mm
MW	Moderately Weathered	Thinly bedded	60 – 200 mm
DW	Distinctly Weathered*	Medium bedded	0.2 – 0.6 m
SW	Slightly Weathered	Thickly bedded	0.6 – 2m
FR	Fresh	Very thickly bedded	> 2 m
	*DW covers HW & MW		

Strength		$Is_{(50)}$ Mpa
EL	Extremely Low	< 0.03
VL	Very Low	0.03 – 0.1
L	Low	0.1 – 0.3
M	Medium	0.3 – 1
H	High	1 – 3
VH	Very High	3 – 10
EH	Extremely High	> 10

X = diametral test
O = axial test

Natural Fractures

Type		Shape		Infill / Coating		Roughness	
JT	Joint	pl	planar	cn	clean	pol	polished
BP	Bedding plane	cu	curved	cl	clay	slk	slickensided
SM	Seam	un	undulose	ca	calcite	smo	smooth
FZ	fractured zone	st	stepped	cb	carbonaceous	rou	rough
SZ	Shear zone	ir	irregular	fe	iron oxide	vro	very rough
VN	Vein	dis	dicontin-uous	mi	micaceous		
				qz	quartz		

Note: Soil and rock descriptions are based on AS 1726 – 1993.

EXCAVATION / DRILLING METHOD & CASING

BH	Backhoe / excavator bucket
NE	Natural exposure
HE	Hand excavation
AS	Auger screwing*
AD	Auger drilling*
	* bit type shown by suffix
	V = 'V' shaped Bit
	T = Tungsten carbide Bit
	B = Blank Bit
R	Roller / Tricone
W	Washbore
NMLC	NMLC size core drilling
NQ/HQ	Wireline core drilling
C	Casing
M	Mud

SAMPLES / TESTS & WATER MEASUREMENTS

B	Bulk sample
D	Disturbed sample
U50	Undisturbed sample ⌖50mm
PP	Pocket penetrometer (kPa)
SV	Shear vane test (kPa)
SPT	Standard penetration test
N*	SPT value (blows/300mm)
	* Denotes sample taken
Nc	SPT value with solid cone
DCP	Dynamic cone penetrometer (blows/150mm)
R	Refusal of SPT or DCP
▼	Water Level during drilling
▽	Water Level after drilling
▲-	Water Inflow
-▲	Water Outflow

APPENDIX B

Laboratory Test Results

Hunter Geotechnics Pty Limited
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SOIL CLASSIFICATION TEST REPORT — Singleton Laboratory

(AUSTRALIAN STANDARDS METHODS)

CLIENT:	ARD Developments Pty Ltd	**REPORT No:**	S2154-03
CLIENT ADDRESS:	PO Box 3063, Singleton NSW 2330		
PROJECT:	**Proposed Effluent Disposal**	**PROJECT No:**	HGS 2154
DATE OF TESTING:	**21/1/11**	**DATE OF REPORT:**	25/3/11
LOCATION:	Lot 22 & 221 Retreat Road, Singleton		
TECHNICIAN:	R.T.	**DATE SAMPLED:**	4/1/11

	SAMPLE No:		1	2	3
	SAMPLE LOCATION:		BH 1 0.0 – 0.1m	BH 1 0.1-0.8m	BH 3 0.1-0.5m
	MATERIAL DESCRIPTION:		Grey Brown Clayey Silt	Dark Brown & Red Brown Silty Clay	Dark Brown & Red Brown Silty Clay
	WASHED / UNWASHED:		-	-	-
AS 1289.3.8.1	**Water Type & Temperature:**		Distilled 21°C	Distilled 21°C	Distilled 21°C
TEST METHOD	**TEST DESCRIPTION**				
AS 1289.3.6.1		75mm	-	-	-
		53mm	-	-	-
		37.5mm	-	-	-
		26.5mm	-	-	-
	% Passing	19.0mm	-	-	-
	Sieve Analysis	13.2mm	-	-	-
		9.5mm	-	-	-
		6.7mm	-	-	-
SAMPLING METHOD		4.75mm	-	-	-
		2.36mm	-	-	-
AS1289.1.2.1		1.18mm	-	-	-
		600µm	-	-	-
		425µm	-	-	-
		300µm	-	-	-
		150µm	-	-	-
		75µm	-	-	-
AS 1289.3.8.1	EMERSON CLASS No:		2	5	5
AS 1289.2.1.1	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.4	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.6	MOISTURE CONTENT	%	-	-	-

			CODE			
AS 1289.3.1.1	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.1.2	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.2.1	PLASTIC LIMIT	%	-	-	-	-
AS 1289.3.3.1	PLASTICITY INDEX	%	-	-	-	-
AS 1289.3.4.1	LINEAR SHRINKAGE	%	-	-	-	-

CODES USED

Sample history for plasticity tests	
Air Dried	1
Low temperature oven (<50°C) dried	2
Other /Unknown	3

Method of preparation for plasticity tests	
Dry sieved	4
Wet sieved	5
Natural	6

Sampled by:	Hunter Geotechnics

Signed: .....

Approved Signatory

Signatory Name: P Deasy
Document ID: R-T02
Issue No: 7
Date of Issue: 30 July 2009

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NATA Accredited Laboratory No: 14490

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SOIL CLASSIFICATION TEST REPORT — Singleton Laboratory

(AUSTRALIAN STANDARDS METHODS)

CLIENT:	ARD Developments Pty Ltd	**REPORT No:**	S2154-04
CLIENT ADDRESS:	PO Box 3063, Singleton NSW 2330		
PROJECT:	**Proposed Effluent Disposal**	**PROJECT No:**	HGS 2154
DATE OF TESTING:	**21/1/11**	**DATE OF REPORT:**	25/3/11
LOCATION:	Lot 22 & 221 Retreat Road, Singleton		
TECHNICIAN:	R.T.	**DATE SAMPLED:**	4/1/11

	SAMPLE No:		4	5	6
	SAMPLE LOCATION:		BH 3 1.0-1.2m	BH 4 0.6-1.0m	BH 4 0.0-0.25m
	MATERIAL DESCRIPTION:		Grey & Pale Grey Brown Mottled Red Silty Clay	Pale Brown & Orange Brown Sandy Clay, some Coarse Gravel	Pale Brown Gravely Sandy Silt
	WASHED / UNWASHED:		-	-	-
AS 1289.3.8.1	**Water Type & Temperature:**		Distilled 21°C	Distilled 21°C	Distilled 21°C
TEST METHOD	**TEST DESCRIPTION**				
AS 1289.3.6.1		75mm	-	-	-
		53mm	-	-	-
		37.5mm	-	-	-
		26.5mm	-	-	-
	% Passing	19.0mm	-	-	-
	Sieve Analysis	13.2mm	-	-	-
		9.5mm	-	-	-
		6.7mm	-	-	-
SAMPLING METHOD		4.75mm	-	-	-
		2.36mm	-	-	-
AS1289.1.2.1		1.18mm	-	-	-
		600µm	-	-	-
		425µm	-	-	-
		300µm	-	-	-
		150µm	-	-	-
		75µm	-	-	-
AS 1289.3.8.1	EMERSON CLASS No:		5	2	2
AS 1289.2.1.1	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.4	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.6	MOISTURE CONTENT	%	-	-	-

			CODE			
AS 1289.3.1.1	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.1.2	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.2.1	PLASTIC LIMIT	%	-	-	-	-
AS 1289.3.3.1	PLASTICITY INDEX	%	-	-	-	-
AS 1289.3.4.1	LINEAR SHRINKAGE	%	-	-	-	-

CODES USED

Sample history for plasticity tests	
Air Dried	1
Low temperature oven (<50°C) dried	2
Other /Unknown	3

Method of preparation for plasticity tests	
Dry sieved	4
Wet sieved	5
Natural	6

Sampled by:	Hunter Geotechnics

Signed: .....

Approved Signatory

Signatory Name: P Deasy
Document ID: R-T02
Issue No: 7
Date of Issue: 30 July 2009

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SOIL CLASSIFICATION TEST REPORT — Singleton Laboratory

(AUSTRALIAN STANDARDS METHODS)

CLIENT:	ARD Developments Pty Ltd	**REPORT No:**	S2154-05
CLIENT ADDRESS:	PO Box 3063, Singleton NSW 2330		
PROJECT:	**Proposed Effluent Disposal**	**PROJECT No:**	HGS 2154
DATE OF TESTING:	**21/1/11**	**DATE OF REPORT:**	25/3/11
LOCATION:	Lot 22 & 221 Retreat Road, Singleton		
TECHNICIAN:	R.T.	**DATE SAMPLED:**	4/1/11

	SAMPLE No:		7	8	9
	SAMPLE LOCATION:		BH 6 0.0-0.1m	BH 8 0.3-1.0m	BH 7 0.1-0.3m
	MATERIAL DESCRIPTION:		Pale Brown Sandy Silt	Orange Brown & Grey Brown Silty Clay, with some Fine Sand	Pale Brown Sandy Silt
	WASHED / UNWASHED:		-	-	-
AS 1289.3.8.1	**Water Type & Temperature:**		Distilled 21°C	Distilled 21°C	Distilled 21°C
TEST METHOD	**TEST DESCRIPTION**				
AS 1289.3.6.1	% Passing Sieve Analysis	75mm	-	-	-
		53mm	-	-	-
		37.5mm	-	-	-
		26.5mm	-	-	-
		19.0mm	-	-	-
		13.2mm	-	-	-
		9.5mm	-	-	-
		6.7mm	-	-	-
SAMPLING METHOD		4.75mm	-	-	-
		2.36mm	-	-	-
AS1289.1.2.1		1.18mm	-	-	-
		600µm	-	-	-
		425µm	-	-	-
		300µm	-	-	-
		150µm	-	-	-
		75µm	-	-	-
AS 1289.3.8.1	EMERSON CLASS No:		2	2	2
AS 1289.2.1.1	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.4	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.6	MOISTURE CONTENT	%	-	-	-

			CODE			
AS 1289.3.1.1	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.1.2	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.2.1	PLASTIC LIMIT	%	-	-	-	-
AS 1289.3.3.1	PLASTICITY INDEX	%	-	-	-	-
AS 1289.3.4.1	LINEAR SHRINKAGE	%	-	-	-	-

CODES USED

Sample history for plasticity tests	
Air Dried	1
Low temperature oven (<50°C) dried	2
Other /Unknown	3

Method of preparation for plasticity tests	
Dry sieved	4
Wet sieved	5
Natural	6

Sampled by:	Hunter Geotechnics

Signed: .....

Approved Signatory

Signatory Name: P Deasy
Document ID: R-T02
Issue No: 7
Date of Issue: 30 July 2009

NATA ACCREDITED FOR TECHNICAL COMPETENCE

This document is issued in accordance with NATA's accreditation requirements. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian / national standards. Accredited for compliance with ISO/IEC 17025

NATA Accredited Laboratory No: 14490

This report remains the property of Hunter Geotechnics Pty Ltd until paid in full.

Hunter Geotechnics Pty Limited
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SOIL CLASSIFICATION TEST REPORT — Singleton Laboratory

(AUSTRALIAN STANDARDS METHODS)

CLIENT:	ARD Developments Pty Ltd	**REPORT No:**	S2154-06
CLIENT ADDRESS:	PO Box 3063, Singleton NSW 2330		
PROJECT:	**Proposed Effluent Disposal**	**PROJECT No:**	HGS 2154
DATE OF TESTING:	**21/1/11**	**DATE OF REPORT:**	25/3/11
LOCATION:	Lot 22 & 221 Retreat Road, Singleton		
TECHNICIAN:	R.T.	**DATE SAMPLED:**	4/1/11

	SAMPLE No:		10	11	12
	SAMPLE LOCATION:		BH 11 0.4-0.8m	BH 13 0.4-0.8m	BH 14 0.0-0.4m
	MATERIAL DESCRIPTION:		Orange Brown & Mottled Red Brown Silty Clay, some Gravel	Orange Brown Gravely Sandy Clay	Pale Brown Gravely Sandy Silt
	WASHED / UNWASHED:		-	-	-
AS 1289.3.8.1	**Water Type & Temperature:**		Distilled 21°C	Distilled 21°C	Distilled 21°C
TEST METHOD	**TEST DESCRIPTION**				
AS 1289.3.6.1		75mm	-	-	-
		53mm	-	-	-
		37.5mm	-	-	-
		26.5mm	-	-	-
	% Passing	19.0mm	-	-	-
	Sieve Analysis	13.2mm	-	-	-
		9.5mm	-	-	-
		6.7mm	-	-	-
SAMPLING METHOD		4.75mm	-	-	-
		2.36mm	-	-	-
AS1289.1.2.1		1.18mm	-	-	-
		600µm	-	-	-
		425µm	-	-	-
		300µm	-	-	-
		150µm	-	-	-
		75µm	-	-	-
AS 1289.3.8.1	EMERSON CLASS No:		2	2	2
AS 1289.2.1.1	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.4	MOISTURE CONTENT	%	-	-	-
AS 1289.2.1.6	MOISTURE CONTENT	%	-	-	-

			CODE			
AS 1289.3.1.1	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.1.2	LIQUID LIMIT	%	-	-	-	-
AS 1289.3.2.1	PLASTIC LIMIT	%	-	-	-	-
AS 1289.3.3.1	PLASTICITY INDEX	%	-	-	-	-
AS 1289.3.4.1	LINEAR SHRINKAGE	%	-	-	-	-

CODES USED

Sample history for plasticity tests	
Air Dried	1
Low temperature oven (<50°C) dried	2
Other /Unknown	3

Method of preparation for plasticity tests	
Dry sieved	4
Wet sieved	5
Natural	6

Sampled by:	Hunter Geotechnics

Signed: .....

Approved Signatory

Signatory Name: P Deasy
Document ID: R-T02
Issue No: 7
Date of Issue: 30 July 2009

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NATA Accredited Laboratory No: 14490

This report remains the property of Hunter Geotechnics Pty Ltd until paid in full.

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ANALYSIS REPORT SOIL

Project No:	**EW110307**	**Date of Issue:**	**15/04/2011**
Client:	Hunter Geotechnics Singleton	Report No:	2
Address:	PO Box 3003	Date Received:	26/03/2011
	Singleton NSW 2330	Matrix:	SOIL
Phone:	02 65721234	Location:	HGS 2154
Fax:	02 65721572	Sampler ID:	Client Supplied
email:	richardt@huntergeotechnics.com.au	Date of Sampling:	4/01/2011

Comments: This report supercedes any previous report with this reference.

Signed: Anne Michie
Laboratory Manager

NATA Accredited Laboratory 15708

This document is issued in accordance with NATA's accreditation requirements.

Accredited for complience with ISO/IEC 17025

This analysis relates to the sample submitted and it is the client's responsibility to make certain the sample is representative of the matrix to be tested.
Samples will be discarded one month after the date of this report. Please advise if you wish to have your sample/s returned.

FOR SOIL, PLANT, WATER & GRAIN ANALYSIS * AGRICULTURAL & ENVIRONMENTAL CONSULTING

ANALYSIS REPORT

Project No: EW110307 Location: HGS 2154

		Sample ID	#1		
		Depth	0.0-0.1m		
Analyte	**Method**	**Units**	**110307-1**		
Electrical Conductivity	Soil:Water (1:5)	*dS/m*	0.07		
pH ($CaCl_2$)	Electrode	*pH units*	4.70		
Phosphorus Ex	Colwell	*mg/kg*	21.5		
Phos Buffer Index	PBI (Col)	*mg/kg*	87.0		
Phos Sorption Capacity	PBI (Col)	*mg/kg*	455		
				mg/kg	*meq/100g*
Potassium Ex	NH_4Cl	R&H 15A1	-	288	0.74
Calcium Ex	NH_4Cl	R&H 15A1	-	670	3.35
Magnesium Ex	NH_4Cl	R&H 15A1	-	530	4.42
Sodium Ex	NH_4Cl	R&H 15A1	-	127	0.55
Aluminium Ex	KCL	R&H 15G1	-	12.1	0.13
Ex Potassium %	Calc	Calc	%	8.03	
Ex Calcium %	Calc	Calc	%	36.4	
Ex Magnesium %	Calc	Calc	%	48.1	
Ex Sodium %	Calc	Calc	%	6.01	
Ex Aluminium %	Calc	Calc	%	1.46	
ECEC	Calc	Calc	*meq/100g*	9.19	
Ca/Mg Ratio	Calc	Calc	*meq/100g*	0.76	
Particle Size Analysis (Hydrometer)					
Clay	ASTM D422-63	%	41.1		
Silt	ASTM D422-63	%	26.3		
Very Fine Sand	ASTM D422-63	%	19.1		
Fine Sand	ASTM D422-63	%	3.9		
Medium Sand	ASTM D422-63	%	2.8		
Coarse Sand	ASTM D422-63	%	1.5		
Very Coarse Sand	ASTM D422-63	%	1.6		
Gravel	ASTM D422-63	%	3.6		
Bulk Density	ASTM F1815-97	*g/cm3*	1.4		
Linear Shrinkage	AS1289:C4.1	%	4.3		
Texture	McDonald et al	*Class*	LMC		

EAST WEST enviroag

Report Date: 15/04/2011

ANALYSIS REPORT

Project No: EW110307 Location: HGS2154

		Sample ID	#5		
		Depth	0.6-1.0m		
Analyte	**Method**	**Units**	**110307-2**		
Electrical Conductivity	Soil:Water (1:5)	*dS/m*	0.20		
pH ($CaCl_2$)	Electrode	*pH units*	4.79		
Phosphorus Ex	Colwell	*mg/kg*	16.4		
Phos Buffer Index	PBI (Col)	*mg/kg*	83.7		
Phos Sorption Capacity	PBI (Col)	*mg/kg*	440		
				mg/kg	*meq/100g*
Potassium Ex	NH_4Cl	R&H 15A1	-	150	0.38
Calcium Ex	NH_4Cl	R&H 15A1	-	141	0.71
Magnesium Ex	NH_4Cl	R&H 15A1	-	976	8.13
Sodium Ex	NH_4Cl	R&H 15A1	-	765	3.33
Aluminium Ex	KCL	R&H 15G1	-	7.8	0.09
Ex Potassium %	Calc	Calc	%	3.04	
Ex Calcium %	Calc	Calc	%	5.6	
Ex Magnesium %	Calc	Calc	%	64.4	
Ex Sodium %	Calc	Calc	%	26.3	
Ex Aluminium %	Calc	Calc	%	0.69	
ECEC	Calc	Calc	*meq/100g*	12.64	
Ca/Mg Ratio	Calc	Calc	*meq/100g*	0.09	
Particle Size Analysis (Hydrometer)					
Clay	ASTM D422-63	%	29.1		
Silt	ASTM D422-63	%	17.9		
Very Fine Sand	ASTM D422-63	%	4.3		
Fine Sand	ASTM D422-63	%	5.7		
Medium Sand	ASTM D422-63	%	14.4		
Coarse Sand	ASTM D422-63	%	4.2		
Very Coarse Sand	ASTM D422-63	%	2.8		
Gravel	ASTM D422-63	%	21.7		
Bulk Density	ASTM F1815-97	*g/cm3*	1.5		
Linear Shrinkage	AS1289:C4.1	%	7.9		
Texture	McDonald et al	*Class*	SC		

EAST WEST enviroag

Report Date: 15/04/2011

ANALYSIS REPORT

Project No: EW110307 Location: HGS2154

		Sample ID	#8		
		Depth	0.3-1.0m		
Analyte	**Method**	**Units**	**110307-3**		
Electrical Conductivity	Soil:Water (1:5)	*dS/m*	0.16		
pH ($CaCl_2$)	Electrode	*pH units*	4.26		
Phosphorus Ex	Colwell	*mg/kg*	16.4		
Phos Buffer Index	PBI (Col)	*mg/kg*	77.8		
Phos Sorption Capacity	PBI (Col)	*mg/kg*	417		
				mg/kg	*meq/100g*
Potassium Ex	NH_4Cl	R&H 15A1	-	137	0.35
Calcium Ex	NH_4Cl	R&H 15A1	-	212	1.06
Magnesium Ex	NH_4Cl	R&H 15A1	-	669	5.58
Sodium Ex	NH_4Cl	R&H 15A1	-	761	3.31
Aluminium Ex	KCL	R&H 15G1	-	43.1	0.48
Ex Potassium %	Calc	Calc	%	3.26	
Ex Calcium %	Calc	Calc	%	9.8	
Ex Magnesium %	Calc	Calc	%	51.7	
Ex Sodium %	Calc	Calc	%	30.7	
Ex Aluminium %	Calc	Calc	%	4.44	
ECEC	Calc	Calc	*meq/100g*	10.8	
Ca/Mg Ratio	Calc	Calc	*meq/100g*	0.19	
Particle Size Analysis (Hydrometer)					
Clay	ASTM D422-63	%	31.6		
Silt	ASTM D422-63	%	14.2		
Very Fine Sand	ASTM D422-63	%	19.6		
Fine Sand	ASTM D422-63	%	13.4		
Medium Sand	ASTM D422-63	%	7.6		
Coarse Sand	ASTM D422-63	%	2.9		
Very Coarse Sand	ASTM D422-63	%	2.8		
Gravel	ASTM D422-63	%	7.9		
Bulk Density	ASTM F1815-97	*g/cm3*	1.6		
Linear Shrinkage	AS1289:C4.1	%	9.8		
Texture	McDonald et al	*Class*	SC		

EAST WEST enviroag

Report Date: 15/04/2011

ANALYSIS REPORT

Project No: EW110307 Location: HGS2154

		Sample ID	#10		
		Depth	0.4-0.8m		
Analyte	**Method**	**Units**	**110307-4**		
Electrical Conductivity	Soil:Water (1:5)	*dS/m*	0.04		
pH ($CaCl_2$)	Electrode	*pH units*	3.83		
Phosphorus Ex	Colwell	*mg/kg*	19.3		
Phos Buffer Index	PBI (Col)	*mg/kg*	210.0		
Phos Sorption Capacity	PBI (Col)	*mg/kg*	777		
				mg/kg	*meq/100g*
Potassium Ex	NH_4Cl	R&H 15A1	-	115	0.29
Calcium Ex	NH_4Cl	R&H 15A1	-	252	1.26
Magnesium Ex	NH_4Cl	R&H 15A1	-	329	2.74
Sodium Ex	NH_4Cl	R&H 15A1	-	83.3	0.36
Aluminium Ex	KCL	R&H 15G1	-	136	1.51
Ex Potassium %	Calc	Calc	%	4.78	
Ex Calcium %	Calc	Calc	%	20.4	
Ex Magnesium %	Calc	Calc	%	44.4	
Ex Sodium %	Calc	Calc	%	5.9	
Ex Aluminium %	Calc	Calc	%	24.49	
ECEC	Calc	Calc	*meq/100g*	6.2	
Ca/Mg Ratio	Calc	Calc	*meq/100g*	0.46	
Particle Size Analysis (Hydrometer)					
Clay	ASTM D422-63	%	32.7		
Silt	ASTM D422-63	%	18.4		
Very Fine Sand	ASTM D422-63	%	17.8		
Fine Sand	ASTM D422-63	%	8.8		
Medium Sand	ASTM D422-63	%	10.8		
Coarse Sand	ASTM D422-63	%	0.7		
Very Coarse Sand	ASTM D422-63	%	0.4		
Gravel	ASTM D422-63	%	10.4		
Bulk Density	ASTM F1815-97	*g/cm3*	1.5		
Linear Shrinkage	AS1289:C4.1	%	11.8		
Texture	McDonald et al	*Class*	SC		

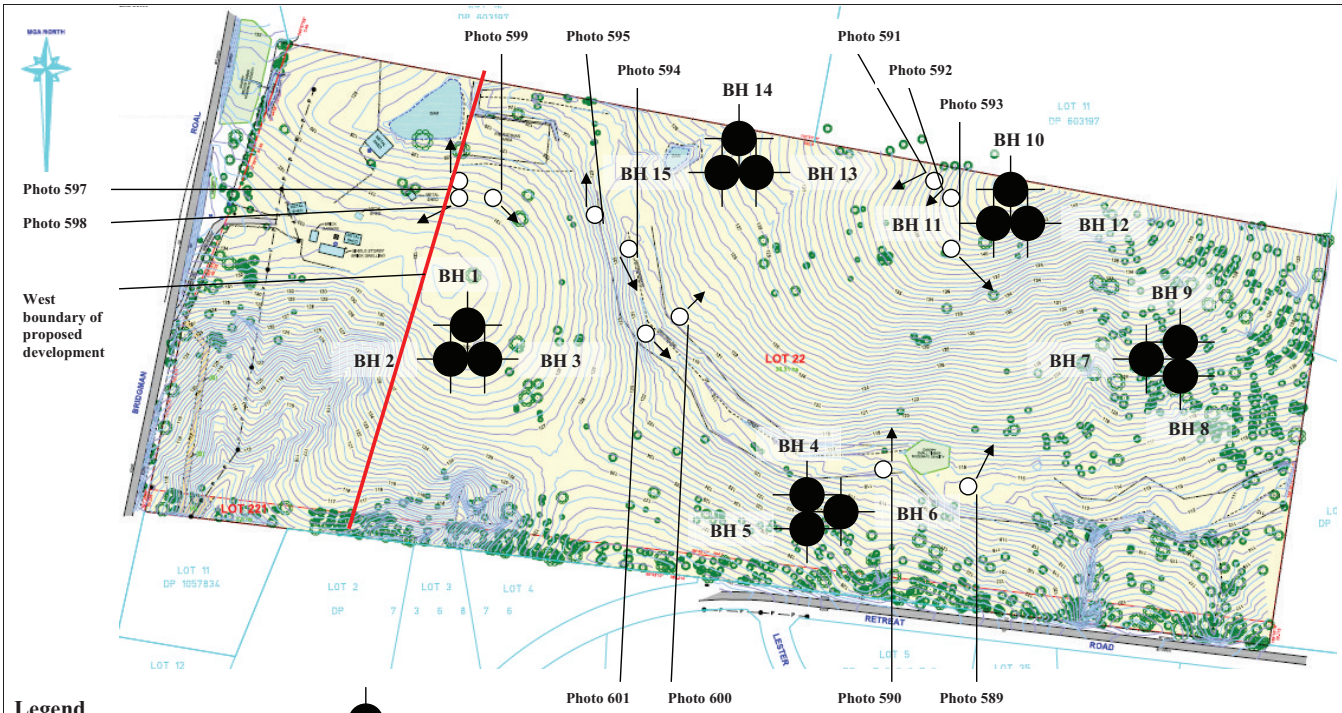
ANALYSIS REPORT

Project No: EW110307 Location: HGS2154

		Sample ID	#11		
		Depth	0.4-0.8m		
Analyte	**Method**	**Units**	**110307-5**		
Electrical Conductivity	Soil:Water (1:5)	*dS/m*	0.18		
pH ($CaCl_2$)	Electrode	*pH units*	4.63		
Phosphorus Ex	Colwell	*mg/kg*	17.8		
Phos Buffer Index	PBI (Col)	*mg/kg*	276.0		
Phos Sorption Capacity	PBI (Col)	*mg/kg*	859		
				mg/kg	*meq/100g*
Potassium Ex	NH_4Cl	R&H 15A1	-	144	0.37
Calcium Ex	NH_4Cl	R&H 15A1	-	160	0.80
Magnesium Ex	NH_4Cl	R&H 15A1	-	570	4.75
Sodium Ex	NH_4Cl	R&H 15A1	-	387	1.68
Aluminium Ex	KCL	R&H 15G1	-	14.7	0.16
Ex Potassium %	Calc	Calc	%	4.75	
Ex Calcium %	Calc	Calc	%	10.3	
Ex Magnesium %	Calc	Calc	%	61.2	
Ex Sodium %	Calc	Calc	%	21.7	
Ex Aluminium %	Calc	Calc	%	2.10	
ECEC	Calc	Calc	*meq/100g*	7.77	
Ca/Mg Ratio	Calc	Calc	*meq/100g*	0.17	
Particle Size Analysis (Hydrometer)					
Clay	ASTM D422-63	%	24.1		
Silt	ASTM D422-63	%	8.9		
Very Fine Sand	ASTM D422-63	%	4.9		
Fine Sand	ASTM D422-63	%	5.0		
Medium Sand	ASTM D422-63	%	11.6		
Coarse Sand	ASTM D422-63	%	9.8		
Very Coarse Sand	ASTM D422-63	%	6.7		
Gravel	ASTM D422-63	%	29.0		
Bulk Density	ASTM F1815-97	*g/cm3*	1.5		
Linear Shrinkage	AS1289:C4.1	%	8.7		
Texture	McDonald et al	*Class*	SC		

EAST WEST enviroag

Report Date: 15/04/2011



Legend

Approximate Borehole Location

Approximate Photo Location & Direction

Hunter Geotechnics Pty Ltd
ABN: 80 088 399 124
Unit 2/8 Mathry Close
PO Box 3003
Singleton NSW 2330
Ph: 02 65721234
Fax: 02 65721572

Drawing No: HGS 2154-01	**ARD Developments**
Scale: NTS	Proposed Residential Subdivision Retreat Road, Singleton
Drawn By: A.C.	
Date: April 2011	SITE PLAN


Photo 589


Photo 590


Photo 591


Photo 592


Photo 593


Photo 594


Photo 595


Photo 597


Photo 598


Photo 599


Photo 600


Photo 601

Hunter Geotechnics Pty Ltd **ABN: 80 088 399 124** Unit 2 / 8 Mathry Close PO BOX 3003 SINGLETON NSW 2330 PH 65721234 FAX 6572 1572	**Job No:** HGS 2154	**ARD Developments Pty Ltd**
	Scale: As Shown	Proposed Residential Subdivision Lots 22 & 221 Retreat Road, Singleton
	Drawn By: LM	
	Date: April 2011	**Photographs**