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17 February 2010

Sekisui House Development Services
C/- Adrian Sains
Cardno (Qld) Pty Ltd

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Dear Adrian

PRELIMINARY GEOTECHNICAL ASSESSMENT
RIPLEY VALLEY – URBAN CORE

Please find attached a copy of our preliminary geotechnical investigation report for the above project.

If you have any queries with regards to this report, please contact the undersigned on 3800 6446.

Yours faithfully

GARY SAMUELS
PRINCIPAL
for **Cardno Bowler**

Cardno Bowler

Shaping the Future

Preliminary Geotechnical Assessment

Ripley Valley – Urban Core

Job Number 9287gs.10

Prepared for Sekisui House Development Service

Date of Report 17 February 2010

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Document Control

Version	Date	Author		Reviewer	
Draft	9 February 2010	Gary Samuels		David Stirling	
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1 INTRODUCTION

A geotechnical investigation was carried out for a proposed township development at Ripley Road, Ripley, as requested by Cardno (Qld) Pty Ltd on behalf of Sekisui House Development Services.

We understand the project involves development of a township including residential dwellings, shopping centre, school etc. At this stage of the assessment some preliminary geotechnical information is required for planning purposes.

Details on earthwork levels were not known at the time of the preparation of this report.

The objectives of the investigation were as follows:

- Determine the nature and certain engineering parameters of subsurface strata.
- Consider the excavatability of material to be cut from the higher areas of the site and its suitability for use as fill.
- Provide stable unprotected batter angles for predominate soil types encountered during the investigation.

This report must be read in conjunction with our attached *'General Notes'*, the ASFE publication *'Important Information About Your Geotechnical Engineering Report'* and *'Guidelines for Hillside Construction'*, Australian Geomechanics Society Journal, Volume 37, No. 2, May 2002.

2 SITE DESCRIPTION

The site was irregular in shape and comprised of well grassed undulating bushland with numerous small to tall trees scattered throughout.

The site was bound by Bundamba Creek to the north and east, and rural residential properties to the west and south. Ripley Road bisects the site in a northwest – southeast direction. The proposed Centenary Highway Extension will eventually represent the southern site boundary.

Refer to Plates 1 to 3 for typical site conditions encountered during our investigation.

PLATE 1: TYPICAL SITE VIEW

PLATE 2: TYPICAL SITE VIEW

PLATE 3: TYPICAL SITE VIEW

3 INVESTIGATION WORK

Fieldwork

Fieldwork for the investigation was carried out the between the 28 and 29 January 2010 and included the drilling of 4 boreholes at locations designated by Cardno (Qld) Pty Ltd.

Borehole locations are shown on the attached site plan, Figure 1. The material encountered at each location is described on borehole log sheets included in Annex A.

Fieldwork was carried out in accordance with Australian Standard, AS1726-1993 *'Site Investigation Code'*.

3.1 Laboratory Testing

Samples of representative strata were recovered and returned to our NATA accredited soils laboratory. The following tests were carried out on a selected sample;

- Moisture Content
- Particle Size Distribution
- Atterberg Limits
- Linear Shrinkage

The laboratory test results are included in Annex B. Laboratory testing was carried out in accordance with Australian Standard AS1289 *'Laboratory Testing For Engineering Purposes'*.

4 SUBSURFACE CONDITIONS

4.1 Subsurface Strata

The logs in Annex A should be referred to for the detailed description of material encountered at each investigation location. A summary of conditions encountered at each investigation location is detailed in Table 1 below.

Table 1: Summary of Subsurface Strata

Soil Descriptions/Depth (m)				
BH No	**Topsoil**	**Residual Clayey/ Silty Sand Medium dense or better**	**Weathered Rock**	**TD**
1	0.0-0.1	0.1-0.5	0.5-TD	2.0
2	0.0-0.3	0.3-0.9	0.9-TD	1.5
3	0.0-0.2	0.2-0.9	0.9-TD	1.9
4	0.0-0.2	0.2-0.5	1.7-TD[(d)]	5.4

NOTES:

a) All depths measured in metres below ground level at the time of the investigation between the 28 and 29 January 2010.
b) TD = Termination Depth.
c) The above termination depths represent 'TC' (tungsten carbide) bit refusal for the drill rig.
d) TC bit refusal at 2.5m. Rock coring carried out to TD.

No groundwater was encountered in any of the boreholes at the time of the investigation. However, seepage could be expected along the soil/weathered rock interface during and after periods of wet weather.

4.2 Laboratory Test Results

A summary of laboratory test results is provided in Table 2 below.

Table 2: Classification and Shrink/Swell Test Results

Particle Size Distribution, Atterberg Limits and Linear Shrinkage						
Bore No	**Depth (m)**	**% Sand & Gravel**	**% Clay & Silt**	**Liquid Limit (%)**	**Plasticity Index (%)**	**Linear Shrinkage (%)**
4	1.0-1.2	61	29	32	11	21

5 GEOTECHNICAL ASSESSMENT

5.1 Earthworks

Details on proposed earthwork levels were not known at the time of the preparation of this report.

Site Preparation

All site preparation work should be carried out in accordance with AS3798-2007 *'Guidelines on Earthworks for Commercial and Residential Developments'*.

All soil containing grass and root material should be stripped from the building sites and access areas prior to construction. This material is not considered suitable for use as structural fill but may be stockpiled for possible future landscaping purposes, if required. Stripping depths will generally be in the order of around 0.1m to 0.3m. However, isolated areas may require a deeper stripping depth.

Prior to the placement of any structural fill the site should be proof rolled using a minimum 10 tonne vibrating padfoot roller. Should isolated soft/loose areas be encountered during this process, this material should be removed and replaced with select fill.

Depressions formed by the removal of vegetation should have all disturbed soil cleaned out and be backfilled with compacted select fill material.

Cardno Bowler should be engaged to confirm the suitability of the stripping depth and confirm the adequacy of the newly exposed soil for fill placement.

Borrow Materials

Based on the results of our investigation to date across the proposed borrow areas, 3 major material types are available for use as structural fill, these being, residual orange brown, low plasticity clayey sand; orange red cream silty/clayey sand and weathered rock.

With the exception of the topsoil stratum, all materials encountered during the investigation are considered acceptable for use as structural fill provided that any pre-treatment (moisture conditioning, removal of oversize), is carried out prior to fill placement.

Structural Fill Placement

To minimise the potential for post compaction volume change due to moisture content variations, any structural clay bearing fill should be placed in loose layers not greater than 200mm thick at a moisture content in the range -2% to +3% of the standard optimum moisture content, and be compacted to a minimum dry density ratio of 95% and 98% standard compaction as per AS1289 5.1.1 for residential and commercial construction respectively.

Measures should be adopted to ensure that this clay fill material is not allowed to dry out prior to the placement of succeeding layers of fill and final covering with building slabs and road pavements.

It is recommended that the placement of all structural fill be inspected, tested and certified by Cardno Bowler to Level 1 requirements, during the earthworks operations to ensure that all fill is placed in a *'controlled manner'*, in accordance with AS3798-2007.

Where filling is to be carried out over sloping land (slope > 8H:1V), the surface of the natural material should be benched so that the fill can be *'keyed'* into the slope, allowing for a good bonding interface

between structural fill and the natural. The maximum height of the step must not exceed 0.5m, and the benching must be sloped to ensure free drainage.

Excavatability (Rippability)

No problems should be encountered in excavating the near surface material on site above *'TC'* bit limit of the drill rig. Most soils encountered on site should be within the excavation limits of a small dozer (e.g. Cat D6 or similar) in bulk excavations or medium size backhoe (e.g. Case 580 or similar) in trench excavations.

'TC' bit refusal was achieved at all the borehole locations. Refer to Table 1 for depth at which *'TC'* bit refusal was achieved. While there is no direct reliable relationship between drilling resistance and excavatability, as a rule of thumb the limit of the *'TC'* bit may be taken as indicative of the limit of excavation of a medium sized dozer in bulk excavation (Cat D7E, D8) or a large excavator in trench excavation (Kato or Hymac).

Generally below the *'TC'* bit limit, larger excavation equipment, explosives, compressor driven pneumatic tools, or hydraulic rock breakers would be required for excavation.

In BH4, rock coring was undertaken to allow for a more detailed assessment of the rippability of the underlying bedrock.

Based on the analysis of the rock core and the parameters set out as per the *'Weaver Rippability Assessment'*, we have concluded that the rippability of the bedrock is considered to have a rating of *'hard rippability'*.

As a guide, hard ripping using a D9/D10 type dozer with shanks, is expected to be sufficient to excavate rock at the location of BH4 to a depth of 5.4m.

The rippability will also be a function of the orientation of the plant to rock mass discontinuities. Given the site is a large greenfield site, this will allow for greater flexibility of the plant with regards to ripping direction. As such increased rippability could be expected where the plant is ripping along and parallel with joint planes.

5.2 Batter Slopes for Benching

For initial design purposes, the following maximum unprotected batter slopes may be adopted for the cut and fill batters on the site based on the predominant material types encountered during the investigation.

Table 3: Maximum Unprotected Batter Slopes

Material Type	Short Term (Maximum)	Long Term (Maximum)
Residual Sands (cut)	1V:2H	1V:2.5H
Fill Batters(1)	1V:2H	1V:2H
Weathered Rock	1V:1H	*

Notes:

1. (1) All fill batters should be overfilled, compacted and cut back at the maximum angles recommended above and with some form of erosion protection to minimise any potential unnecessary scour effects due to weathering.
2. * Denotes requirement for detailed stability assessment.

6 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill and cut/fill batters be inspected, tested and certified where necessary, by Cardno Bowler Pty Ltd to ensure recommendations made in this report have been adhered to.

Should subsurface conditions other than those described in this report be encountered, Cardno Bowler Pty Ltd should be consulted immediately and appropriate modifications developed and implemented if necessary.

7 CONCLUSIONS AND RECOMMENDATIONS

The following is a summary of the conclusions and recommendations in regard to the preliminary geotechnical investigation for the proposed development of the Urban Core, Ripley Valley. However, the preceding sections of this report should be read for a full description of the conclusions and recommendations.

1. The subsurface conditions, at the investigation locations generally consisted of a veneer of topsoil overlying natural clayey/silty sands which in turn overlaid shallow weathered rock.

2. Earthworks should be carried out in accordance with AS3798.2007 *'Guidelines on Earthworks for Commercial and Residential Developments'*. Refer to Section 5.1 for details on recommendations for earthwork operations.

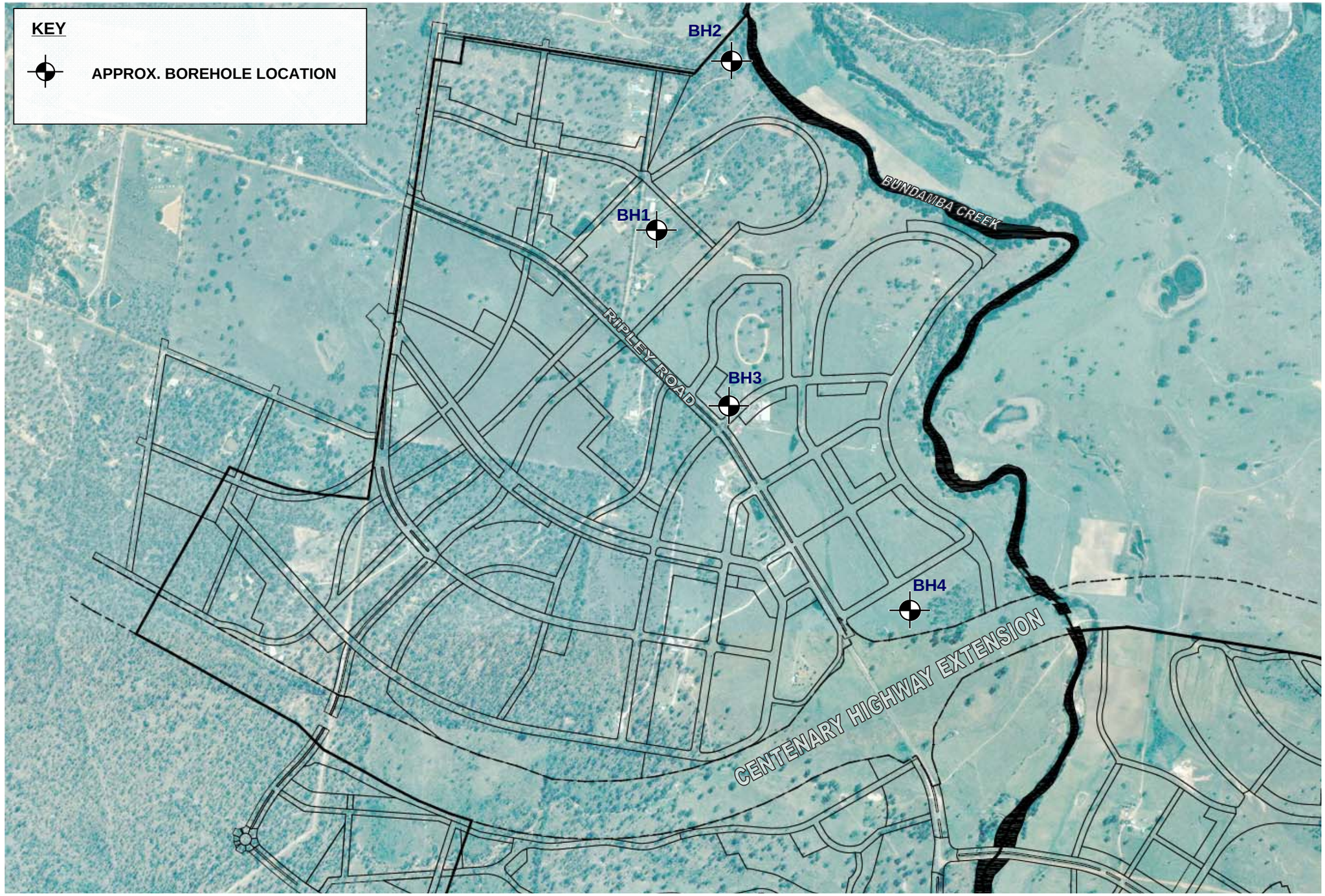
3. Refer to Section 5.1 for details on the suitability of materials for use as structural fill and rippability.

4. Refer to section 5.2 for recommendations on maximum unprotected cut/fill batter angles for the site.

Yours faithfully

GARY SAMUELS
PRINCIPAL

DAVID STIRLING
SENIOR GEOTECHNICAL ENGINEER



NOT TO SCALE

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SITE INVESTIGATION LOCATIONS

PROPOSED TOWNSHIP DEVELOPMENT – RIPLEY URBAN CORE

RIPLEY ROAD, RIPLEY

JOB NO.: **9287**

FIGURE 1

GENERAL NOTES

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April 2005

GENERAL

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the introduction section(s) of the document. The report should not be used by other parties or for other purposes as it may not contain adequate or appropriate information.

TEST HOLE LOGGING

The information on the Test Hole Logs (Boreholes, Backhoe Pits, Exposures etc.) has been based on a visual and tactile assessment except at the discrete locations where test information is available (field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and Rock Descriptions).

GROUNDWATER

Unless otherwise indicated the water levels given on the test hole logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities. Final confirmation of levels can only be made by appropriate instrumentation techniques and programmes.

INTERPRETATION OF RESULTS

The discussion and recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised or idealised subsurface conditions (including any cross-sections contained in the report) have been assumed or prepared by interpolation/extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete test hole locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil structure interaction behaviour of the site.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to this firm for appropriate assessment and comment.

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Footing drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction should include at least all the relevant test hole and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions that any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE / The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predications. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage*, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional test are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use*. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by The Institution of Engineers Australia, National Headquarters, Canberra, 1987.

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Annex A

Fieldwork Results and Photographs of Rock Core

September, 2001

SOIL DESCRIPTION

This procedure involves the description of a soil in terms of its visual and tactile properties, and relates to both laboratory samples and field exposures as applicable. A detailed soil profile description, in association with local geology and experience, will facilitate the initial (and often complete) site assessment for engineering purposes.

The method involves an evaluation of each of the items listed below and is in general agreement with the Site Investigation Code AS1726-1993.

SOIL TYPE
The soil is described on the basis of the grain size composition of the constituent particles, and the plasticity of the fraction of material passing the 425µm sieve.

Furthermore, as most natural soils are part combinations of various constituents, the primary soil is described and modified by minor components. In brief, the system is as follows;

SILT OR CLAY AS MINOR COMPONENT		GRAVEL OR SAND AS MINOR COMPONENT	
% Fines	**Modifier**	**% Coarse**	**Modifier**
≤5 >5 ≤12 >12	omit, or use "trace" describe as "with clay/silt" as applicable prefix soil as "silty/clayey" as applicable	≤15 >15 ≤30 >30	omit, or use "trace" describe as "with sand/gravel" as applicable prefix soil as "sandy/gravelly' as applicable

Note: For soils containing both sand and gravel the minor coarse fraction is omitted if less than 15%, or described as "with sand/gravel" as applicable when greater than 15%.

The appropriate classification group symbol for soil classification is also given before the soil type description in accordance with AS1726-1993, Table A1.

For granular soils, an assessment of grading (well, uniform, gap or poor), particle size (fine, medium etc), angularity, shape and particle composition may also be given.

COLOUR
Colour is important for correlation of data between test holes and for subsequent excavation operations. The prominent colour is noted, followed by (spotted, mottled, streaked etc.) secondary colours as applicable. Colour should be described in the "moist" condition, though both wet and dry colours may also be appropriate.

MOISTURE
The moisture condition of the soil is described by the appearance and feel of the soil using one of the following terms:
Dry cohesive soils - hard, friable or powdery; granular soils - cohesionless, free funning.
Moist soil cool, darkened colour: cohesive soils - can be moulded; granular soils - tend to cohere.
Wet soil cool, darkened colour: cohesive soils - usually weakened, free water on hands when handling; granular soils - tend to cohere.

In addition, the presence of any seepage or free water is noted on all test hole logs.

CONSISTENCY/RELATIVE DENSITY
Granular soils are generally described in terms of relative density (density index) as listed in Table A5 AS1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, DCP or CPT) is used in conjunction with published correlation tables. Alternatively, insitu density tests can be conducted in association with minimum and maximum densities performed in the laboratory.

Cohesive soils can be assessed by direct measurement (shear vane), or estimated approximately by tactile means and/or the aid of a geological pick as given on the following table. It is emphasised that a "design shear strength" must take cognisance of the insitu moisture content and the possible variations of moisture with time.

Term	Tactile Properties	Undrained Shear Strength (kPa)
Very Soft	Exudes between the fingers when squeezed in the hand.	≤12
Soft	Easily penetrated by thumb about 30-40mm. Pick head can be pushed in up to shaft. Moulded by light finger pressure.	>12 ≤25
Firm	Penetrated by thumb 20-30mm with moderate effort. Sharp end of pick pushed in some 30-40m. Moulded by strong finger pressure.	>25 ≤50
Stiff	Indented by thumb about 4mm with moderate effort. Pick pushed in up to 10mm. Cannot be moulded in fingers.	>50 ≤100
Very Stiff	Readily indented by thumb nail. Slight indentation produced by pushing pick into soil.	>100 ≤200
Hard	Difficult to indent with thumb nail. Requires power tools for excavation.	>200

STRUCTURE/OTHER FEATURES
The structure of the soil may be described with reference to: zoning, where soils consist of separate zones differing in colour, grain size or other properties; defects, including fissures, cracks, root-holes and the like; cementing, with the strength (weakly to strongly), and nature of the cementing agent; additional observations including geological origin, odour and the like. In addition, the presence of other features (ferricrete nodules, organic inclusions) should also be noted as applicable.

September, 2001

ROCK DESCRIPTION

This method is based on AS1726 (1993) Appendix A. The procedure involves a visual and tactile assessment of the rock mass and the nature of defects in order to facilitate a prediction of engineering behaviour.

DESCRIPTION: Rock Type is described on the basis of bedded (mostly sedimentary), foliated (mostly metamorphic) and rocks with massive structure and crystalline texture (mostly igneous), with the common types listed below. Rocks are generally in order of decreasing grain size down the table.

Bedded			Foliated	Massive
	≥50% carbonate grains	**≥50% fine grained volcanic rock grains**	gneiss schist slate phyllite	granite gabbro basalt rhyolite andesite
conglomerate sandstone siltstone mudstone shale claystone	limestone dolomite chalk	agglomerate volcanic breccia tuff		

GRAIN SIZE: refers to the average dimension of the material or rock fragments comprising the rock.

TEXTURE & FABRIC: refer to the individual grains and the arrangement of grains respectively. Textural terms frequently used include porphyritic, crystalline, cryptocrystalline, granular, amorphous and glassy.

COLOUR: is given to assist in rock identification and the interpretation of field data. Colour should be described in the moist condition, though both wet and dry colours may also be appropriate.

ESTIMATED STRENGTH: This refers to the strength of the rock substance and not that of the rock mass. The strength of the rock substance is estimated by the Point Load Strength Index I_s (50) and refers to the strength measured in the direction normal to the bedding for sedimentary rocks. A field guide is given below:

Term	Symbol	I_s (50) MPa	Field Guide (The Core refers to a 150mm x 50mm diameter sample)
Extremely Low	EL	≤0.03	Remoulded by hand to a material with soil properties.
Very Low	VL	>0.3 ≤0.1	Material crumbles under firm blows with sharp end of pick. Can be peeled with knife.
Low	L	>0.1 ≤0.3	The core may be broken by hand and easily scored with a knife. Sharp edges or core may be friable and break during handling.
Medium	M	>0.3 ≤1.0	The core may be broken by hand with considerable difficulty. Readily scored with knife.
High	H	>1.0 ≤3.0	Core can be broken by pick with a single firm blow, but not by hand. Rock rings under hammer.
Very High	VH	>3.0 ≤10.0	Hand specimen breaks with pick after more than one blow. Rock rings under hammer.
Extremely High	EH	>10.0	The core is difficult to break with geological pick. Rings when struck with hammer.

WEATHERING: The assignment of weathering is somewhat subjective. Weathering assists identification but does not imply engineering behaviour. No distinction is drawn between chemical weathering and alteration for most engineering purposes. These procedures are collectively described as "weathering" using the following terms which do not describe the related strength change. Carbonate rocks generally do not conform to this classification.

Term	Symbol	Definition
Residual Soil	RS	Soil developed on XW rock; mass structure and substance fabric no longer evident.
Extremely Weathered Rock	XW	The rock exhibits soil-like properties though the texture of the original rock is still evident.
Distinctly Weathered Rock	DW	Rock strength usually changed by weathering. Rock may be highly discoloured.
Slightly Weathered Rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh Rock	F	Rock shows no sign of decomposition or staining.

STRUCTURE: is concerned with the larger scale inter-relationship of textural features. Common terms include: - Sedimentary rocks - bedded, laminated; Metamorphic rocks - foliated, banded, cleaved; Igneous rocks - massive, flow banded.

DEFECTS: This important feature can control the overall engineering behaviour of a rock mass. All types of natural fractures across which the core is discontinuous are noted. These fractures include bedding plane partings, joints and other defects but exclude artificial fractures such as drilling breaks. The nature of the defects (joints, partings, seams, zones and veins) is also noted with description, orientation, infilling or coating, shape, roughness, thickness, etc. given generally in accordance with AS1726 Table A10. The spacing of natural fractures excludes bedding partings unless there is evidence that they were separated prior to drilling. This notwithstanding, bedding partings may be considered as points of weakness in an engineering assessment.

BOREHOLE LOG SHEET

Client: Cardno (Qld) Pty Ltd			**Hole No: BH1**
Project: Proposed Township Development			
Location: Ripley Road, Ripley	**Job No: 9287**		**Sheet: 1 of 1**
Position: Refer Site Sketch Figure 1	**Angle from Horizontal: 90°**		**Surface Elevation:**
Rig Type: Q Drill 3000	**Bit:**		**Driller: DL**
Casing Diameter:	**Contractor: Cardno (Qld) Pty Ltd**		
Date Started : 29/1/10	**Date Completed: 29/1/10**	**Logged By: DL**	**Date Logged: 29/1/10**

Depth (m)	Drilling: Auger 'V' Bit	Drilling: Auger 'TC' Bit	Drilling: Washbore	Drilling: Casing	Drilling: Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
							D 0.00 - 0.10 m		7			SM	SILTY SAND, fine to coarse grained sand, grey, with some grass roots, dry, medium dense, TOPSOIL
									10				CLAYEY SILTY SAND, fine to coarse grained sand, orange red cream, dry, medium dense to dense, NATURAL
									10			SM	
									15				
									18				
0.5													SANDSTONE
1.0												XW	
1.5													
							D 1.80 - 1.90 m						
2.0													TC BIT REFUSAL BOREHOLE TERMINATED AT 2.00 m
2.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Cardno (Qld) Pty Ltd
Project: Proposed Township Development
Location: Ripley Road, Ripley

Hole No: BH2

Job No: 9287 **Sheet:** 1 of 1

Position: Refer Site Sketch Figure 1 **Angle from Horizontal:** 90° **Surface Elevation:**

Rig Type: Q Drill 3000 **Bit:** **Driller:** DL

Casing Diameter: **Contractor:** Cardno (Qld) Pty Ltd

Date Started : 28/1/10 **Date Completed:** 28/1/10 **Logged By:** DL **Date Logged:** 28/1/10

Depth (m)	Drilling: Auger 'V' Bit	Drilling: Auger 'TC' Bit	Drilling: Washbore	Drilling: Casing	Drilling: Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
									8 10 11			SM	SILTY SAND, fine to coarse grained sand, grey, with some grass roots, dry, medium dense, TOPSOIL
									8 10 7 5 10 12			SM	CLAYEY SILTY SAND, fine to coarse grained sand, orange red cream, dry, medium dense to dense, NATURAL
0.5									20			XW	SANDSTONE
1.0													
1.5													TC BIT REFUSAL BOREHOLE TERMINATED AT 1.50 m
2.0													
2.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Cardno (Qld) Pty Ltd			**Hole No: BH3**
Project: Proposed Township Development			
Location: Ripley Road, Ripley	**Job No: 9287**		**Sheet: 1 of 1**
Position: Refer Site Sketch Figure 1	**Angle from Horizontal: 90°**		**Surface Elevation:**
Rig Type: Q Drill 3000	**Bit:**		**Driller: DL**
Casing Diameter:	**Contractor: Cardno (Qld) Pty Ltd**		
Date Started : 29/1/10	**Date Completed: 29/1/10**	**Logged By: DL**	**Date Logged: 29/1/10**

Depth (m)	Drilling: Auger 'V' Bit	Drilling: Auger 'TC' Bit	Drilling: Washbore	Drilling: Casing	Drilling: Coring	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
									12			SM	SILTY SAND, fine to coarse grained sand, grey, with some grass roots, dry, medium dense, TOPSOIL
									13				
									16			SM-SC	SILTY SAND/CLAYEY SAND, fine to coarse grained sand, orange red cream, dry, hard, FILL
							D 0.30 - 0.40 m						
0.5									>20			SM-SC	SILTY SAND/CLAYEY SAND, fine to coarse grained sand, orange red cream, dry, hard, NATURAL
1.0												XW	SANDSTONE, trace clay balls
1.5													
2.0													TC BIT REFUSAL BOREHOLE TERMINATED AT 1.90 m
2.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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CORE LOG SHEET

Client: Cardno (Qld) Pty Ltd
Project: Proposed Township Development
Location: Ripley Road, Ripley

Hole No: BH4

Job No: 9287 | **Sheet:** 1 of 2

Position: Refer Site Sketch Figure 1 | **Angle from Horizontal:** 90° | **Surface Elevation:**

Rig Type: Hydropower Scout | **Bit:** V/TC/NMLC | **Driller:** MATT

Casing Diameter: 80mm | **Contractor:** Drillsure

Date Started : 28/1/10 | **Date Completed:** 28/1/10 | **Logged By:** DA | **Date Logged:** 28/1/10

Drilling: Auger 'V' Bit	Drilling: Auger 'TC' Bit	Drilling: Washbore	Drilling: Casing	Drilling: Coring	Core Recovery (%)	Samples & Field Tests	Depth (m)	Groundwater (m)	Graphic Log	Description	Weathering	Inferred Strength $Is_{(50)}$ MPa	NATURAL FRACTURES: Defect Spacing (mm)	NATURAL FRACTURES: RQD (%)	NATURAL FRACTURES: Additional Data
							0.0			SM, SILTY SAND, fine to medium grained, brown, some fine to medium roots, dry, loose, TOPSOIL					
										SC, CLAYEY SAND, fine to coarse grained sand, orange brown, low to medium plasticity clay, dry to moist, medium dense, RESIDUAL	RS				
							0.5			SC, CLAYEY SAND, fine to medium grained, brown orange, low plasticity fines, moist, very dense, RESIDUAL					
						D SPT 12, 30/140	1.0								
							1.5								
										XW, SANDSTONE, coarse grained, granular, orange brown	XW				
							2.0			TC BIT REFUSAL AT 2.5m. COMMENCE NMLC CORING AT 2.5m					
					100%	D SPT 20/0 (Hammer and rods bouncing)	2.5			SANDSTONE, coarse grained, granular, orange brown, medium strength, fractured, distinctly weathered	DW				2.50 - 2.64 m: FZ 2.64 - 2.69 m: CS, 40°, P, R, O, CL 2.72 - 2.90 m: CS, 35°, P, R, O, CL

Inferred Strength $Is_{(50)}$ MPa: EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH

Defect Spacing (mm): 20, 40, 100, 300, 1000

See Standard Sheets for details of abbreviations & basis of descriptions

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NOTES:

1) Visual strength classification
2) Discontinuities recorded from the horizontal

CORE LOG SHEET

Client: Cardno (Qld) Pty Ltd
Project: Proposed Township Development
Location: Ripley Road, Ripley

Hole No: BH4

Job No: 9287 | **Sheet:** 2 of 2

Position: Refer Site Sketch Figure 1 | **Angle from Horizontal:** 90° | **Surface Elevation:**

Rig Type: Hydropower Scout | **Bit:** V/TC/NMLC | **Driller:** MATT

Casing Diameter: 80mm | **Contractor:** Drillsure

Date Started : 28/1/10 | **Date Completed:** 28/1/10 | **Logged By:** DA | **Date Logged:** 28/1/10

Drilling: Auger 'V' Bit	Drilling: Auger 'TC' Bit	Drilling: Washbore	Drilling: Casing	Drilling: Coring	Core Recovery (%)	Samples & Field Tests	Depth (m)	Groundwater (m)	Graphic Log	Description	Weathering	Inferred Strength $Is_{(50)}$ MPa	NATURAL FRACTURES: Defect Spacing (mm)	RQD (%)	Additional Data (Joints, partings, seams, zones, etc.) fracture type, orientation, shape, roughness, separation, infilling or coating
					100%		3.5			SANDSTONE, coarse grained, granular, orange brown, medium strength, fractured, distinctly weathered	DW	EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	20 40 100 300 1000	22%	2.90 - 3.67 m: FZ 3.87 m: J, 40°, P, R, O, CL
							4.0								4.00 m: J, 5°, P, R, O 4.14 m: J, 0°, P, R, C, CN
					100%		4.5							95%	4.32 m: J, 40°, U, R, C, CN 4.44 m: J, 5°, U, R, C, CN
							5.0								4.93 m: J, 25°, ST, R, C, CN 5.24 m: J, 20°, U, R, C, CN 5.38 m: J, 0°, U, R, C, CN
							5.5			BOREHOLE TERMINATED AT 5.40 m					

See Standard Sheets for details of abbreviations & basis of descriptions

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NOTES:

1) Visual strength classification
2) Discontinuities recorded from the horizontal

Borehole Number: BH4
Box 1 of 1
2.5m to 5.4m

Annex B

Laboratory Test Results

September, 2001

LABORATORY TESTING

GENERAL

Samples extracted during the fieldwork stage of a site investigation may be "disturbed" or "undisturbed" (as generally indicated on the test hole logs) depending upon the nature and purpose of the sample as well as the method of extraction. Nominally "undisturbed" samples may suffer a varying degree of disturbance during extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results which must of necessity reflect the effects of such disturbance.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions, and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory test results provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and project in hand.

TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 as amended, or Queensland Transport Standards when specified. The routine Australian Standard tests are as follows:

Sample Preparation	Test 1
Moisture Content	Test 2.1.1
Liquid Limit	Test 3.1.1)
Plastic Limit	Test 3.2.1) collectively known as Atterberg Limits
Plasticity Index	Test 3.3.1)
Linear Shrinkage	Test 3.4.1
Particle Density	Test 3.5.1
Particle Size Distribution	Tests 3.6.1, 3.6.2, 3.6.3
Emerson Class Number	Test 3.8.1)
Percent Dispersion	Test 3.8.2) collectively, Dispersion Classification
Pinhole Dispersion Classification	Test 3.8.3)
Organic Matter	Test 4.1.1
Sulphate content	Test 4.2.1
pH Value	Test 4.3.1
Resistivity	Test 4.4.1
Standard Compaction	Test 5.1.1
Modified Compaction	Test 5.2.1
Dry Density Ratio	Test 5.4.1
Minimum/Maximum Density	Test 5.5.1
Density Index	Test 5.6.1
California Bearing Ratio	Tests 6.1.1, 6.1.2
Undrained Triaxial Shear	Test 6.4.1
One Dimensional Consolidation	Test 6.6.1
Constant Head Permeability	Test F7.1
Shrink Swell Index	Test 7.1.1

Where tests are used which are not covered by appropriate standard procedures, details are given in the report.

LABORATORY

Our laboratory is a Registered Laboratory with the National Association of Testing Authorities (NATA).

Cardno Bowler
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Geotechnical Engineering Consultants
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Environmental Consultants
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SOIL CLASSIFICATION TEST REPORT

SAMPLING PROCEDURES: A.S.1289.1.2.1-6.5.3 TEST PROCEDURES: AS1289.2.1.1, .3.1.2, .3.2.1, .3.3.1, .3.4.1

CLIENT:	**SEKISHI HOUSE DEVELOPMENT SERVICES**	*JOB No.: GC*	**2317**
PROJECT:	**URBAN CORE, RIPLEY VALLEY**	*REPORT No:*	**1**
		DATE ISSUED:	**15/02/10**
TEST ITEM:	**DISTURBED SAMPLE**		
SITE TEST No.:	**Q 1**	*LOCATION:*	**BOREHOLE No.4**
SAMPLE No.:	**81780**		
DATE SAMPLED:	**28/01/10**	*SOIL DESCRIPTION:*	**SC CLAYEY SAND**
MATERIAL SOURCE:	**INSITU**		**brown**
PROPOSED MATERIAL TYPE:	**-**	*ELEVATION m:*	**1.0 TO 1.2**

ATTERBERG LIMITS & LINEAR SHRINKAGE

SAMPLE HISTORY: Air Dried

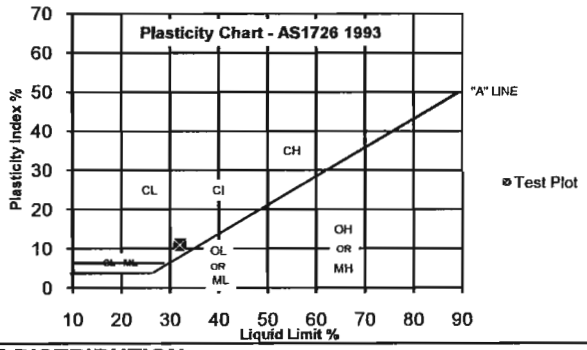
METHOD OF PREPARATION: Dry Sieved

RESULTS

LIQUID LIMIT	**32**	%
PLASTIC LIMIT:	**21**	%
PLASTICITY INDEX	**11**	%
LINEAR SHRINKAGE:	**-**	%

PLASTICITY

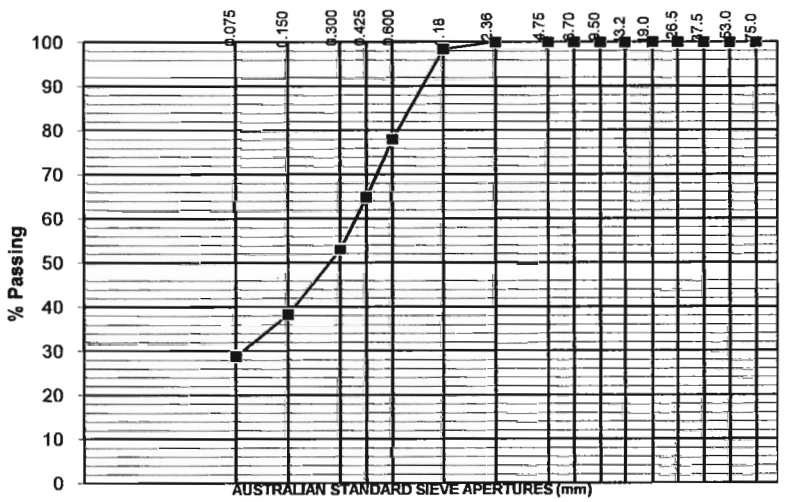
Descriptive Term	Range of L.L.
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50



PARTICLE SIZE DISTRIBUTION

TEST PROCEDURES: AS1289.3.6.1 - WET SIEVED

SIEVE SIZE (mm)	% PASSING (by mass)
75.0	**100**
53.0	**100**
37.5	**100**
26.5	**100**
19.0	**100**
13.2	**100**
9.5	**100**
6.7	**100**
4.75	**100**
2.36	**100**
1.18	**98**
0.600	**78**
0.425	**65**
0.300	**53**
0.150	**38**
0.075	**29**



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Mr M. Tyrrell
(Approved Signatory)