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STOCKLAND DEVELOPMENT PTY LTD
BROAD GEOTECHNICAL APPRAISAL
SITE B
SOUTH DEEBING CREEK ROAD
DEEBING HEIGHTS
BRADLEES CONSULTING PTY LTD

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8th November, 2010

Stockland Development Pty Ltd
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ATTENTION: MR JASON MURDOCH
Email: Jason@bradlees.com.au

Dear Sir,

RE: BROAD GEOTECHNICAL APPRAISAL – SITE B – SOUTH DEEBING CREEK ROAD, DEEBING HEIGHTS

1.0 INTRODUCTION

This report presents the results of a broad geotechnical appraisal for the proposed residential subdivision termed Site B (the Site) including Precinct A at South Deebing Creek Road, Deebing Heights. From information received from BradLees Consulting, the proposed subdivision will involve the creation of new residential allotments with associated roads and services.

Our research has indicated that the Site is not affected by old underground mining activities. This report is based on underground mining not being a geotechnical constraint for the Site. The issue of underground mining activity is excluded from this report, but must be taken up with an appropriate consultant. Moreton Geotechnical Services (Mr Ken Grubb) is a local consultant who provides advice relating to old mine workings and would be able to help in this regard.

It should be noted that a large area of the Site was not accessible due to dense vegetation. The inaccessible area covered the eastern and extreme southern portions of the Site, outside the defined boundaries of proposed Precincts A and B. These areas must be tested before construction commences in these areas.

The broad geotechnical appraisal was commissioned by Stockland Development Pty Ltd.

The purpose of the investigation was to broadly assess the subsurface conditions at the Site, and conduct fieldwork and laboratory testing to provide preliminary advice and recommendations relating to:

- Subsurface conditions in accordance with AS1726;
- Preliminary broadscale existing site classifications in accordance with AS2870;
- Broadscale soil dispersion assessments;
- Broadscale excavation conditions;
- Broadscale slope stability assessment in accordance with Appendix C of Australian Geomechanics Society (AGS) "Landslide Risk Management ", March, 2007, with assumptions;
- Preliminary design soaked CBR values based on visual assessments of likely prevailing subgrade materials;

Site classification in accordance with AS.2870 "Residential Slabs and Footings" for each individual residential lot is excluded from the scope of work, requiring further testing at a later date.

This report has been written with consideration to the relevant sections of the Ipswich City Council Planning Scheme Part 12 Div 15 Earthworks Code in the absence of any specific guidelines or specifications under ULDA requirements.

The stability assessment has been carried out in accordance with Appendix C of Australian Geomechanics Society (AGS) "Landslide Risk Management ", March, 2007. This approach for risk assessment is qualitative or semi-quantitative, suiting sites where historic instability data are not available and combines the likelihood of an instability event with the consequences to property to derive an assessment of risk. The process is inherently subjective. Assumptions regarding the proposed earthworks and development have been made.

This report has been prepared to address the suitability of the Site for residential development with respect to slope stability and other geotechnical constraints. It identifies the predominant geotechnical constraints associated with the proposed development, as well as providing recommendations to minimise the risk of future slope instability and poor performance

2.0 METHODOLOGY

A 4WD Jacro 200 utility mounted drill rig was used to drill 41 boreholes to depths generally ranging between 1.50m and 3.00m beneath the ground surface at the Site. Drilling refusal at "max TC bit" in weathered rock was achieved in the following boreholes and at the following depths below the ground surface:-

- Borehole BH2 – 1.00m;
- Borehole BH3 – 1.50m;
- Borehole BH4 – 1.50m;
- Borehole BH5 – 1.70m;
- Borehole BH7 – 0.60m;
- Borehole BH8 – 1.50m;
- Borehole BH9 – 1.20m;
- Borehole BH11 – 1.50m;
- Borehole BH19 – 2.50m;
- Borehole BH23 – 1.40m;
- Borehole BH33 – 1.45m; and
- Borehole BH40 – 2.20m.

Borehole drilling was conducted using a 100mm diameter tungsten carbide (TC) bit.

Boreholes were positioned on a 150m (approx) grid using a hand held Garmin GPS 60 unit, which recorded the borehole co-ordinates. General borehole location accuracy was ±5m.

Dynamic Cone Penetration (DCP) tests were conducted adjacent to each borehole. A pocket penetrometer was used to test for the estimated unconfined compressive strength of cohesive materials.

A walk-over survey of the Site was undertaken by a Geoscientist from our Darra office during October and November 2010, which involved mapping and measuring observed features of significance to slope stability such as soil type, slope gradients and direction, erosion features, surface and subsurface drainage, filled and cut areas, vegetation density and the presence of irregular surface features such as erosion rills and gullies, slips, slumps, hummocks, back scarps, scree debris fans or any associated features.

The results of the walkover survey, the subsurface conditions in the boreholes, the ground surface slope angles and laboratory test results were used to assess the broadscale post development risk level for this Site.

The following disturbed samples were tested in the Emerson Class Dispersion test at the Morrison Geotechnic Darra Laboratory:-

- Borehole BH3 between 0.10m and 0.20m;
- Borehole BH13 between 0.00m and 0.10m and 1.20m and 1.30m;
- Borehole BH15 between 0.40m and 0.50m;
- Borehole BH22 between 0.50m and 0.60m;
- Borehole BH25 between 0.00m and 0.10m;
- Borehole BH26 between 0.65m and 0.75m;
- Borehole BH27 between 2.00m and 2.40m;
- Borehole BH29 between 1.20m and 1.50m; and
- Borehole BH32 between 2.10m and 2.50m.

The following samples were taken in thin wall 'U50' tubes and tested in the Shrink/Swell test at the Morrison Geotechnic Darra Laboratory:-

- Borehole BH2 between 0.20m and 0.50m;
- Borehole BH11 between 0.50m and 0.66m;
- Borehole BH13 between 0.35m and 0.61m;
- Borehole BH14 between 0.60m and 0.74m;
- Borehole BH30 between 0.10m and 0.30m;
- Borehole BH31 between 0.30m and 0.55m; and
- Borehole BH41 between 0.20m and 0.47m.

The following samples were taken in thin wall 'U50' tubes and tested in the Shrink/Swell with Swell Pressure test at the Trilab Laboratory:-

- Borehole BH7 between 0.20m and 0.37m; and
- Borehole BH16 between 1.80m and 2.12m.

The approximate locations of the boreholes are presented in a site plan contained in Appendix A.

The borehole log sheets are presented in Appendix B.

The laboratory test result sheets are presented in Appendix C.

The 2007 AGS "Landslide Risk Management" Guidelines and the AGS Guidelines for Hillside Construction are attached as Appendix D.

3.0 SITE DESCRIPTION

The Site is orientated in a north-south orientation and is characterised by undulating and gentle ground surface slopes generally ranging between 5^0 and 7^0. A creek gully runs the entire length of the Site in a north-south orientation and essentially divides the Site into eastern and western portions. A smaller gully approximately 30m to 40m long, 4m wide and 2m deep was observed adjacent to borehole BH6 within the extreme northwestern portion of the Site towards the entry gate at the southern end of South Deebing Creek Road. A large dam is present towards the centre of the Site and several smaller dams are also present in low lying areas across the Site. Scattered tree vegetation is present along with a moderate, low to medium length grass cover. Dense tree vegetation is present within the eastern and extreme southern portions of the Site and this prevented the drilling of boreholes within these areas.

Some cobbles were observed over the ground surface in scattered locations across the elevated hillside portions of the Site, indicating creep movement of soil and rock material downslope. These areas are not likely to pose significant instability risks to development. Extensive erosion and gully features were observed across the Site, especially within the main drainage channel towards the centre, and within the northern portion of the Site. These areas displayed sub vertical to vertical eroded faces visually up to 5m to 6m high, with tunnel and rill erosion features evident immediately behind and within the exposed faces. These areas are highly unstable and prone to slips, slumping and general failure associated with rainfall discharges and evidenced by fallen trees lying at the base of the eroded faces in the drainage channel.

There were no other observed recent past or historical failure or slip areas observed during the walkover survey of the Site.

4.0 SUBSURFACE CONDITIONS

The regional geology, local subsurface conditions and local groundwater conditions are described in Sections 4.1, 4.2 and 4.3.

4.1 Regional Geology

The regional geology sequence of the area is made up of alluvium underlain by the Gatton Sandstone Formation. The alluvium materials are thought to have been deposited in the Quaternary Geological Time Period and consist of clay, silt, sand and gravel. The Gatton Sandstone Formation was thought to have formed in the Jurassic Geological Time Period and consists of lithic labile and feldspathic labile sandstone (Ipswich 1 : 100 000 Geological Series, 9442, 2006, produced by the Queensland Department of Natural Resources, Mines and Water).

4.2 Local Subsurface Conditions

The local subsurface conditions encountered within the depth range of the boreholes are described as follows:-

Uncontrolled Fill: Encountered only in borehole BH21, comprising moist, medium dense silty sand extending to 0.60m;

Topsoil: Encountered in most boreholes and ranging between 50mm (0.05m) and 200mm (0.2m) in thickness and generally comprising moist, wet and dry, loose, loose to medium dense and medium dense silty sand and clayey sand;

Slopewash Soil: Encountered in boreholes BH4, BH5, BH9, BH11 and BH15, comprising moist and wet, loose, loose to medium dense and medium dense silty sand and clayey sand, extending to depths ranging between 0.30m and 0.50m;

Alluvial Soil: Encountered in the low lying boreholes and generally comprising an interlayered clay and sand sequence. Alluvial clay soils generally comprised moist, stiff, very stiff and hard sandy clay and silty clay of high plasticity. Alluvial sandy soils generally comprised moist, moist to wet and wet, loose, medium dense, dense and very dense silty sand and clayey sand. Alluvial gravel soils may be encountered in localised areas across the site. Weak soils including loose and wet alluvial sandy soils may be encountered to depths of up to 2m to 3m below the ground surface in localised areas. The alluvial soil sequence extends to depths ranging between 1.3m and in excess of 3m;

Residual Soil: Encountered in the elevated boreholes, generally comprising moist, dense clayey sand and moist, stiff, very stiff and hard sandy clay and silty clay of medium and high plasticity, extending to depths ranging between 0.20m and 2.80m, underlain by;

Weathered Rock: Generally encountered in the elevated boreholes, comprising Extremely Weathered (XW) Sandstone of Extremely Low Strength (ELS), Very Low Strength (VLS) and becoming Distinctly Weathered (DW) and Low Strength (LS) with depth in some boreholes. The Weathered Sandstone rock may be completely decomposed in localised areas, with engineering properties equivalent to a dense clayey sand soil. The Weathered Sandstone rock sequence is quite variable in strength across the Site and may either be completely decomposed and weak and layered with residual soils or comparatively strong with Low Strength (LS) and Distinctly Weathered (DW) characteristics. The Weathered Rock sequence extends to depths ranging between 0.60m (at refusal) and in excess of 3m.

Drilling refusal at "maximum TC bit" in weathered rock was achieved in the following boreholes and at the following depths below the ground surface:-

- Borehole BH2 – 1.00m;
- Borehole BH3 – 1.50m;
- Borehole BH4 – 1.50m;
- Borehole BH5 – 1.70m;
- Borehole BH7 – 0.60m;
- Borehole BH8 – 1.50m;
- Borehole BH9 – 1.20m;
- Borehole BH11 – 1.50m;
- Borehole BH19 – 2.50m;
- Borehole BH23 – 1.40m;
- Borehole BH33 – 1.45m; and
- Borehole BH40 – 2.20m.

4.3 Local Groundwater Conditions

Groundwater was not intersected within the depth range of the boreholes immediately after borehole drilling.

The presence and depth to groundwater will vary with rainfall, subsurface material type and permeability conditions, the integrity of adjacent buried services and the proximity, type and density of vegetation.

5.0 LABORATORY TEST RESULTS

Seven (7) undisturbed samples of the natural clay soils were retrieved in thin wall 50mm diameter steel tubes and tested to assess the natural clay soil volume change capability in the Shrink Swell test at the Morrison Geotechnic Darra laboratory. An additional two (2) samples were tested for Shrink/Swell and Swell Pressure properties at the Trilab Windsor laboratory. The Shrink Swell and Shrink Swell with Swell Pressure laboratory test result sheets are presented in Appendix C to this report and summarised in Table 1.

Table 1 – Shrink/Swell Index and Swell Pressure Test Results

Borehole	Sample Depth (m)	Material*	Shrink Specimen Moisture Content (%)	Swell Specimen Moisture Content (%)	Shrink (%)	Swell (%)	Shrink Swell Index (Iss %)	Swell Pressure (kPa)
BH2	0.20 – 0.50	Residual Soil – Sandy Clay (CH)	16.4	16.0	2.2	0.6	1.4	-
BH7	0.20- 0.37	Residual Soil – Sandy Clay (CH)	11.3	10.8	1.6	1.0	1.2	200
BH11	0.50 – 0.66	Residual Soil – Sandy Clay (CH)	13.0	12.2	2.1	2.8	2.0	-
BH13	0.35 – 0.61	Residual Soil – Sandy Clay (CH)	17.3	13.4	1.0	0.1	0.6	-
BH14	0.60 – 0.74	Alluvial Soil – Sandy Clay (CH)	11.6	11.7	1.6	0.9	1.2	-
BH16	1.80- 2.12	Alluvial Soil – Silty Clay (CH)	19.6	20.5	3.8	5.7	3.7	800
BH30	0.10- 0.30	Alluvial Soil – Silty Clay (CH)	31.9	34.9	3.8	2.2	2.7	-
BH31	0.30- 0.55	Alluvial Soil – Sandy Clay (CH)	17.8	14.1	2.7	0.8	1.7	-
BH41	0.20- 0.47	Alluvial Soil – Silty Clay (CH)	25.2	19.1	7.4	2.9	4.9	-

*Material description based on a visual description of recovered drill cuttings in the field.

The results of the Emerson Class Dispersion tests are summarised below in Table 2.

Table 2 – Emerson Class Dispersion Test Results

Borehole Number	Depth (m)	Material*	Emerson Class Dispersion Number
BH3	0.10-0.20	Residual Soil – Sandy Clay (CH)	2
BH13	0.00-0.10	Topsoil – Silty Sand (SM)	6
	1.20-1.30	XW Sandstone Rock	2
BH15	0.40-0.50	Residual Soil – Sandy Clay (CH)	4
BH22	0.50-0.60	Alluvial Soil – Clayey Sand	2
BH25	0.00-0.10	Topsoil – Clayey Sand	6
BH26	0.65-0.75	Residual Soil – Clayey Sand	2
BH27	2.00-2.40	Alluvial Soil – Sandy Clay (CH)	3
BH29	1.20-1.50	Alluvial Soil – Clayey Sand	2
BH32	2.10-2.50	XW Sandstone Rock	2

*Material description based on a visual description of recovered drill cuttings in the field.

6.0 BROADSCALE EXISTING SITE CLASSIFICATIONS

The site classifications will depend on the predominant soil profile at each location. Preliminary broadscale site classifications based on the likely range of predominant soil profiles are given below in Table 3.

Table 3 – Preliminary Broadscale Existing Site Classifications

Predominant Soil Profile After Earthworks	Most Likely Classification to AS2870
Fill	M to H[1]
Natural Clay Soils (CI)	M
Natural Clay Soils (CH)	H to E[2]
Alluvial Sands (SM and SC)	S to M[3]
XW and DW Sandstone	S to M[4]

[1]Classification based on the fill materials not containing any high plasticity clay soils (CH).
[2] Note the likely E classification would predominantly apply to the low areas of the Site nearest the drainage lines where the high plasticity clay profile is typically at least 2m thick.
[3] Prevailing near drainage lines with sandy soils to at least 1m; not expected to be widespread.
[4]High areas where cutting exposes sandstone rock.

The Site classifications may be more severe where the following situations apply:-

- Further earthworks to that described in this Section are carried out; and/or
- Extensive tree and vegetation planting or clearing is performed on site.

It should be noted that a large area of the Site within the eastern and extreme southern portions could not be accessed due to the presence of dense vegetation. Further testing must be conducted in these areas before construction commences. Furthermore, a lot by lot borehole drilling and testing investigation will be required to determine the site classifications for individual lots, after the earthworks have been completed.

7.0 BROADSCALE SOIL DISPERSION

Disturbed samples were taken in the various soil profile strata and tested in the Emerson Class Dispersion test with the interpretation of results based on AS1289.3.8.1. The Emerson Class Dispersion results are presented in Table 4.

Table 4 – Broadscale Soil Dispersion

Material	Emerson Class Dispersion Number	Dispersive* (Yes/No)
Topsoils (Silty Sands and Clayey Sands)	6	No
Alluvial Soils (Sandy Clay – CH and Clayey Sand)	2, 3	Yes
Residual Soils (Sandy Clay – CH and Clayey Sand)	2, 4	Yes (Emerson Class 2)
XW Sandstone Rock	2	Yes

* Soils determined as dispersive or non dispersive based on the Emerson Class Dispersion results and the information contained in AS1289.3.8.1 – Section 6

Based on the results of the Emerson Class Dispersion tests and in accordance with AS1289.3.8.1, alluvial soil, residual soil and XW sandstone rock materials are likely to be dispersive. Severe erosion and sedimentation is expected within these profiles at the Site. Erosion causing gully channels, rills and tunnel features, as observed in the field, may be an ongoing process at locations across the Site, resulting from concentrations of rainfall runoff. The main drainage channel within the central and northern portion of the Site contains sub vertical to vertical eroded faces up to 5m to 6m high, with tunnel and rill erosion features observed immediately behind and within the erosion faces. These areas are highly unstable and pose a high instability risk to development, as observed by fallen trees lying at the base of the erosion faces in the drainage channel. Refer to recommendations given in Section 10.0 of this report for further management recommendations. There were no other observed existing or historical failures or slip areas observed during the walkover survey of the Site.

Topsoils are likely to be inert and not dispersive. However, topsoils are typically highly erodible as they are typically encountered in thin and loose profiles at the ground surface.

8.0 EXCAVATION CONDITIONS

Excavation conditions within the low lying areas of the Site towards the centre and in the natural soils to depths of up to 3m will be possible using small to medium sized excavators fitted with normal soil buckets, and will require only light ripping using small or medium sized tractors.

Excavation conditions within the elevated site areas surrounding the central regions of the Site and in the natural soils to depths of up to 0.5m to 1.5m will be possible using small to medium sized excavators fitted with normal soil buckets, and will require only light ripping using small or medium sized tractors.

Below these depths, and within the XW sandstone rock, excavation rates are expected to be considerably slower, especially in localised regions where drilling refusal was achieved. Excavation rates below 0.5m to 1.5m will require the use of large excavators fitted with ripper attachments or heavy tractor ripping using medium sized tractors. Groundwater seepage into excavations should be minor and readily controllable by pumping from sumps.

Temporary cut batters up to 3.0m deep can be constructed at no steeper than 0.5H:1V in the XW sandstone rock and 1:1 in the natural soils. Where the natural alluvial soils towards the centre of the Site are observed to be wet and loose, temporary cut batters are to be no steeper than 2H:1V, subject to confirmation by appropriate inspection during construction. Steeper batter slopes, will require short and long term lateral support.

Permanent batters in cuttings should be no steeper than 3H:1V in the weak natural alluvial soils towards the centre of the Site, 2H:1V in all other natural soils and 1H:1V with benches every 2.0m in the XW rock, subject to on-site inspections during construction. Permanent batters must be inspected by this office during construction to confirm the above recommended batter slopes and identify any unstable zones or unfavourably dipping defects or sheared zones which may affect long term stability.

Temporary and permanent fill batters should not be steeper than 2H:1V and must be over-compacted and trimmed back to ensure proper compaction in the outer zones.

It is very important that all cut and fill batters, once constructed are immediately protected from scouring and erosion by suitable protection measures, such as establishing a plant cover and drainage to limit the potential for erosion of the highly dispersive soils and rock present at the Site. Refer to Section 10.0 of this report for further information.

9.0 BROADSCALE SLOPE STABILITY ASSESSMENT

At the time of the walkover survey, unstable areas were observed within the central and northern portions of the Site within the drainage channels. These unstable areas comprised the highly eroded vertical and sub vertical bank sections up to 5.0m high characterized by severe gullies, rills, undercutting and tunnel features. The Site displayed no other evidence of existing or recent past instability involving large scale or small scale movements of significant quantities of soil or rock in a short duration event such as a slip or landslide.

Minor creep movement of the topsoil and natural soils to depths of up to 0.30m to 0.50m is expected in the future, but this is not anticipated to significantly impact on properly designed, constructed and maintained residential development. Erosion is expected to potentially be the most significant instability mechanism in the future impacting on residential development, requiring careful design and management techniques to control and minimise erosion sediment runoff and maintain stability.

It is essential that all earthworks, including but not limited to minor cuts or fills, be structurally engineered to the recommendations made in Section 10.0 of this report, which will reduce the probability of erosion, scouring or general batter failure and limit the potential of extensive damage due to these events. The descriptor "Unlikely" means that "the event could occur under very adverse circumstances" and is considered appropriate to describe the likelihood of a rainfall triggered slump or soil creep within the batters of low fills or the natural soils, with an Annual Indicative Probability of about 10^{-4}. Slumping and erosion of batters or soil creep would likely cause limited damage to parts of a house structure, with a descriptor of damage as "Minor".

On this basis, the risk to property can be assessed as "Low" if the earthworks are strictly limited and carried out in accordance with our recommendations. This level of risk is "Tolerable" provided the guidelines in Section 10.0 are followed in all development phases.

10.0 GENERAL GUIDELINES FOR DEVELOPMENT

Erosion and sediment transport is seen as the most significant geotechnical challenge for the development of the Site and close design attention must be given to minimizing the potential for, and the effects of, these processes. Inevitably, controlling surface water runoff will be a major factor in addressing these geotechnical issues.

The following development guidelines, in conjunction with the AGS Guidelines for Hillside Construction, attached as Appendix D, must be incorporated into future development to maintain a Tolerable level of risk in relation to slope stability for the residential subdivision and development:-

- Engineering controls and/or structures to reduce the potential for erosion and general bank instability must be provided along drainage gully banks. These structures could include gabions, rock mattress or other structural interventions which control runoff and limit the effect of water discharges. A buffer area where no development is allowed should be provided behind the crests of the banks in these areas. The buffer area and engineering controls should be monitored and reviewed periodically at regular time frequencies and especially where further erosion, gully widening and general bank or slope failures are observed, for reassessments of management strategies;

- All stormwater and other discharge outfalls into the gullies must incorporate headwalls and energy dissipating devices to reduce flow velocities and therefore reduce the potential for scour and erosion;

- Due to the presence of highly dispersive soils, recycled water should not be permitted for use at any time onsite, either before, during or after construction;

- Existing tree and grass vegetation should be retained where possible during and after the development to limit erosion and instability potential;

- Cuts and fills should be minimised where possible to less than 1m to 2m in height;

- Retaining structures should be provided for cuts or fills greater than 1m in height/depth. Where retaining walls are to be constructed they must be designed so as not to introduce unacceptably high risks to life and property and have a factor of safety of at least 1.5 with respect to global stability as well as internal stability. Internal stability includes design against sliding, overturning and bearing capacity failure. Internal retaining wall stability is the responsibility of the retaining wall designer. All retaining wall designs must be certified by a Registered Professional Engineer of Queensland (RPEQ). Retaining walls must also incorporate adequate internal drainage behind the walls to limit the potential for lateral surcharge due to the buildup of groundwater pressures;

- Fill batters shall be over-compacted and trimmed back to required levels to ensure that the outer zones are suitably compacted and stable;

- Diversion and cut off drains are to be constructed on the upstream side of work areas;
- Hay bales should be used to reduce scour and run-off velocities and restrict sediment movement;

- Silt fences and cut off drains should be constructed on the downstream side of work areas;
- Downstream detention basins should be constructed for silt capture during the earthworks phase with a final clean out when the Site is stabilised;
- All ground surface runoff and house roof water must be discharged into stormwater systems, not over the ground surface. Alternatively roof water can be discharged into water tanks for storage, with the water tanks located well downslope or to the side of the houses at each lot;
- All storage tank overflow water must be piped to the nearest drainage system, well downslope of the house or into the stormwater system. Uncontrolled discharge to hill slopes is not permitted;
- No on-site effluent disposal systems are permitted for this site, due to the unacceptably high risk of erosion occurring as a result of introducing wastewater into slopes and the highly dispersive in-situ materials;
- Stockpiled soils should be covered to prevent turbid runoff of dispersive soils;
- Stockpiles and cut and fill batters may be required to be chemically stabilised to prevent dispersion and turbid run-off to stormwater;
- The pH of the soil should be considered when using any chemical treatments;
- The pH of the soils should also be reviewed for areas of revegetation and landscaping works where soil fertilisation is required;
- Watering trucks should be frequently used on site during excavation to limit the production of dust. Watering trucks should not use recycled water to reduce the potential for soil and rock dispersion;
- All earthworks should be compacted as specified with good moisture content control to minimise the potential for dispersion;
- Holes left by removed trees/root balls are to be filled with good quality materials and compacted to 95% Standard Maximum Dry Density;
- Stabilise areas as soon as practical after earthworks are completed; this work should involve sealing disturbed areas and new fill by roller compaction and establishing vegetation where appropriate;
- All earthworks should be constructed so as not to "cause an increase in flooding and/or drainage problems or adversely affect floodwaters or surrounding properties and are not constructed in gullies and/or overland flow paths" (Ipswich City Council Planning Scheme Earthworks Code (Part 12, Div 15))"; and
- An Erosion and Sediment Control Investigation Report and Management Plan, providing recommendations on management of the in-situ dispersive soils and rock materials should be produced well before earthworks begin onsite.

Where required, Morrison Geotechnic can provide earthworks supervision and compaction testing services in accordance with AS3798 to ensure that the recommendations described above are carried out during the earthworks phase.

If the recommendations outlined above in this Section are followed, the risk to property from landslide instability can be assessed as Tolerable.

11.0 PAVEMENTS

Based on our visual observations in the field and knowledge of the materials, Table 4 presents the typical, estimated design soaked CBR values of the various materials likely to form the subgrade for pavements constructed on-grade and in shallow cut. Soaked CBR testing should be conducted as soon as practical to confirm the information given in Table 5.

Table 5 – Typical, Estimated Design Soaked CBR Values

Subgrade Material	Estimated Design Soaked CBR Value (%)
Natural Clay Soils (CI&CH)	1-2
Natural Sandy Soils (SM&SC)	5-8
XW Rock	8-10

For on-grade and shallow cutting alignments, the exposed subgrade should be tyned, moisture conditioned as required to Optimum Moisture Content (OMC) ±2%, and compacted to 100% Standard Maximum Dry Density (SMDD). For natural clay subgrades, treatment should achieve OMC +4% and 98% SMDD to reduce the potential for excessive movements of the reactive clay soils.

Surface and subsoil drains should be constructed along both sides of road pavements.

12.0 RETAINING WALLS

The insitu natural clay soils adjacent to and within the low lying drainage gully at the centre of the Site have the potential to exert high lateral swelling pressures on the back of retaining walls supporting cuts, particularly if these soils are normally consolidated or only slightly overconsolidated. Due to the low lying position of the highly reactive soils at the site, cutting is not likely in these areas, however, if cuts in low lying site areas towards the centre of the Site near the drainage gully are proposed, the following construction technique is recommended for in-ground retaining walls:

- Overexcavate a wedge of the natural clay soils at an angle of 45^0 behind all retaining walls.
- Mix the excavated natural clay soils with 20% by mass of granulated rubber or 4% to 5% by mass of lime to reduce the swell pressure potential.
- Replace the treated clay soils or imported sandy soil in thin layers with each layer compacted to 95% Standard Maximum Dry Density (SMDD) and moisture conditioning to 2% to 4% wet of the Optimum Moisture Content (OMC), or place and compact imported, non-reactive granular materials such as clayey sands or gravels to 95% SMDD.
- Place suitable drainage material behind the wall to prevent the buildup of groundwater pressures.

Backfill behind all retaining walls should comprise non-reactive granular soils such as clayey sands or gravels obtained from on-site excavations of the alluvial soils or XW sandstone rock. The alluvial clay soils, where obtained from low lying on-site excavations can be used providing these reactive soils are treated with lime or granulated rubber to reduce the swell potential and are placed and compacted to 95% SMDD and 2% to 4% wet of OMC. This may be impractical, whereby the use of the alluvial sands is preferred.

13.0 LIMITATIONS OF BROAD GEOTECHNICAL APPRAISAL

Recommendations given in this report are based on information supplied by Stockland Development and BradLees Consulting regarding the proposed subdivision and construction in conjunction with the findings of the investigation. Any change in subdivision type or location may require additional testing and/or make recommendations invalid.

Every reasonable effort has been made to locate test sites so that bores are representative of the soil conditions within the area to be investigated. The Client should be made aware that this assessment has been based on limited site data using small diameter boreholes. The eastern and extreme southern portions of the Site were not able to be accessed by the utility mounted drill rig due to the presence of dense vegetation and these areas should be tested as soon as practical and well before construction and development commences on site.

In some cases, soil conditions can change dramatically over short distances, therefore even careful exploration programmes may not locate all the variations. If subsurface materials differing from those shown on the borehole log sheet are encountered at any time, this office should be advised immediately. In all cases, material and material properties should be confirmed onsite during construction by a qualified geotechnical engineer/consultant.

Unless otherwise stated in commissioning documents, any dimensions or slope directions and magnitudes should not be used for any building or costing calculations. Any sketch supplied should be considered only as approximate pictorial evidence of site work.

Your attention is drawn to the document, "Important Information about your Geotechnical Engineering Report", a copy of which is attached to this report.

Please do not hesitate to contact this office if you require any further information.

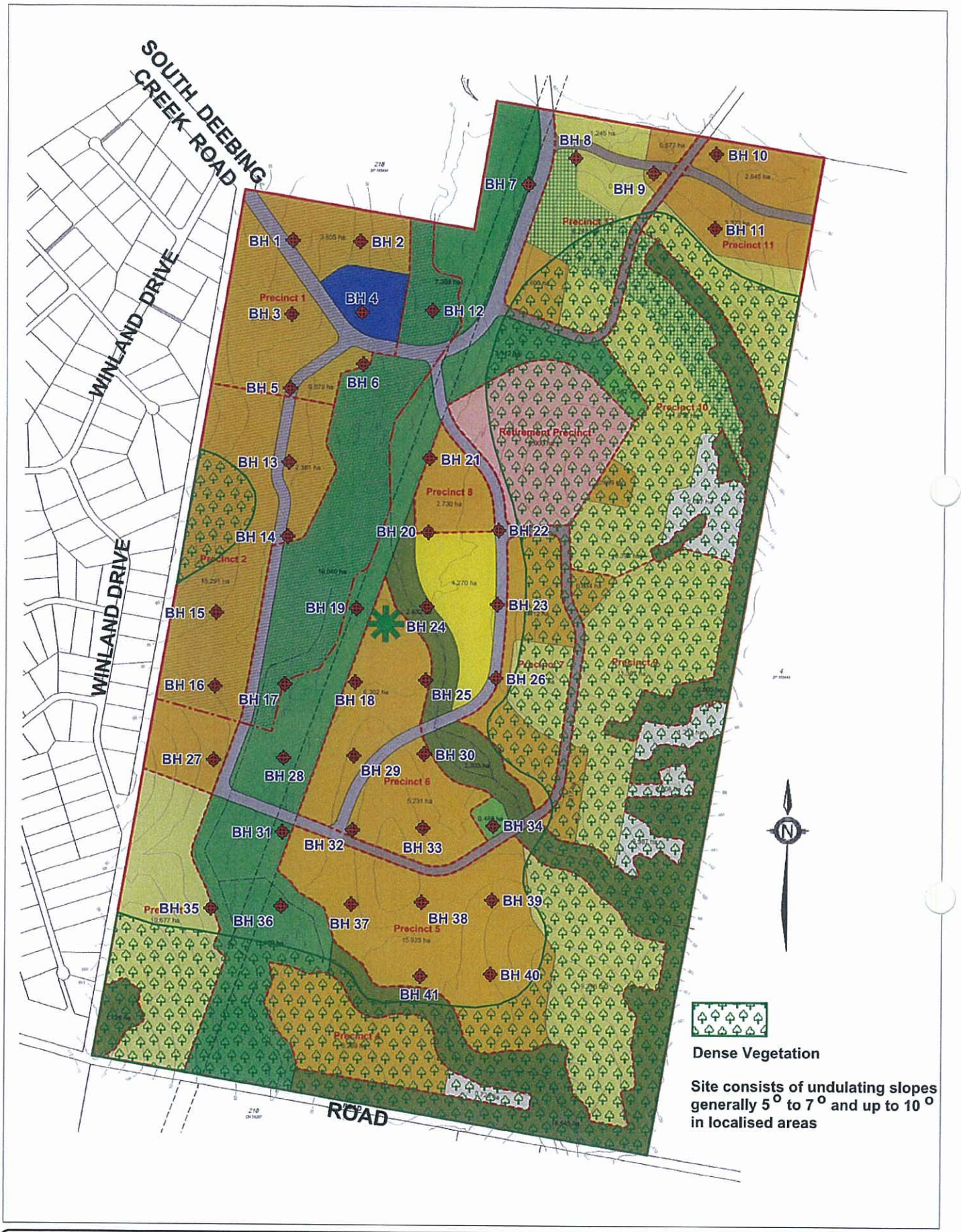
Yours faithfully

MD RILEY (RPEQ 5641)
for and on behalf of
MORRISON GEOTECHNIC PTY LIMITED

Encl Appendix A – Site Plan
Appendix B – Borelogs
Appendix C – Laboratory Test Results
Appendix D – 2007 AGS Landslide Risk Management Guidelines and the AGS Guidelines for Hillside Construction
"Important Information about your Geotechnical Engineering Report"

APPENDIX 'A'

SITE PLAN



MORRISON GEOTECHNIC PTY LTD
ABN: 51 009 878 899

MORRISON GEOTECHNIC

Unit 1/ 35 Limestone St, Darra 4076 Ph: 3279 0900
Email: brisbanelab@morrisongeo.com.au Fax: 3279 0955

Engineers: D.Riley
Geologists: L.Bexley & R.Howchin
Laboratory: M.Morrison

Map Description :	**BOREHOLE TEST LOCATIONS (Approximate Only)**
Client :	STOCKLAND DEVELOPMENT PTY LTD
Project :	**BROAD GEOTECHNICAL APPRAISAL** **Site B, South Deebing Creek Road, Deebing Heights**
LEGEND :	Borehole Locations
Project No : DE10/162	Drawing No : DE10/162 - 01 Scale : Not to Scale

APPENDIX 'B'

BOREHOLE LOG SHEETS

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH1

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476700.00
Northing: 6937200.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.2	Topsoil		SM	**Silty Sand:** Loose, grey mottled orange brown, fine to coarse sand, with medium plasticity fines, moist		M	L	2 3			
			0.6	Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to coarse sand, moist		M	H	6 6 7 10	0.4 –	PP	430kPa
			1.0 1			CH	**Sandy Clay:** As above, but with Sandstone layers		M	H	17 19 10/70mm			
			1.7	Rock		SST	**Sandstone:** Extremely low strength, extremely weathered, light grey mottled orange brown, with Siltstone layers	XW		ELS				
			1.9 2.0			SST	**Sandstone:** As above, but very low strength, orange brown mottled grey	XW		VLS				
			3.0 3			SST	**Sandstone:** As above, but low strength, distinctly weathered, very slow drilling	DW		LS				
							3.00m: BOREHOLE TERMINATED							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH2

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476844.00
Northing: 6937194.00
RL:
Total Depth: 1.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.05	Topsoil		SM	**Silty Sand:** Loose, Moist Silty Sand Topsoil		M	L	3	0.1 –	PP	470kPa
				Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to coarse sand, moist		M	H	5	0.2		
											4			
											4		U50	lss=1.4%; PP>600kPa
											5			
											5			
											8			
			0.8								14			
				Rock		SST	**Sandstone:** Low strength, distinctly weathered, orange brown	DW		LS	10/40mm			
			1.0				**1.00m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH3

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476700.00
Northing: 6937050.00
RL:
Total Depth: 1.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description								Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		SM	**Silty Sand:** Medium dense, Moist Silty Sand Topsoil		M	MD	4	0.1	Emerson	Class 2
				Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to coarse sand, moist		M	H	4			
			0.3								7			
						CH	**Sandy Clay:** As above, but with Sandstone layers		M	H	11			
			0.4	Rock		SST	**Sandstone:** Very low strength, extremely weathered, grey mottled orange brown	XW		VLS	16			
			0.6			SST	**Sandstone:** As above, but with low strength, distinctly weathered layers	XW		VLS	17			
											20			
			1.0											
			1.3			SST	**Sandstone:** As above, but low strength, distinctly weathered, very slow drilling	DW		LS				
			1.5				**1.50m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH4

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476850.00
Northing: 6937050.00
RL:
Total Depth: 1.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.35	Slopewash Soil		SC	**Clayey Sand:** Loose, grey, fine to coarse sand, high plasticity fines, wet		W	L	1 1 2	0.4 –	PP	180kPa
			0.5	Residual Soil		CH	**Sandy Clay:** Stiff, high plasticity, grey mottled orange brown, fine to coarse sand, moist		M	St	2 4			
			0.7			CI	**Sandy Clay:** As above, but hard, medium plasticity		M	H	8 16			
			1.0	Rock		SST	**Sandstone:** Very low strength, extremely weathered, grey mottled orange brown	XW		VLS	15/50mm			
			1.1			SST	**Sandstone:** As above, but low strength, distinctly weathered, very slow drilling	DW		LS				
			1.5				**1.50m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH5

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476700.00
Northing: 6936900.00
RL:
Total Depth: 1.70
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.0	Topsoil		SM	**Silty Sand:** Loose to medium dense, moist, silty sand topsoil		M	L MD	3			
											4			
			0.2	Slopewash		SM	**Silty Sand:** Medium dense, light grey, fine to medium sand, moist		M	MD	4			
											10			
			0.4	Residual Soil		SC	**Clayey Sand:** ,Dense, grey mottled orange brown, fine to coarse sand high plasticity fines, moist		M	D	14			
											13			
											10			
			1.0								13			
											18			
											15			
											12			
			1.2								12			
						SC	**Clayey Sand:** As above, but orange brown mottled grey		M	D	8			
											10			
			1.5								20/75mm			
				Rock		SST	**Sandstone:** Low strength, distinctly weathered, orange brown mottled grey	DW		LS				
			1.7				**1.70m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH6

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476855.00
Northing: 6936945.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		SM	**Silty Sand:** Loose, Moist Silty Sand Topsoil		M	L	2			
				Residual Soil		CH	**Sandy Clay:** Very stiff, high plasticity, grey mottled orange brown, fine to medium sand, moist		M	VSt	5			
											8			
											10			
											7			
											7			
			0.7								7			
				Rock		SST	**Sandstone:** Completely decomposed rock, engineering properties of a dense clayey sand, grey white mottled light orange brown				7			
											7			
			1.0								12			
											15			
											15			
											16			
											16			
											14			
											11			
											13			
											13			
											14			
			2.0								11			
											10			
											10			
											11			
											12			
											12			
											11			
											11			
											10			
			3.0								8/80mm			
							3.00m: BOREHOLE TERMINATED							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH7

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 477200.00
Northing: 6937300.00
RL:
Total Depth: 0.60

Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.0	Topsoil		SC	**Clayey Sand:** Loose, grey mottled orange brown, fine to coarse sand, high plasticity fines, wet		W	L	2			
											2			
			0.2	Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to coarse sand, moist		M	H	5	0.2	U50	lss=1.2%; Swell Pressure=200kPa; PP>600kPa
											9			
			0.5	Rock			**Sandstone:** Low strength, distinctly weathered, orange brown mottled grey white				10/10mm			
			0.6			SST		DW		LS				
							0.60m: DRILLING REFUSAL							
			1.0											
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH8

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 477300.00
Northing: 6937350.00
RL:
Total Depth: 1.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		SM	**Silty Sand:** Loose to medium dense, Moist, Silty Sand Topsoil		M	L-MD	3			
				Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to coarse sand, moist		M	H	2	0.2 –	PP	>600kPa
											5			
											7			
			0.8								8			
											7			
											6			
											6			
				Rock		SST	**Sandstone:** Low strength, distinctly weathered, grey white mottled orange brown	DW		LS	17			
			1.0								25			
											25/50mm			
			1.5				**1.50m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH9

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 477467.00
Northing: 6937315.00
RL:
Total Depth: 1.20
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.0	Slopewash Soil		SM	**Silty Sand:** Medium dense, grey mottled orange brown, fine to medium sand, with medium plasticity fines, moist		M	MD	3 5 8 7 10			
			0.5	Rock		SST	**Sandstone:** Low strength, distinctly weathered, grey mottled orange brown, with some Siltstone layers	DW		LS	10/30mm			
			1.0											
			1.2				**1.20m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH10

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 477600.00
Northing: 6937350.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.2	Topsoil		SC	**Clayey Sand:** Loose, grey brown, fine to medium sand, medium plasticity fines, moist		M	L	2			
											2			
			0.4	Residual Soil		SC	**Clayey Sand:** Medium dense, grey white mottled orange brown, fine to coarse sand, medium plasticity fines, trace of fine gravel, moist		M	MD	4			
											6			
				Rock		SST	**Sandstone:** Completely decomposed rock, engineering properties of a dense clayey sand				13			
			1.0								12			
											11			
											10			
											9			
											7			
											12			
			2.0								23			
											17			
											19			
											20/75mm			
			3.0				**3.00m: BOREHOLE TERMINATED**							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH11

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 477600.00
Northing: 6937200.00
RL:
Total Depth: 1.50
Drilling Rig: Jacro 200
Driller: Morrison Geotechnic
Logged By: R. Howchin
Date: 04/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.2	Topsoil		SC	**Clayey Sand:** Loose, grey brown, fine to medium sand, medium plasticity fines, moist		M	L	1			
											3			
			0.4	Slopewash		SC	**Clayey Sand:** Loose to medium dense, grey white, fine to medium sand, medium plasticity fines, moist		M	L MD	2			
											3			
				Residual Soil		CH	**Sandy Clay:** Stiff, high plasticity, grey mottled orange brown, fine to medium sand, moist		M	St	4	0.5	U50	Iss=2.0%; PP>600kPa
											4			
			0.65			CH	**Sandy Clay:** As above, but very stiff		M	VSt	6			
											9			
			0.8			CI	**Sandy Clay:** As above, but hard, medium plasticity, fine to coarse sand		M	H	11			
			1.0								9			
											8			
			1.2								11			
				Rock		SST	**Sandstone:** Low strength, distinctly weathered, grey white mottled orange brown	DW		LS	10/20mm			
			1.5				**1.50m: DRILLING REFUSAL**							
			2.0											
			3.0											

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH12

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 477000.00
Northing: 6937050.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.2	Residual Soil		SC	**Clayey Sand:** Dense, grey brown, fine to medium sand, medium plasticity fines, moist		M	D	14			
				Rock		SST	**Sandstone:** Completely decomposed rock, grey mottled orange brown, engineering properties of a dense clayey sand				30/75mm			
											Drilled			
											to			
											0.50m			
											14			
			1.0								14			
											11			
											18			
											20			
			1.3	Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to coarse sand, moist, with clayey sand layers		M	H				
			2.0											
			3.0				**3.00m: BOREHOLE TERMINATED**							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH13

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476700.00
Northing: 6936750.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.15	Topsoil		SM	**Silty Sand:** Loose, Moist Silty Sand Topsoil		M	L	2	0	Emerson	Class 6
				Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown fine to medium sand, moist		M	H	1			
			0.6								1			
						CH	**Sandy Clay:** As above, but grey white mottled orange brown		M	H	1	0.35	U50	lss=0.6%; PP>600kPa
			0.9								3			
			1.0								4			
						CH	**Sandy Clay:** As above, but grey white mottled orange brown		M	H	5			
											5			
											6			
			1.1			CI	**Sandy Clay:** As above, but medium plasticity		M	H	6			
				Rock		SST	**Sandstone:** Extremely low strength, extremely weathered orange brown mottled grey white	XW		ELS	10			
											15/70mm	1.2	Emerson	Class 2
			1.9											
			2.0	Residual Soil		CH	**Sandy Clay:** ,Hard, high plasticity, grey brown, fine to medium sand moist		M	H				
			2.4			CH	**Silty Clay:** ,Hard, high plasticity, grey white mottled orange brown with fine to medium sand, moist		M	H				
			3.0											
							3.00m: BOREHOLE TERMINATED							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH14

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476700.00
Northing: 6936600.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.15	Topsoil		SM	**Silty Sand:** Loose, brown, fine to medium sand, with medium plasticity fines, moist		M	L	2			
				Alluvial Soil		SC	**Clayey Sand:** Medium dense, orange brown mottled red brown, fine to medium sand, medium plasticity fines, moist		M	MD	5			
			0.35			CH	**Sandy Clay:** Hard, high plasticity, red brown mottled grey, fine to medium sand, moist		M	H	3			
											4			
											6			
											7			
											9	0.6	U50	Iss=1.2%; PP>600kPa
											10			
			1.0								7			
			1								12			
						SC	**Clayey Sand:** Medium dense, orange brown, fine to coarse sand, medium plasticity fines, moist		M	MD	11			
											10			
											9			
											10			
			1.5								10			
						SC	**Clayey Sand:** As above, but orange brown mottled grey white, fine to medium sand		M	MD	9			
			1.85								11			
			2.0			CH	**Sandy Clay:** Hard, high plasticity, orange brown mottled brown, fine to medium sand, moist		M	H				
			2.1			CH	**Sandy Clay:** As above, but dark grey mottled orange brown		M	H				
			3.0	3										
							3.00m: BOREHOLE TERMINATED							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH15

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476550.00
Northing: 6936450.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.1	Topsoil		SM	**Silty Sand:** Loose, Moist Silty Sand Topsoil		M	L	2			
				Slopewash Soil		SM	**Silty Sand:** Loose to medium dense, grey white mottled orange brown, and light grey white, fine to medium sand, moist		M	L-MD	3			
			0.35								7			
				Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey mottled red brown, fine to medium sand, moist		M	H	12	0.4	Emerson	Class 4
			0.9								7			
			1.0								5			
											5			
											5			
						CH	**Sandy Clay:** As above, but light grey mottled light orange brown, occasional sand layers		M	H	6			
											5			
											5			
											5			
											5			
											5			
											7			
											9			
			2.0								9			
											8			
											6			
			2.7								6			
				Rock		SST	**Sandstone:** Extremely low strength, extremely weathered, orange brown, some red brown ironstone layers	XW		ELS				
			3.0											
							3.00m: BOREHOLE TERMINATED							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH16

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476550.00
Northing: 6936300.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.06	Topsoil		SM	**Silty Sand:** Loose, Moist Silty Sand Topsoil		M	L	1			
						SM			M	L	2			
			0.2	Alluvial Soil		CH	**Silty Sand:** Loose, grey brown, fine to medium sand, medium plasticity fines, moist		M	H	2			
			0.35			GC	**Sandy Clay:** Hard, high plasticity, grey mottled orange brown, fine to medium sand, moist		M	MD	5			
							Clayey Sandy Gravel: Medium dense, fine to medium gravel, fine to medium sand, medium plasticity fines, moist				10			
											15/70mm			
			1.0 1			GC	**Clayey Sandy Gravel:** As above, but orange brown mottled yellow brown		M	MD				
			1.25			CH	**Sandy Clay:** Hard, high plasticity, brown, fine to medium sand, moist		M	H				
			1.5			CH	**Silty Clay:** Hard, high plasticity, grey, moist, with fine to medium sand, trace of fine gravel		M	H		1.8	U50	Iss=3.7%; Swell Pressure=800kPa; PP>600kPa
			2.0											
			2.4			CH	**Silty Clay:** As above, but with sand layers		M	H				
			2.6			CH	**Silty Clay:** As above, but no sand or gravel layers, grey mottled orange brown and black		M	H				
			3.0 3				**3.00m: BOREHOLE TERMINATED**							

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH17

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476700.00
Northing: 6936300.00
RL:
Total Depth: 3.00

Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.0	Alluvial Soil		SC	**Clayey Sand:** Loose, brown, fine to medium sand, with medium plasticity fines, moist		M	L	1			
											2			
											2			
											2			
			0.45			SM	**Silty Sand:** Loose, orange brown, fine to coarse sand, with medium plasticity fines, moist to wet		M-W	L	1			
											2			
											1			
											2			
											2			
			1.0 0.95			SC	**Clayey Sand:** Loose, grey mottled orange brown, fine to coarse sand, medium plasticity fines, moist to wet		M-W	L	3			
											1			
											1			
			1.25			SC	**Clayey Sand:** As above, but wet, seepage at 1.25m		W	L	2			
											2			
											1			
			1.5			SC	**Clayey Sand:** As above, but orange brown mottled yellow brown		W	L	1			
											2			
											2			
											2			
			2.0								5			
											2			
											2			
											4			
			2.4			CH	**Sandy Clay:** Firm, high plasticity, dark grey mottled orange brown, fine to coarse sand, moist to wet		M-W	F	6	2.4 –	PP	70kPa
											5			
											6			
			2.7			CH	**Sandy Clay:** As above, but stiff, moist		M	St	5			
											4	2.8 –	PP	120kPa
											6			
			3.0 3								8			
							3.00m: BOREHOLE TERMINATED				8			

Comments:

Authorised by: .....

Date: .....

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

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Engineering Log - Borehole

Borehole No.: BH18

Job Number: DE10/162
Client: Stockland Development Pty Ltd
Project: Broad Geotechnical Appraisal
Location: Site B, South Deebing Creek Rd, Deebing Heights

Easting: 476850.00
Northing: 6936300.00
RL:
Total Depth: 3.00
Drilling Rig: Jacro 105
Driller: Civiltech
Logged By: R. Howchin
Date: 05/10/2010

Drilling Information				Material Description								Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
TC bit with 100mm Dia. Auger			0.05	Topsoil		SC	**Clayey Sand:** Loose, moist Clayey Sand Topsoil		M	L	2			
			0.15			SC			M	L	2			
				Residual Soil		CH	**Clayey Sand:** Loose, grey mottled light grey brown, fine to medium sand, medium plasticity fines, moist		M	St	2	0.2 –	PP	160kPa
							Sandy Clay: Stiff, high plasticity, grey mottled orange brown, fine to medium sand, moist				3			
											3			
											6			
			0.75								7			
						CH	**Sandy Clay:** As above, but hard, grey mottled orange brown and red brown, trace of fine gravels		M	H	11	0.8 –	PP	420kPa
			0.9								10			
			1.0			CH	**Sandy Clay:** As above, but orange brown mottled red brown, no gravels		M	H	9	0.95 –	PP	>600kPa
			1.1			CH	**Sandy Clay:** As above, but some Sandstone layers		M	H	8			
											7			
											9			
											9			
			1.5	Rock		SST	**Sandstone:** Extremely low strength, extremely weathered, grey white mottled orange brown	XW		ELS	11			
											17			
			2.0											
			2.1	Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, grey white mottled orange brown, fine to medium sand, moist		M	H				
			2.5	Rock		SST	**Sandstone:** Extremely low strength, extremely weathered, orange brown mottled grey white	XW		ELS				
			2.7	Residual Soil		CH	**Sandy Clay:** Hard, high plasticity, orange brown mottled grey white, fine to medium sand, moist		M	H				
			3.0				**3.00m: BOREHOLE TERMINATED**							

Comments:

Authorised by: .....

Date: .....

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Tests & Results
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