Douglas Partners
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Report on
Preliminary Geotechnical Investigation

M2 Site
Delhi Road
North Ryde

Prepared for
UrbanGrowth NSW

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1. Introduction

This Report on a Phase 1 Preliminary Geotechnical Investigation was originally prepared in support of a Rezoning Study in respect of the North Ryde Station Precinct Project (NRSPP) for Transport for NSW (TfNSW). The M2 site is located within the NRSPP.

With the permission of TfNSW, this report reproduces the original report for the precinct but concentrates on M2 Site only. Site specific information on the other four sites, which made up the precinct at that time, have been removed from the report.

This report was prepared for UrbanGrowth NSW, the new owners of the M2 Site for the purpose of providing preliminary geotechnical information to support the subdivision development application for the M2 site.

The aim of the preliminary geotechnical investigation is to provide information on subsurface conditions for the preliminary design and planning of earthworks, foundations, excavation support and pavements.

2. Site Description

The North Ryde Station Precinct is located within the Macquarie Park Corridor, a predominantly commercial area that lies between the M2 Motorway and Epping Road, North Ryde. The Precinct is situated within the City of Ryde Local Government Area, at the southern end of the Macquarie Park Corridor.

The M2 site is bounded by the M2 motorway to the east, Delhi Road to the south, Epping Road to the south-west and low rise commercial/industrial buildings to the north-west.

The area is an irregular shaped land parcel covering approximately 9.15 ha and is some 600 m long and about 150 m wide. Site levels slope down to the north with a difference in level of 28 m over about 300 m, or an average slope of about 5^{o}.

Bushland occupies the northern part of the site. Porters Creek crosses the site at the northern end within the bushland.

The Epping to Chatswood railway (ECRL) tunnel passes under the site at the southern end and it is understood that the site was previously used as a works site for the construction of the tunnel.

Drawings for the project indicate that there was a temporary shaft and tunnel incline to the rail tunnel, which would have been backfilled after the works were completed.

Due to the previous site uses, the site has been subjected to significant changes over the years, more recently as a works depot for work on the M2 motorway.

The site is shown on Drawing 1 and 4 in Appendix B.

3. Report Clarification

At the time of carrying out the fieldwork and laboratory testing for the Phase 1 Preliminary Geotechnical Investigation in October 2011, reference was made to various sites and organisation names that have since changed. These changes are as follows:

Previous name	**Current Name**
Transport Construction Authority (TCA)	Transport for NSW (TfNSW)
Roads and Traffic Authority (RTA)	Roads and Maritime Services (RMS)

The previous names remain on the logs and laboratory records.

4. Geology

Part of the Sydney 1:100 000 Geological Series Sheet is reproduced on Drawing 2 in Appendix B and indicates that the northern part of the site is underlain by Hawkesbury Sandstone and the southern part by Ashfield Shale.

Hawkesbury Sandstone typically comprises medium to coarse grained, quartz sandstone while Ashfield Shale typically comprises black to dark grey shale and laminate.

Between the younger Ashfield Shale and the older Hawkesbury Sandstone there is sometimes the Mittagong Formation. This is a relatively thin transition layer of interbedded sandstones and siltstones and is often omitted from the geological maps.

Reference to the Sydney 1:100,000 Soils Landscape Sheet, a part of which is reproduced on Drawing 3 in Appendix B, indicates that the site is underlain by soils belonging to the Lucas Heights group in the northern part and Glenorie group in the southern part .

The Lucas Heights soils are generally moderately deep, hardsetting yellow podzolic soils and yellow soloths which are generally stony soils of low fertility. Lucas Heights soils tend to occur on gently undulating crests and ridges on plateau surfaces of the Mittagong Formation.

Glenorie Soils are described as red and brown podzolic soils which are highly plastic, moderately reactive, impermeable soils that are prone to erosion. They are located on undulating to rolling hills on Wianamatta Shales.

Reference to digital data for Acid Sulphate Soil Risk (supplied by NSW Department of Environment and Climate Change in 2008 based on published 1:25,000 Acid Sulphate Soils Risk Mapping, 1994-1998) indicates that the site is located outside areas of known acid sulphate soils.

5. Field Work Methods

The geotechnical field work was undertaken between 14 and 20 October 2011 and included the following for the M2 Site:

- Set-out of the borehole location by an engineer, including a review of client-provided services plans and Dial Before You Dig (DBYD) drawings followed by electromagnetic scanning for underground services at borehole locations.
- Pot holing using non-destructive drilling to depths between 1 m and 1.5 m. The method used high pressure water to loosen the soils. Both the water and disturbed soils were immediately removed by vacuum into a closed steel tank for disposal at a licensed waste depot.
- Seven boreholes (Boreholes 1 to 7) were drilled over the site. Boreholes 1 and 5 were drilled with a geotechnical drilling rig, and taken to refusal on rock (at depths of 2.2 m and 2.4 m) using solid flight augers. At the other locations (Boreholes 2, 3, 4, 6, and 7), the boreholes were continued into the underlying rock using diamond core drilling to depths of approximately 10 m. The retrieved rock cores were photographed and point load strength tests undertaken on the rock. Regular standard penetration tests (SPTs) were generally undertaken within the soils from a depth of 1.0 m to 1.5 m.

The final borehole location and level was determined by GPS methods with the accuracy generally within 0.1 m.

Notes about this report and classification methods and descriptive terms are given in Appendix A.

6. Field Work Results

Boreholes 1 to 7 were drilled on the M2 site and their locations are shown on Drawing 4 in Appendix B. Details of the results of boreholes and in situ testing are given in the borehole logs in Appendix C. The subsurface conditions may be broadly summarised as follows:

- **Filling –** gravelly sandy clay filling to depths of between 1.1 m and 3.0 m; underlain by,
- **Silty Clay** – firm to hard, light grey and red, high plasticity; silty clay, to depths of 1.9 m to 2.2 m in Boreholes 4 and 6 only; underlain by,

- **Bedrock** – extremely low to low strength rock at depths ranging from 1.1 m to 3.0 m depth and increasing in strength with depth.

In all the cored boreholes, the recovered rock was generally shale, siltstone and fine grained sandstone near the rock surface indicating that these rocks belongs to Mittagong Formation. With depth, the rock changes to Hawkesbury Sandstone which tendered to be generally high strength rock.

No free groundwater was observed whilst augering at any borehole location.

The exception to the above will occur in the area of the tunnel decline and the shaft built for the tunnel boring machine.

7. ECRL Investigations

The geotechnical reports prepared for the railway ECRL included two boreholes (Boreholes CB30 and CB31) drilled on the site. The results are consistent with the current findings with some filling over silty or sandy clay over rock. Both boreholes had either Mittagong Formation or Ashfield Shale over medium grained Hawkesbury Sandstone which was generally being high strength rock. The boreholes are included in Appendix E.

From groundwater observations made during the geotechnical investigation for the ECRL, the groundwater table was measured at RL 38.66 m to RL 39.03 m in Borehole CB31 between February 2001 and October 2001.

8. Laboratory Testing

Laboratory testing was undertaken on selected soil and groundwater samples for the purpose of assessing engineering properties and subsurface aggressivity. The results sheets for these laboratory tests are included in Appendix D, and are summarised in the following sections.

8.1 Soil Engineering Testing

For soil classification purposes, two samples of silty clay were tested for Atterberg Limits. The results are summarised in Table 1.

Table 1: Results of Laboratory Classification Testing

Borehole	Sample Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
4	1.8	64%	29%	35%	15.5%
6	1.5	50%	26%	24%	11.0%

These results indicate that the natural site soils are of high plasticity clays with a relatively high potential for movements with changes in moisture content.

For the purpose of pavement design, two samples of filling were tested to determine the California Bearing Ratio (CBR) value of the site soils that could form the subgrade for pavements associated with the development. The compaction properties of the sample were determined, and the sample then prepared in a CBR mould at approximately 100% of the Standard Maximum Dry Density (SMDD) at Standard Optimum Moisture Content (SOMC). Once prepared, the sample was surcharged and immersed in a water tank for soaking for a four day period. The results of the laboratory compaction and CBR tests are summarised in Table 2.

Table 2: Results of Compaction and CBR Testing

Borehole	Sample Depth (m)	SMDD (t/m^3)	SOMC (%)	CBR (%) 4 day soaked	Swell (%)
1	0 – 1.0 m	1.94 t/m^3	11.5%	12%	0
2	0 – 1.0 m	1.79 t/m^3	17.0%	5.0%	0

8.2 Aggressivity Testing

Selected soil samples were also submitted to Envirolab Services Pty Ltd, a NATA accredited testing laboratory, for the purpose of chemical testing for assessment of subsurface aggressivity. Soil samples were tested for pH and concentration of chloride and sulphate ions. The results are summarised in Table 3.

Table 3: Results of Aggressivity Testing - Soil

Borehole	Sample Depth (m)	pH	Chloride (mg/kg)	Sulphate (mg/kg)
2	1.0	9.5	240	72
3	1.5	6.4	270	99
4	1.8	4.4	69	14
7	1.5	5.4	74	49

9. Proposed Development

It is understood that proposed development options will be transit-oriented, locating residential development and employment opportunities close to public transport infrastructure.

M2 Site has been targeted for mixed use providing convenience retail and residential development in proximity to North Ryde Station. Public recreation areas are also proposed throughout the precinct to provide a series of public open space areas.

The extent of excavation and earthworks at the site will vary depending on the final staging strategy and adopted site levels. Basements of varying depths are expected under most of the buildings. Therefore, comments are provided to cover a range of options for earthworks, excavations and foundations. Works within the site will also need to consider any potential impacts on the ECRL. This is addressed further in Section 10.17.

10. Comments

10.1 Geotechnical Model

Based on the results of the investigation and other geotechnical investigation reports, the interpreted geotechnical model is provided in Table 4.

Table 4: M2 Site Geotechnical Model

Unit	Material	Description
1	**Filling**	Deep filling was encountered in the majority of the borehole locations across the M2 site (Boreholes 1 to 7) to depths of 1.0 m to 3.0 m.
2	**Silty Clay**	Hard silty clay identified at Boreholes 4, 6 and CB31 only, to depths of 1.9 m and 2.2 m (up to 1.9 m thick).
3	**Shale, Siltstone and Sandstone (Mittagong Formation)**	Extremely low to very low strength shale and siltstone to depths of 3.0 m to 3.7 m was encountered in Boreholes 6, 7 and CB31.
		Low to medium strength siltstone to depths of 5.1 m to 6.0 m in Boreholes 6 and 7 only.
		Extremely low to low strength, fine grained sandstone to depths of 2.1 m to 4.25 m.
4	**Sandstone (Hawkesbury Sandstone)**	At cored locations - medium to high strength sandstone, moderately to slightly fractured to unbroken with depth, was proven to depths of 9.55 m to 41 m. Some very low strength bands were encountered at various depths.

An interpreted cross-section is included in Drawing 5 in Appendix D, indicating the above geotechnical profile as well as showing the approximate location of the ECRL tunnel. A plan of the approximate locations of the tunnel, shaft and decline is given on Drawing 6.

In the absence of specific information on compaction, the existing site filling must be assumed to be uncontrolled even though it has been used as a works compound and vehicles have travelled over the site and areas have been subjected to preloading by stockpiles. It is, however, understood that the backfilling of the shaft was done under controlled conditions with results available from the contractor.

The groundwater table was measured at RL 39 m in 2001 (about 20 m below the surface).

10.2 ECRL

The ECRL is under part of the site. There is also a decline and shaft, which were large open excavations during the construction to facilitate the entry of equipment. Refer to Drawing 6 for extent of ECRL, decline and shaft. It has been reported that the decline had bolts installed as temporary support when it was an open excavation and the excavation has been backfilled with a concrete plug and filling.

Any surface development within the zone of influence of the tunnel will have to consider the effects on the tunnel.

For buildings over the backfilled decline, special attention will be required on the foundations so that they are not affected by the decline.

10.3 Existing Filling

The boreholes indicate that the filling on the site is generally between about 1.0 m to 3.0 m thick. In its present condition, the filling is considered to be “uncontrolled” and accordingly unsuitable for the support of structural loads, ground slabs and pavements.

The variable compaction within the existing filling could give rise to differential settlement unless some form of treatment is adopted. It is very difficult to estimate the extent of settlement which may take place; nevertheless it is contrary to standard engineering practice to build on variable compacted filling.

Generally, the options for the support of columns, slabs and pavements on the existing filling should include either support on reworked filling or on natural material below the filling. Reworking of the filling, however may not be sufficient to limit deflections of the internal ground slab which may have very stringent deflection requirements. The following section refers only to reworking of filling.

10.4 Site Preparation

Previous developments on the site have altered the site profile. Site preparations on the M2 site are expected to include some bushland clearing and possibly filling a retention pond.

In clearing the bushland, it is expected to create abnormal moisture conditions in the remaining clays. The moisture condition should be allowed to stabilise or otherwise moisture conditioned prior to construction works on the clays.

The existing retention pond present on site in November 2012 is concrete lined above the water line and, for discussion purposes, is assumed to be fully lined. It is understood that the detention pond was to be removed and the site remediated before the site was handed back to TfNSW. Any further remediation works should be carried out using good engineering practice. The concrete lining should be removed; any soft or moisture effected material surrounding the pond should also be removed prior

to any earthworks or development. Filling should be carried out under Level 1 supervision in accordance with AS 3798-2008 and a Level 1 report prepared.

Site preparation for load bearing areas on the existing filling could include complete excavation and recompaction of the filling or partial excavation and recompaction of the filling with high energy impact rolling of the deeper filling. The choice of which option to adopt will not only depend on geotechnical reasons but also on other factors such as time and costs.

Compaction testing of all engineered filling and prepared subgrade surfaces should be carried out in accordance with AS3798 (known as "Earthworks Code"). In particular, the rate of testing suggested in the Earthworks Code should be adopted.

10.4.1 Complete Excavation and Replacement

Complete excavation and replacement of the filling will almost eliminate the risk of ongoing and differential settlements within the filling under typical structural loadings. This method would include removal of all the filling, sorting the filling by discarding unsuitable material and reuse of the filling by compacting it under controlled conditions. This option would be the most expensive and time consuming, but would ensure that ongoing settlements of pavements are minimised.

Site preparation for complete excavation and replacement should include the following steps:

- Strip the surface of any vegetation or unsuitable material. This material should not be used as structural filling, however can be stockpiled for landscaping purposes;
- Excavate the filling to expose the underlying natural material (clay and/or rock);
- Proof roll the exposed surface with six passes of an 8-10 tonne roller, with the final pass carried out under observation of a geotechnical engineer to check for any soft or saturated zones. Any such zones should be over-excavated to a maximum depth of 300 mm and replaced with compacted granular material;
- The existing filling materials may require some sorting by removal of oversize or unsuitable material to be considered for use as an "engineered" filling; then,
- Filling should be placed in 300 mm thick horizontal layers and each layer compacted to 98% standard maximum dry density up to depths of 500 mm below the proposed subgrade level and to 100% standard maximum dry density in the upper 500 mm of filling. The moisture content during filling should be controlled so that it is always within ±2% of optimum moisture content determined in the standard compaction test.

10.4.2 Partial Excavation and Compaction

The advantage of partial excavation and compaction of the filling is that excavation can be limited, however it is noted that this method of site preparation presents a higher risk of settlements compared to complete excavation and replacement.

Partial removal of the filling and construction of a bridging layer using conventional filling methods may be used in conjunction with high energy impact compaction of the deeper filling from the excavation

level. It is suggested that as a minimum, provision be made for over excavating to a depth of at least 1 m below the proposed construction level unless rock is encountered.

High energy impact compaction would be carried out from this depth to compact the underlying filling and provide a bridging layer over natural stiff clays. This method involves the use of three to five sided heavy rollers to compact the ground. Difficulties are sometimes encountered using impact compaction in clayey soils. Accordingly the impact compaction should initially be carried out over a trial area to assess number of passes required and effectiveness. It is noted that impact rolling would not be required where excavation of the filling exposed rock or shaly clay.

The advantage of this method is that it is relatively quick as only the exposed surface is compacted and rolling takes place at speeds between 10 and 20 km/hour. There remains a risk, however of minor settlements, which may lead to some differential settlements.

Site preparation for partial excavation and replacement in conjunction with high energy impact compaction should include the following steps:

- Strip the surface of any vegetation and unsuitable material. This material should not be used as structural filling, however can be used for landscaping purposes;
- Excavate the existing filling to 1 m below finished subgrade levels for pavements, leaving a horizontal level surface;
- Impact roll the exposed filling. Take levels at regular intervals (say every 10 passes) to measure the amount of settlement. Experience would suggest that the number of passes required could be between 30 and 50;
- The existing filling materials may require some sorting by removal of oversize or unsuitable material to be considered for use as an “engineered” filling; then,
- Filling should be placed in 300 mm thick layers with each layer compacted to 98% standard maximum dry density up to depths of 500 mm below the proposed subgrade level and to 100% standard maximum dry density (SMDD) in the upper 500 mm of filling. The moisture content during filling should be controlled so that it is within ±2% of optimum.

10.5 New Filling

For the construction of engineered filling platforms, or pavements, the following site preparation and earthworks measures are recommended for new filling on natural ground:

- Any unsuitable material should be removed including grass roots, vegetation and tree roots, together with any existing, uncontrolled filling or other deleterious material. If any other material is substantially root affected, the material should also be removed.
- Following stripping, the exposed surface should be tyned and moisture conditioned to approximately optimum moisture content then proof rolled using a smooth drum roller of at least 10 tonnes deadweight.
- Proof rolling of exposed subgrade and stripped areas should be observed by an experienced geotechnical professional to detect excessively loose or spongy areas which may require

rectification. Any soft or spongy areas should be excavated a further 600 mm depth and backfilled with clean filling placed in compacted layers to 98% of SMDD and within 2% of the SOMC. The re-instated surface should again be subject to proof rolling to assess the adequacy of the prepared surface.

- Materials used for replacing soft areas or site re-grading may comprise either the site soils other than topsoil or unsuitable material (e.g. contaminated materials, wet soil, materials with oversize inclusions or organics), or materials imported specifically for the purpose. If imported materials are used, preference should be given to select readily compactable, well-graded granular material such as crushed sandstone or crushed recycled concrete. If clay filling is used, then the reactivity of the filling should be equal or less than the reactivity of the natural soils. Filling should be placed in layers not more than 300 mm loose layer thickness and compact to at least 98% of SMDD generally, and to at least 100% SMDD within 0.3 m of pavement subgrade surfaces. Moisture contents of the fill material should be maintained within 2% of the SOMC. If smaller compaction plant (8 tonnes or less) needs to be used due to space restrictions, a maximum loose layer thickness of 200 mm should be adopted.

For new filling on existing filing, the existing filling should be treated as discussed in Section 10.4 before placing and compacting the filling as given above.

10.6 Working Platforms

Once exposed, the silty clay and filling on the site may be susceptible to loss of strength if the moisture content increases (e.g. following prolonged rain events, or if water is permitted to pond on the clay surface). In the event of rain, consideration could be given to the provision of a nominal working platform of 200 mm thickness of crushed rock or concrete, to improve trafficability of the site.

A more substantial working platform may be required for the operation of heavy plant on the exposed site soils. The specific requirements will depend on the particular loading applied by the plant and subgrade conditions at the time of loading.

10.7 Excavation Conditions

It is expected that excavation for basements or other needs will entail cutting through 1 m to 3 m of overburden overlying extremely low to medium strength shales and siltstone grading into high strength sandstone. Removal of overburden soils and highly weathered rock should be readily accomplished with an excavator.

The Mittagong Formation tends to comprise extremely low strength and medium strength, fractured siltstone and shales while most of the Hawkesbury Sandstone is generally medium to high strength, slightly fractured to unbroken sandstone. Heavy duty equipment, such as large dozers with a ripper, is expected to be required for excavation into rock especially if the excavation is in Hawkesbury Sandstone. For detailed excavation, the use of excavator mounted hammers and rock saws will be required to excavate the medium and high strength sandstone.

Avoidance of overbreak along lines of intended excavation can prove difficult in medium and high strength sandstone. Experience has shown that the use of excavator mounted saws or milling heads can often successfully overcome overbreak problems. Regular inspections of the excavation works by an experienced engineering geologist/geotechnical engineer are suggested to check for potential unstable rock wedges.

Noise and vibration will be generated by excavation work on the site. Care will be required when excavating close to the existing buildings on adjacent properties. There are commercial buildings adjacent to the site. There is debate as to the maximum amount of vibration that buildings can accommodate without signs of distress. The level of acceptable vibration is dependent on various factors including the type of building structure (e.g. reinforced concrete, brick, etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.

It is also noted that humans are very sensitive to vibrations and consequently will be disturbed by vibration levels which are considered relatively insignificant for buildings. Taking these factors into account, it is suggested that a maximum vibration of 5 mm/s at the foundation level of the adjacent buildings be adopted. From previous monitoring in similar conditions, a Krupp 600 hammer or equivalent should be used no closer than 3 m to 5 m from the foundations and a Krupp 950 hammer no closer than 15 m from the foundations. It is recommended that vibration monitors be installed during bulk and detailed excavation when removing rock close to adjacent buildings.

Specific vibration monitoring is expected to be required for construction activities in vicinity of the ECRL which crosses underneath the site. The ECRL is addressed further in Section 10.17

10.8 Waste Classification

NSW EPA guidelines state that all material to be disposed off site should be the subject of a Waste Classification Assessment which is not included in this report.

10.9 Excavated Material Disposal and Re-use

Care should be taken to keep separate the filling, topsoil material and natural soils and rock during excavation, as these materials are expected to have different requirements with respect to disposal and/or re-use.

From a geotechnical perspective, the following comments are provided with respect to reuse of materials on site:

- The natural topsoil materials (where present) would be unsuitable for reuse as engineered filling, but could potentially be used in landscaping.
- The filling, less any organic matter or oversized particles (i.e. greater than 150 mm), is generally considered suitable for reuse as engineered filling. Some sorting may be required to remove any unsuitable or oversized material.

- The natural material, which is clay and rock, on the site is likely to generally be suitable for reuse from a geotechnical point of view. However, any organic matter encountered in the natural material should also be removed. Some moisture conditioning of the material may be required.
- Excavated rock may have to be broken down to provide a well graded material with maximum size of about 150 mm for re-use as filling. It may be difficult to break down the high and very high strength sandstone.

The re-use of the filling is also subject to a waste classification from a contamination viewpoint.

10.10 Excavation Batters

Excavations may be temporarily battered for the construction of basement retaining walls. The maximum short and long term batter slopes for the materials encountered in the boreholes are given in Table 5: Maximum Safe Batter Slopes for batter heights of up to 2 m, and where surcharges are not present at the batter crest.

Table 5: Maximum Safe Batter Slopes

Material	Retaining Wall Design Parameters (H:V)	
	Short term temporary	Long term permanent
Uncontrolled filling and firm silty clay	1.5:1	2.5:1
Stiff and hard silty clay	1:1	2.0:1
Extremely to low strength rock	0.75:1	1:1
Medium to very high strength rock	vertical	0.75:1

Flatter slopes than those above may be required to allow for maintenance. Provision for maintenance and protective measures may be required for the protection of long-term batters, such as pinned shotcrete protection against erosion or weathering.

All batters should be subject to geotechnical inspection for every 1.5 m of vertical excavation, to confirm the adequacy of the slopes indicated above.

10.11 Excavation Support

Where insufficient space is available for temporary batters, excavation support will be required for the overburden and extremely low to low strength rock. Excavation support may also be preferred to reduce volumes of material excavation and/or disposal.

Appropriate shoring may comprise bored soldier pile walls with shotcrete panels. Shoring piles, which would typically be spaced approximately 2.0 m apart, may be used to carry vertical structural loads and should be socketed below the bulk excavation level. Excavation should proceed in drops of no

greater than 1.5 m before infill panels are formed. Closer pile spacing's would be appropriate where existing foundations or other high surcharges are located behind the wall.

For relatively low retaining walls, say up to 3 m high, where lateral movement is not a concern, cantilever walls may be appropriate.

Where the retaining walls are designed as cantilevered or singly propped retaining walls with a level retained surface, preliminary wall design may be based on the following triangular earth pressure distribution, and the parameters given in Table 6

$$\sigma_{hz} = K \cdot z \cdot \gamma$$

Where, σ_{hz} is the horizontal pressure at depth z (kPa)

γ is the bulk unit weight of soil or rock (kN/m^3); and,

K is the earth pressure coefficient

Table 6: Parameters for Cantilevered or Singly Propped Retaining Wall Design

Soil Type	Unit Weight (kN/m^3)	Active Earth Pressure Coefficient (K_a)	
		Temporary	Permanent
Existing filling	20	0.3	0.4
Natural stiff to very stiff clay	20	0.25	0.3
Engineered filling	20	0.25	0.3
Extremely to Low Strength rock	22	0.2	0.25
Medium to Very High Strength rock	22	0	0

Where the lateral movement of the wall needs to be limited, an "at rest" earth pressure coefficient 50% greater than the active earth pressure may be adopted. It should be noted, however, that it is not possible to totally eliminate lateral movement towards an excavation. Should existing foundations be present behind the wall, a cantilevered wall design may not be appropriate.

Additional allowance should be given to hydrostatic loads and surcharge loading such as sloping ground, construction traffic and adjacent foundations. Hydrostatic pressures may be ignored if allowance is made for the permanent drainage of any perched groundwater flow or seepage from behind the proposed building and retaining walls.

Where soil is backfilled immediately behind retaining walls, free-draining, granular material should be used and suitable drainage provided. Compaction of the soils should be undertaken using hand-operated equipment only.

Where reliance on passive resistance is required, the ultimate passive pressure considered appropriate for design in at least very stiff to hard clay soils is 100 kPa (or passive coefficient, Kp, of 2) or 1000 kPa in low strength rock. This would only be achieved following significant movement of the retaining wall, and hence the value should be factored down appropriately so as to limit movement.

10.12 Groundwater

Groundwater levels on the site were recorded at relatively deep levels within the rock during previous investigations. It is noted, however, that groundwater levels would be expected to vary seasonally and with climatic influences, and that perched groundwater levels may occur due to rainfall events.

Should excavations intercept the perched groundwater table, then some groundwater inflows could be expected. Estimates of inflow are difficult to assess and a better assessment could be made at the excavation stage. Allowance should be made for possible buoyant forces that may act upon the basements, unless drainage of seepage or groundwater is provided.

Only minor, periodic inflows are expected into any basement excavation, and it is expected that such inflows could be readily managed in the short and long term by the use of a normal "sump-and-pump" drainage system.

10.13 Foundations

10.13.1 Site Classification

It should be noted that site classification in accordance with AS2870 – 2011 Residential Slabs and Footings would generally only be applicable to buildings supported on shallow foundations at, or near present ground surface levels (i.e. with no basements) and if they are similar to houses in size, loading and superstructure flexibility. Notwithstanding this, site classification provides a useful indication of the potential for shrinkage and swelling of the site soils, although it is not suggested that the standard footing designs presented in AS2870 be adopted for this development.

Given the depth of filling on the site, a 'Class P' classification would generally apply to the southern end of the site in its present condition.

Additional surface movement due to trees (y_t) should be expected. The influence of trees on surface movements would be expected to continue after removal of the trees, until seasonal moisture changes result in climate-controlled moisture contents within the soil. This could take many years.

Further assessment would be required should an alternative site classification be required. It is noted that the natural clays on site are considered to be moderately to highly reactive to changes in moisture content.

10.13.2 Design

Rock is generally close to the surface. Accordingly it is suggested that large buildings are founded on rock. In the case of buildings with no basements, shallow footings or bored piers are appropriate. For buildings with basements, rock is expected to be exposed in the bulk excavation and therefore shallow footings may be appropriate.

Recommended maximum ultimate and allowable pressures and modulus values for the foundation materials encountered in the field investigations at the site are presented in Table 7.

Table 7: Recommended Parameters for Foundation Design

Material	End Bearing Pressure (kPa)		Shaft adhesion * (kPa)		Field Elastic Modulus, E (MPa)
	Allowable	Ultimate	Allowable	Ultimate	
Extremely low to very low strength shale	700	3,000	40	75	50
Low strength siltstone and Shale	1,000	3,000	100	350	200
Medium strength siltstone and Shale	3,500	10,000	350	600	400
High Strength Sandstone	6,000	40,000	600	1,500	1,000

Note: * For pile foundations in compression only; assumes adequately roughened pile sockets and a minimum pile depth of 1.5 times the pile diameter; reduce by 50% to obtain values for design against uplift.

For buildings and structures within the zone of the ECRL tunnel, shaft and decline, foundations may have to be piles founded below the zone of influence of the tunnel and decline unless it can be shown that the foundations do not adversely affect the tunnel. For piles founded below the zone of influence of the tunnel, they would be expected to be relatively deep and therefore drilled through high and possibly, very high strength sandstone. Piles should be debonded through the zone of influence to mitigate the effects of skin friction.

A similar situation exists for structures over the decline. Unless it can be established that the decline was properly backfilled and is suitable to support structures above it, it will be prudent to allow for piled footings founded below the influence of the decline.

End bearing pressures for preliminary design of foundations are given Table 7 above. It is expected that deep piles will be founded in high strength sandstone with bearing pressures of the order of 6 000 kPa.

The settlement of foundations proportioned on the basis of the above allowable parameters would be expected not to exceed 1% of the footing width/diameter.

10.13.3 Construction

All foundation excavations should be clean and free of loose debris with pile sockets free of smear and adequately roughened immediately prior to concrete placement. Some softening of the rock may occur after exposure, particularly in wet weather. Any softened or loose material within the excavation or socket length would need to be removed. Any surface water or groundwater inflow into footing excavations should be removed prior to pouring of concrete.

In situations where pile foundations are considered, suitable pile types include conventional bored piers or Continuous Flight Auger (CFA) piling.

If bored piles are used, temporary casing may be required to prevent the collapse of materials, especially the filling, into the pile hole. Should groundwater infiltration occur into the pile excavation, then the water would need to be removed from the excavation prior to pouring of concrete.

As CFA piles are a 'blind' piling technique (and hence not suited to geotechnical inspection), the piles will need to be certified by the piling contractor to confirm that the piles have reached a suitable depth, and that the material encountered is consistent with the design assumptions. The selected piling rig should also be able to drill to the required depths. For example, in the case of deep piles, the piling rig must be capable of drilling through high and very high strength sandstone.

10.14 Soil Aggressivity

Based on the results from the chemical laboratory testing of soil sample collected on the site, and with reference to Table 6.4.2 (A) & (C) and 6.5.2 (A) & (C) in AS 2159-2009, the exposure classification for piles (and other structural elements such as pad footings, etc) falls into the non-aggressive or mild exposure classification for steel and concrete elements.

The site is located outside of areas of known acid sulphate soils, and no signs of concern for acid sulphate soils were identified during the investigation. Therefore, acid sulphate soils are not anticipated on the site.

10.15 Soil Erodibility

Filling and clay layers may be susceptible to erosion during construction. During construction erosion control measures should be implemented. Design and implementation of control measures should comply with the NSW Guideline *Soils and Construction: Managing Urban Stormwater, Landcom, 2004*. For the purposes of preliminary design of control measures, soils are expected to fall within the Type C or Type F classification (as described in the aforementioned guideline).

10.16 Pavements

The design of the pavements will depend on the CBR of the subgrade material and the final levels. At present, there is a significant amount of variable filling on the site and therefore the CBR of the material is expected to be variable.

CBR tests on the site had results of 5% and 12%.

Where imported fill is used to raise the existing site levels, the design CBR value will depend on the type of imported material. Assessment of any imported materials would require further inspection and laboratory testing to confirm the appropriate CBR value for design purposes. It would be normal practice to only import material with a minimum CBR value of 5%, where it is to be used to form pavement subgrades.

Where pavement levels are significantly lowered, hard clay or rock could be exposed as subgrade.

When pavement levels are known, the pavement design will have to be reviewed. In the meantime, a provisional design CBR of 5% based on an assessment of the existing material on the site could be used for the concept design of the pavements only.

The design CBR value will depend on the provision of adequate surface and subsoil drainage to maintain the subgrade as close to OMC as possible. Subsoil drainage should be installed to not less than 500 mm depth below subgrade level adjacent to pavement areas and to any lawns or garden areas, where the ingress of water beneath the neighbouring pavement subgrade may be possible. Preparation of subgrade surfaces should be such that adequate cross-falls for surface drainage purposes are achievable across the final pavement.

10.17 Epping to Chatswood Railway Line (ECRL)

Development near the southern end of the site will be located over the zone of influence of the ECRL and the decline and the effects of the development on the tunnel and decline will have to be considered.

Details are contained in the document “ECRL Underground Infrastructure Protection Guidelines (UIPG), Report No. 20007300 / PO-4532”, by Transport Infrastructure Development Corporation (now TfNSW), dated May 2009. Reference is also made to the “Development sites Report on Assessment of Impacts on Epping to Chatswood Rail Line”, prepared by Parsons Brinckerhoff Australia Pty Limited, dated August 2008.

The Guidelines require that the potential impact of a proposed building or structure in the vicinity of ECRL be assessed in terms of potential effects on stress distribution, deformation and groundwater movements. The Guidelines also suggest that designers of proposed developments carry out an assessment of the effect of the ECRL infrastructure on their structure. All potential effects such as vibrations, long term creep movements, groundwater table variations and stress imposed by new buildings need to be considered.

The Guidelines define the “support zone” for tunnels as 10 m vertically above and 5 m vertically below or horizontally from the finished internal surfaces of the running tunnels.

The “zone of influence” for the tunnels is defined as the area vertically above the structure to the existing surface level. The tunnel influence zone is bounded by a line extending outwards at a slope of 1V:1H from the edge of the tunnel support zone at the lowest level of the tunnel for a horizontal distance of 20 m.

The ECRL Protection Guideline documents define a 1st Reserve and a 2nd Reserve zone. The 1st Reserve aligns with the ECRL “Support Zone”. The 2nd Reserve aligns with the ECRL “Influence Zone”. Development within these zones shall consider the protection guidelines and relevant requirements.

Proposed developments should induce negligible or allowable stress and strain changes around the tunnel and station infrastructure. Stress changes of less than 10% are generally considered acceptable.

The lateral movements of excavated rock faces due to stress relief must be considered and their effects on the tunnels and station.

There is also a recommendation that any basement within 14 m of the tunnels or loads associated with the development which are non-uniform be analysed for displacements and stresses at the tunnel lining. Point loads, eccentric loads and concentrated loads should be avoided above tunnels and stations.

The guidelines recommend that a monitoring program is implemented during construction to measure any movements for assessment. The movements include: surface settlement, lateral movement within excavations and internal ground movements including lateral bedding plane shear and bedding plane dilation.

Some of these guidelines include:

- No excavation within the support zone;
- No shallow footings within the support zone;
- Limitations on development in the vicinity of the tunnel;
- Insignificant construction effects, e.g. vibrations, on the tunnel;
- Detailed assessments of the development on the tunnel.

The ECRL will potentially affect the type of developments on the M2 Sites. It is understood that the Precinct planning and Indicative Layout Plan (ILP) has been developed so as to avoid impacts on the ECRL.

It is expected that monitoring will be required for any development near the ECRL and could involve, but not be limited to:

- Precise levelling and surveying;
- Installation of inclinometers and regular measurements;
- Vibration monitoring; and Site inspections.

11. Further Investigation

The geotechnical investigation carried out is preliminary in nature for the preliminary design of the NRSPP only. For detailed design purposes, further geotechnical investigation(s) appropriate for the proposed development should be carried out.

Detailed CBR testing of the subgrade will be required for pavement design as the subgrade materials vary across the sites.

For development of building lots, investigations for building with basements should involve cored bores taken to at least 3 m below basement level. The cored boreholes from the current and previous investigations have encountered medium to very high strength rock. As this investigation is only a preliminary investigation, lower bound bearing pressures have been provided for preliminary design purposes. With project specific additional investigations, it is possible that the end bearing pressures and shaft adhesion given above in Table 7 may be increased.

Further investigation and assessment of impacts on the ECRL from temporary and permanent works should be undertaken in accordance with the ECRL Protection Guidelines and Railcorp requirements.

12. Limitations

Douglas Partners (DP) has prepared this report for a project at M2 Site, North Ryde. The report is provided for the exclusive use of UrbanGrowthNSW for this project only and for the purpose described in the report. It should not be used for other projects or by a third party. In preparing this report DP reproduced sections of the report prepared for TfNSW.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of man-made changes. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

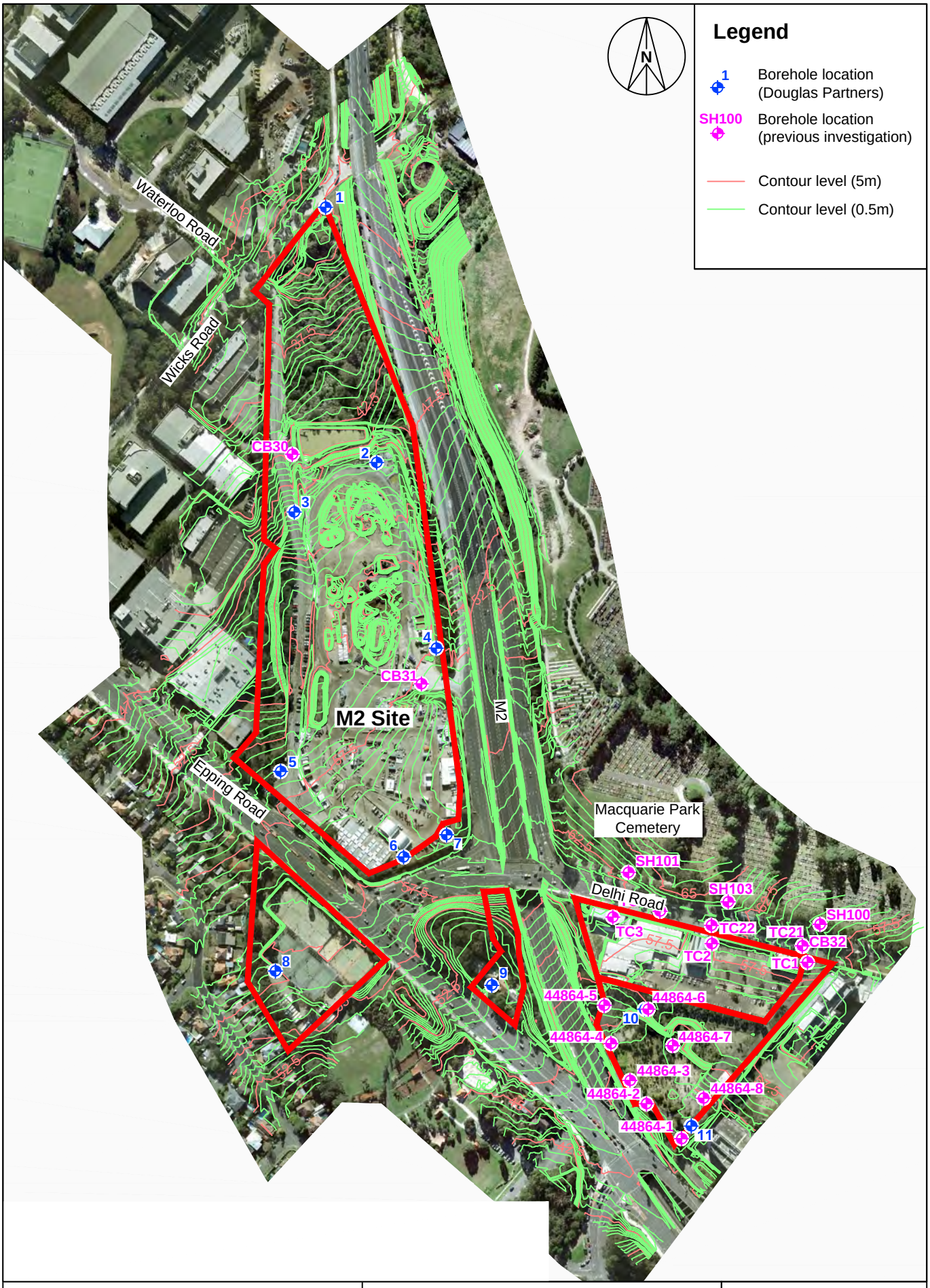
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

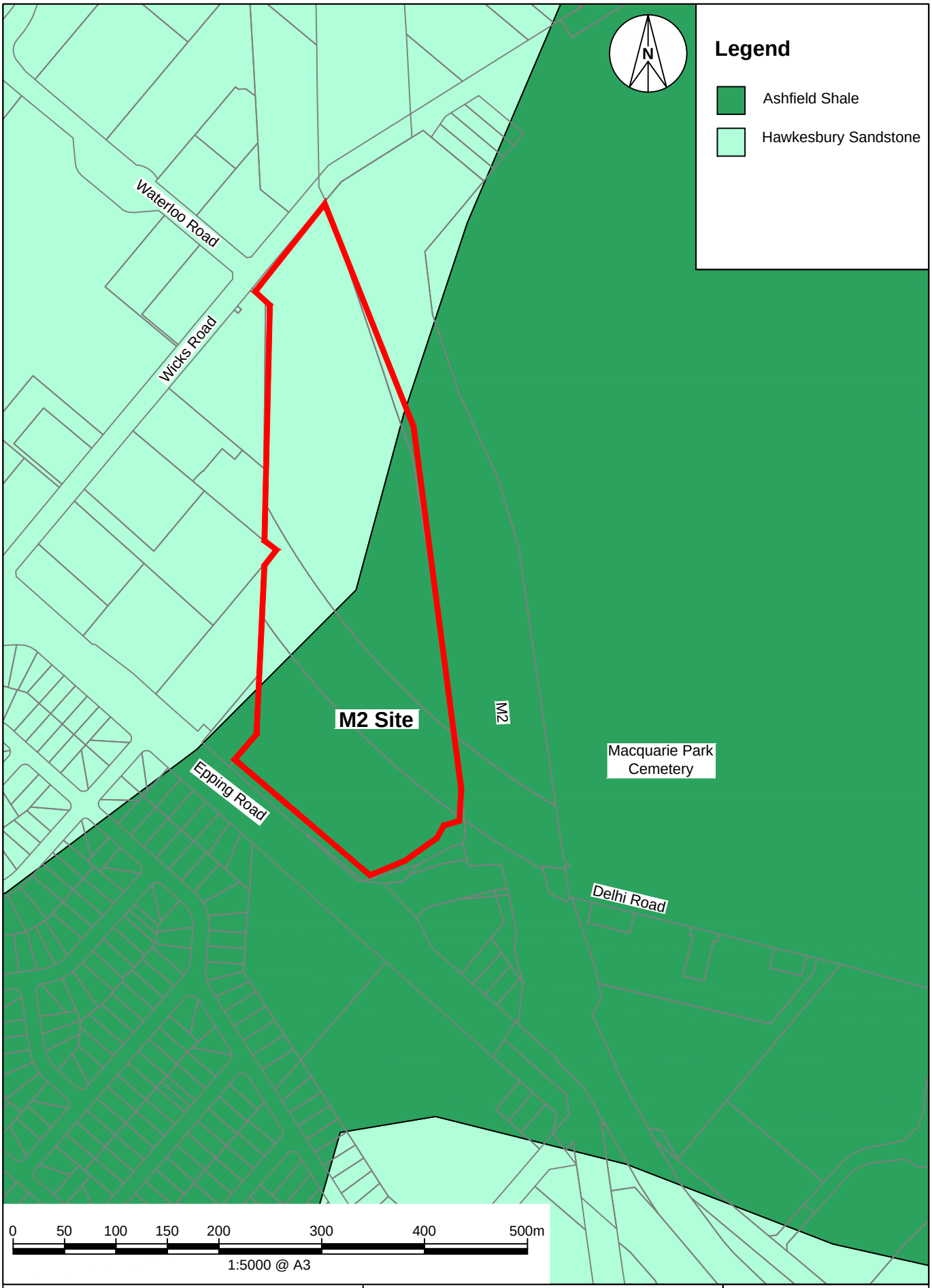
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings



Douglas Partners Geotechnics / Environment / Groundwater	**Site Location Plan** **North Ryde Station Precinct**	PROJECT No: 73937.01 DRAWING No: 1 REVISION: 0
	CLIENT: UrbanGrowth NSW	DATE: 10.04.2014



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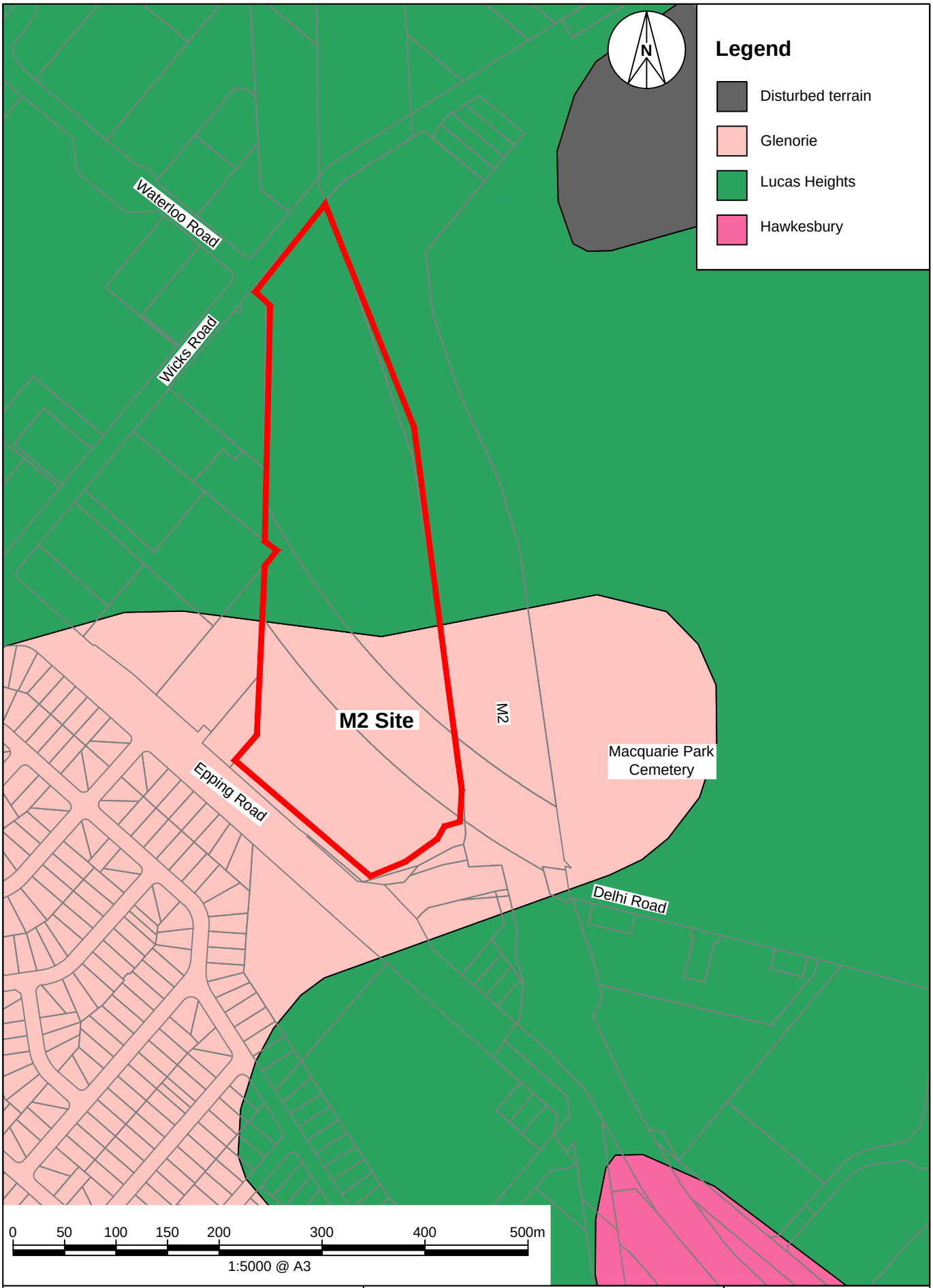
Regional Geology
M2 Site, North Ryde

PROJECT No:	73937.01
DRAWING No:	2
REVISION:	0
CLIENT: UrbanGrowth NSW	DATE: 10.04.2014



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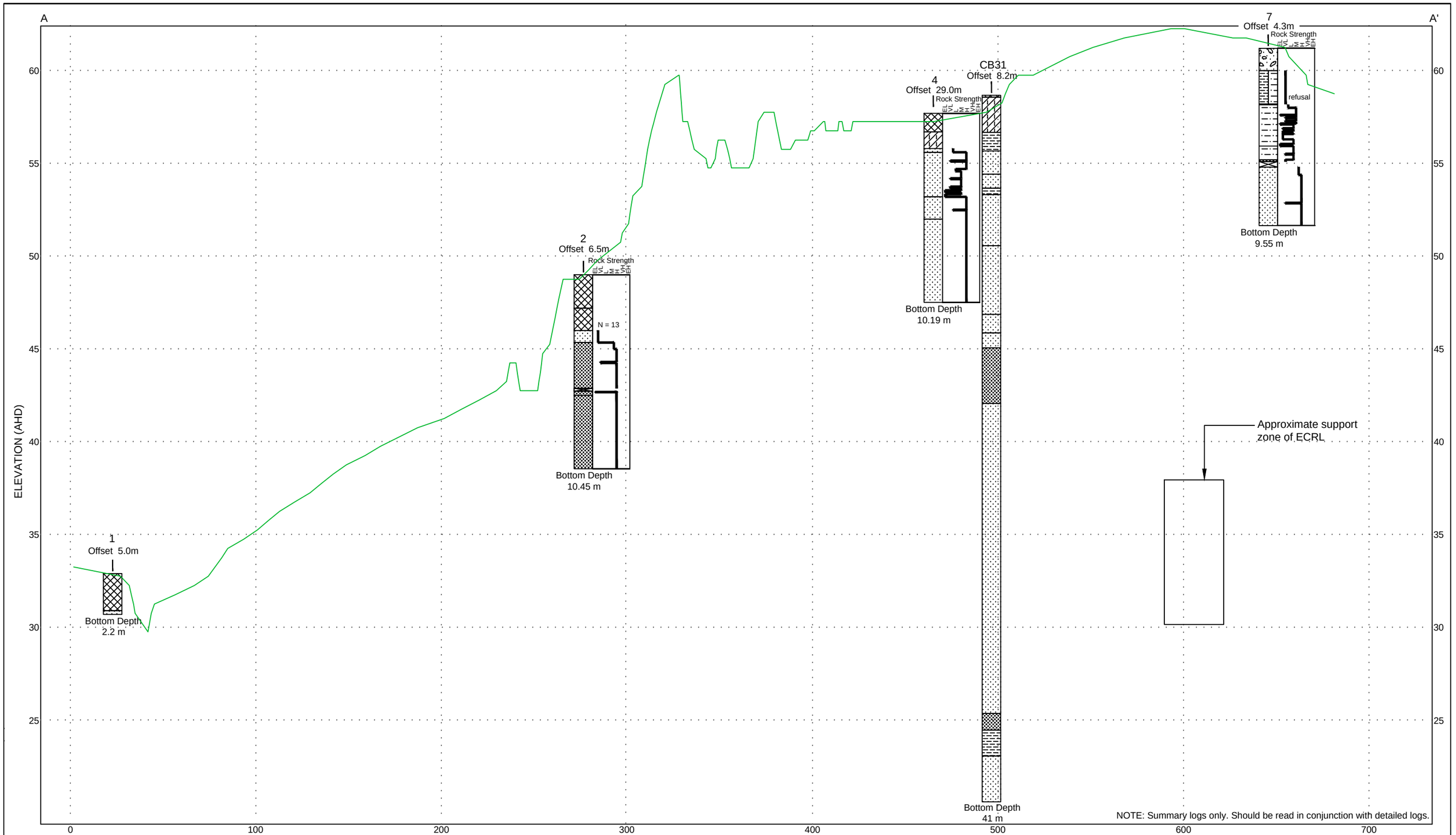
Regional Soil

M2 Site, North Ryde

PROJECT No:	739937.01
DRAWING No:	3
REVISION:	0
CLIENT: UrbanGrowth NSW	DATE: 10.04.2014

Douglas Partners Geotechnics / Environment / Groundwater	**Borehole Location Plan** **M2 Site, North Ryde**	PROJECT No: 73937.01 DRAWING No: 4 REVISION: 0
	CLIENT: UrbanGrowth NSW	DATE: 10.04.2014



LEGEND

- Core Loss
- Basecourse
- Filling
- Sandstone coarse grained
- Sandstone fine grained
- Shale
- Siltstone
- Silty Clay
- Topsoil
- Ground profile

Scale 1:2000 (H) 1:200 (V) @A3

ROCK STRENGTH

EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY

vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER

N - Standard penetration test value
▽ - Water level

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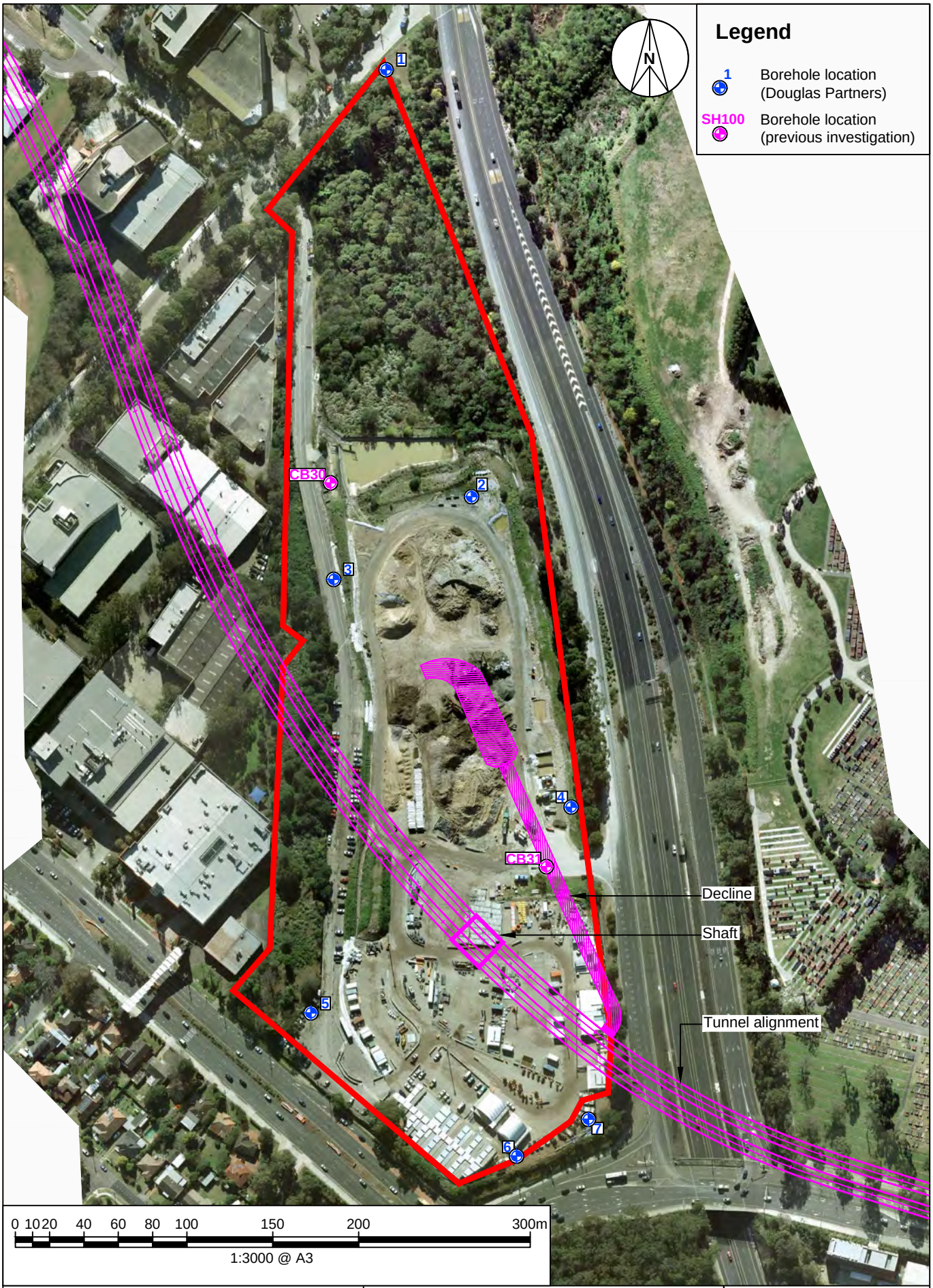
Geotechnics | Environment | Groundwater

CLIENT: UrbanGrowth NSW		TITLE: **Cross-Section A**	PROJECT No: 73937.01
OFFICE: Sydney	DRAWN BY: JCP	**M2 Site**	DRAWING No: 5
SCALE: As shown	DATE: 10.04.2013	**North Ryde**	REVISION: 0

File Name: P:\73937.01 NORTH RYDE, M2 Site Delhi Rd Geotech GSY\Drawings\73937.01_5.dwg Date printed: 11 Apr 2014 - 09:39AM



Douglas Partners Geotechnics / Environment / Groundwater	**Approximate Location of ECRL, Shaft and Decline** **M2 Site** **North Ryde**	PROJECT No: 73937.01 DRAWING No: 6 REVISION: 0
	CLIENT: UrbanGrowth NSW	DATE: 10.04.2014

Appendix C

Results of Field Work

Sampling Methods

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Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

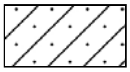
Soils


Topsoil

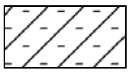

Peat


Clay

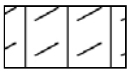

Silty clay

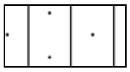

Sandy clay

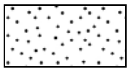

Gravelly clay

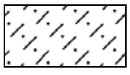

Shaly clay

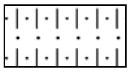

Silt


Clayey silt


Sandy silt

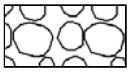

Sand

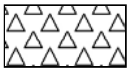

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

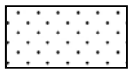

Talus

Sedimentary Rocks

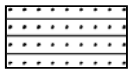

Boulder conglomerate

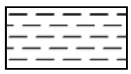

Conglomerate


Conglomeratic sandstone

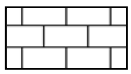

Sandstone


Siltstone


Laminite

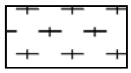

Mudstone, claystone, shale

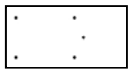

Coal


Limestone

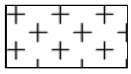
Metamorphic Rocks

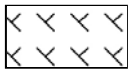

Slate, phyllite, schist

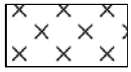

Gneiss

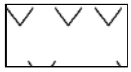

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: Off Wicks Road, North Ryde

SURFACE LEVEL: 32.9 AHD
EASTING: 327248.161
NORTHING: 6259776.967
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 72518
DATE: 18/10/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
32	1	FILLING - dark grey, silty sand filling with some gravel							A			
31	2	2.0 SANDSTONE - extremely low to low strength, brown, fine to medium grained sandstone with ironstone bands							A			
		2.2 Bore discontinued at 2.2m - refusal										
30	3											
29	4											
28	5											
27	6											
26	7											
25	8											
24	9											
23												

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger 1.10m to 2.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 2 PROJECT 72518 OCT 2011

3.65 – 8.0m

DOUGLAS PARTNERS PTY LTD

NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 2 PROJECT 72518 OCT 2011

8.0 – 10.45m

BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 49.0 AHD
EASTING: 327297.947
NORTHING: 6259528.128
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 72518
DATE: 19/10/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
49		FILLING - dark grey and grey, sandy clay and rock fragment filling							A			
48	1											
	1.8	FILLING - moderately compacted, grey brown, clay and shale fragment filling, moist										
47	2								S			1,4,9 N = 13
46	3							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°				
	3.0	SANDSTONE - extremely low strength, light grey brown, fine to medium grained sandstone										
	3.65	SANDSTONE - medium to high then high strength, moderately to slightly weathered, slightly fractured, light grey and red brown, medium grained sandstone. Some very low strength bands						3.8 & 3.92m: B10°- 20°, pl, ro, fe				PL(A) = 1
45	4							4.23m: B0°, cly co, 2mm				PL(A) = 1.2
								4.7m: B0°, Ds, 50mm				
44	5								C	95	90	
								5.4 & 5.5m: B10°, cly vn, ti				PL(A) = 1.4
43	6							5.81m: B0°, cly vn 5.97m: J30°, pl, ro, cln 6.09m: J, sv, pl, ro, cly co 6.12m: J, sv, pl, ro, cly co CORE LOSS: 150mm				
	6.27											
	6.5	SANDSTONE - high strength, moderately weathered, slightly fractured and unbroken, brown, medium to coarse grained sandstone						6.33m: B0°- 5°, cly co, 5mm				PL(A) = 1.8
42	7											PL(A) = 2.1
41	8							8.06m: B0°, cly vn	C	100	98	
								8.53 & 8.6m: J65°, un, ro, fe, cln 8.8m: B10°, cly vn, ti				
40	9											PL(A) = 1.6
									C	100	100	

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 3.5m

TYPE OF BORING: Solid flight auger 1.10m to 3.5m; Rotary to 3.65m; NMLC-Coring to 10.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. 40% water loss from 8.5m. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 49.0 AHD
EASTING: 327297.947
NORTHING: 6259528.128
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 72518
DATE: 19/10/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
39									C	100	100	PL(A) = 1.7
	10.45	Bore discontinued at 10.45m										
38	11											
37	12											
36	13											
35	14											
34	15											
33	16											
32	17											
31	18											
30	19											

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 3.5m

TYPE OF BORING: Solid flight auger 1.10m to 3.5m; Rotary to 3.65m; NMLC-Coring to 10.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. 40% water loss from 8.5m. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 3 PROJECT 72518 OCT 2011

2.8 – 7.0m

DOUGLAS PARTNERS PTY LTD

NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 3 PROJECT 72518 OCT 2011

7.0 – 9.6m

BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 47.8 AHD
EASTING: 327217.649
NORTHING: 6259479.957
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 72518
DATE: 19/10/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
47	0.0	ROAD PAVEMENT										
	0.3	FILLING - grey to grey brown, sandy clay filling with some rock fragments							A			
46	1							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°				
	2.1	SANDSTONE - very low strength, brown, fine to medium grained sandstone							A			
45	2.8	SANDSTONE - medium then high strength, slightly then moderately weathered, slightly fractured and unbroken, light grey and brown, medium to coarse grained sandstone										PL(A) = 0.5
	3							3.42m: B5°- 10°, fe, ti	C	95	93	PL(A) = 1.3
44	3.96							3.8m: J, sv, pl, ro, fe, cly 3.9m: CORE LOSS: 60mm				
	4											
43	5											PL(A) = 1.4
								5.8-5.86m: B (x3) 0°- 5°, fe, cly vn	C	100	100	PL(A) = 1.6
42	6											
41	7											PL(A) = 1.7
												PL(A) = 1.7
40	8							7.55m: J35°, pl, ro, cln 7.85m: J30°, he, ti 7.9m: B10°, cly co, 2mm 8.09m: J30°, pl, ro, fe 8.2m: J25°- 30°, fe, he, ti	C	100	98	
39	9											PL(A) = 1.9
		- becoming fresh from 9.35m						9.38m: B5°, cly co				PL(A) = 1.3
	9.6	Bore discontinued at 9.6m										
38												

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 1.6m to 2.5m; Rotary to 2.8m; NMLC-Coring to 9.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 4 PROJECT 72518 OCT 2011

2.1 – 6.0m

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NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 4 PROJECT 72518 OCT 2011

6.0 – 10.19m

BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 57.7 AHD
EASTING: 327355.964
NORTHING: 6259347.276
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 72518
DATE: 17/10/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
57	0	FILLING - gravelly clay filling										
56	1	1.0 SILTY CLAY - hard, light grey and red brown, silty clay, moist						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping at 0°-10°	A			
	2	1.9 SANDSTONE - very low to low strength, brown, fine to medium grained sandstone 2.1 SANDSTONE - high then medium strength, highly and moderately to slightly weathered, fractured and slightly fractured, light grey and orange brown, fine to medium grained sandstone. Some very low strength bands						2.6-2.75m: J75°, un, ro, cly co 2.81m: J45°, pl, ro, cly co, 2mm 3.06-3.2m: B (x3) 0°- 5°, cly vn 3.5m: B0°, Ds, 30mm 3.65m: B0°- 10°, fe, cly vn 3.93m: B0°, fe, Ds, 40mm 4.05m: B0°, fe, cly vn 4.15m: B5°, Ds, 100mm 4.37m: B/J20°, Ds, 130mm 4.73-5.7m: B (x3) 0°-10°, fe	C	100	94	PL(A) = 1.9
55	3								C	100	75	PL(A) = 0.8
54	4											
53	4.5	SANDSTONE - high strength, moderately weathered then fresh stained, slightly fractured, brown then light grey brown, fine to medium grained sandstone										PL(A) = 0.5
	5											PL(A) = 1.7
52	5.7	SANDSTONE - high strength, fresh, unbroken, light grey, fine to medium grained sandstone							C	100	91	PL(A) = 2.1
	6							6.18m: B6°, cbs, 1mm				
51	7											PL(A) = 1.7
50	8											PL(A) = 2
49	9							8.9m: B0°, cbs, 1mm	C	100	100	PL(A) = 2.1
48												PL(A) = 2

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.1m

TYPE OF BORING: Solid flight auger 1.2m to 2.1m; NMLC-Coring to 10.19m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 57.7 AHD
EASTING: 327355.964
NORTHING: 6259347.276
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 72518
DATE: 17/10/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
									C	100	100	
47	10.19	Bore discontinued at 10.19m										
	11											
46	12											
45	13											
44	14											
43	15											
42	16											
41	17											
40	18											
39	19											
38												

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.1m

TYPE OF BORING: Solid flight auger 1.2m to 2.1m; NMLC-Coring to 10.19m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 56.6 AHD
EASTING: 327204.408
NORTHING: 6259227.277
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 72518
DATE: 19/10/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
56	0	FILLING - gravelly clayey sand filling										
55	1.6	SANDSTONE - very low strength, brown, fine to medium grained sandstone							A			
54	2.4	Bore discontinued at 2.4m							A			
53	3											
52	4											
51	5											
50	6											
49	7											
48	8											
47	9											

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger 1.10m to 2.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 6 PROJECT 72518 OCT 2011

3.0 – 7.0m

DOUGLAS PARTNERS PTY LTD

NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 6 PROJECT 72518 OCT 2011

7.0 – 10.07m

BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 60.4 AHD
EASTING: 327324.179
NORTHING: 6259143.833
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 72518
DATE: 14/10/2011
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
60		HARDSTAND										
59	1.0	SILTY CLAY - hard, light grey brown, silty clay with some concrete gravel (possible filling)							A			
58	2.2	SHALE/SILTSTONE - extremely low strength, light grey and red brown, shale/siltstone with ironstone bands						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	A S			6,18,23 N = 41
57	3.0	SILTSTONE - extremely low and very low strength, extremely to highly weathered, fractured, light grey and grey brown siltstone. Some medium strength bands						3.16m: J35°, un, ro, fe 3.26m: J25°, un, ro, cly 3.26 & 3.43m: cly band 3.55m: B0°- 5°, Ds, 40mm 3.69m: B0°, Ds, 50mm 3.8m: J20° & 30°, st, ro, fe	C	100	26	PL(A) = 0.7
56	3.71	SILTSTONE - medium strength, highly then moderately to slightly weathered, fractured and slightly fractured, grey brown siltstone 4.65-5.1m: siltstone with some fine grained sandstone laminations						3.87m: B0°, cly co 4.2m: J20°, pl, ro, fe 4.24-4.36m: B (x3) 0°-5°, fe 4.38m: B0°, fe, cly vn 4.5m: J25°, fe, Cz, 20mm 4.62-4.74m: B (x3) 0°, fe 4.74m: B0°, cly, 10mm 4.87m: B0°, cly, 5mm 5.16m: J, sv, un, ro, fe 5.45 & 5.77m: B0°, fe 5.6m: B0°, Ds, 40mm	C	100	73	PL(A) = 0.6 PL(A) = 0.9 PL(A) = 1.3
55	5.1	SANDSTONE - high strength, moderately to slightly weathered then fresh, slightly fractured and unbroken, light grey brown then light grey, fine to medium grained sandstone. Some carbonaceous laminations from 7.4m						6.33m: B5°, Ds, 150mm 6.58-6.8m: J90°, he 7.38m: B0°, cbs, 1mm 7.58m: J25°, pl, ro, cln				PL(A) = 1.5 PL(A) = 2
52									C	100	100	PL(A) = 2.3
51								9.17m: B0°, cbs, 2mm				PL(A) = 2.2

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger 1.6m to 2.5m; Rotary to 3.0m; NMLC-Coring to 10.07m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 60.4 AHD
EASTING: 327324.179
NORTHING: 6259143.833
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 72518
DATE: 14/10/2011
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	10.07	Bore discontinued at 10.07m										
50	11											
49	12											
48	13											
47	14											
46	15											
45	16											
44	17											
43	18											
42	19											
41												

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger 1.6m to 2.5m; Rotary to 3.0m; NMLC-Coring to 10.07m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 7 PROJECT 72518 OCT 2011

3.0 – 7.0m

DOUGLAS PARTNERS PTY LTD

NORTH RYDE STATION PRECINCT – NORTH RYDE

BORE 7 PROJECT 72518 OCT 2011

7.0 – 9.55m

BOREHOLE LOG

CLIENT: Transport Construction Authority
PROJECT: North Ryde Station Precinct
LOCATION: M2 Works Compound, North Ryde

SURFACE LEVEL: 61.2 AHD
EASTING: 327366.051
NORTHING: 6259165.306
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 72518
DATE: 17/10/2011
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
61	0	HARDSTAND										
60	1.2	SHALE/SILTSTONE - very low strength, grey shale with ironstone band						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	A			
59	2											
	3.0								A			9,25/100mm refusal
58	3.04	SILTSTONE - low to medium and medium strength, highly and slightly weathered, fragmented to fractured, grey and brown siltstone. Some extremely low and very low strength bands						3m: CORE LOSS: 40mm 3.04-3.34m: fg, fe, cly co 3.34m: J25°, pl, ro, fe 3.39 & 3.45m: B5°- 10°, fe 3.45-3.47m: B0°- 5°, fe 3.5m: J30°, pl, ro, fe 3.57m: B0°, cly, 10mm 3.65m: B10°, cly, 2mm 3.69-3.8m: fg, fe 3.87m: J20°, fe, cly co 3.9-3.95m: Ds, 50mm 4.05-4.2m: fg, fe 4.28m: J25°, un, ro, cln 4.28-4.40m: fg, fe, cly 4.46-4.9m: fg, fe, cly, he 4.95m: B5°, cly, 10mm 5.0-5.15m: J (x3) 30°-40°, un, ro, fe 5.15-5.26m: Ds, 110mm 5.7m: J, sv, un, ro, Cz, 30mm	C	100	0	PL(A) = 0.4
57	4											PL(A) = 0.3
56	5								C	87	32	
	5.26	SILTSTONE - low to medium strength, slightly weathered, slightly fractured, light grey siltstone										PL(A) = 0.3
55	6.0	SANDSTONE - very low strength, highly weathered, brown, medium grained sandstone						6.1m: CORE LOSS: 300mm				
	6.4	SANDSTONE - medium to high then high strength, fresh, slightly fractured and unbroken, light grey, fine to medium grained sandstone						6.4-6.72m: B (x3) 0°, fe 6.78-6.82m: Cz, 40mm				PL(A) = 1
54	7											PL(A) = 2.7
53	8							7.97m: B0, cly co 8.31-8.36m: Cz, 50mm	C	100	94	
		8.3-8.97m: laminite bands with approximately 50% siltstone laminations and bands										PL(A) = 1.3
52	9											PL(A) = 2.2
	9.55	Bore discontinued at 9.55m										

RIG: DT 100 **DRILLER:** S Salib **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger 1.2m to 2.5m; Rotary to 3.0m; NMLC-Coring to 9.55m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Survey measurements determined by GPS with most measurements to an accuracy of 0.1m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Appendix D

Results of Laboratory Tests

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Results of Moisture Content, Plasticity and Linear Shrinkage Tests

Client:	**TRANSPORT CONSTRUCTION AUTHORITY**	**Project No:**	72518
		Report No:	S11-229 E
Project:	NORTH RYDE STATION PRECINCT	**Report Date:**	3/11/2011
		Date Sampled:	-
Location:	NORTH RYDE	**Date of Test:**	1/11/2011
		Page:	1 of 1

Test Location	Depth (m)	Description	Code	W_F %	W_L %	W_P %	PI %	*LS %
BH4	1.8	SILTY CLAY - Light grey and red/brown silty clay.	2,5	-	64	29	35	15.5
BH6	1.5	SILTY CLAY - Light grey/brown silty clay with some concrete gravel	2,5	-	50	26	24	11.0
BH10	1.5	CLAY - Red/brown clay with some ironstone gravel.	2,5	-	62	29	33	17.0

Legend:

W_F	Field Moisture Content
W_L	Liquid limit
W_P	Plastic limit
PI	Plasticity index
LS	Linear shrinkage from liquid limit condition (Mould length125mm)

Test Methods:

Moisture Content:	AS 1289 2.1.1
Liquid Limit:	AS 1289 3.1.2
Plastic Limit:	AS 1289 3.2.1
Plasticity Index:	AS 1289 3.3.1
Linear Shrinkage:	AS 1289 3.4.1

Code:

Sample history for plasticity tests

1. Air dried
2. Low temperature (<50°C) oven dried
3. Oven (105°C) dried
4. Unknown

Method of preparation for plasticity tests

5. Dry sieved
6. Wet sieved
7. Natural

*Specify if sample crumbled CR or curled CU

Sampling Methods: By Engineering Department.

Remarks:

NATA Accredited Laboratory Number: 828

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ACCREDITED FOR TECHNICAL COMPETENCE

Tested: RR
Checked: NW

Norman Weinmann
Laboratory Manager

Douglas Partners
Geotechnics / Environment / Groundwater

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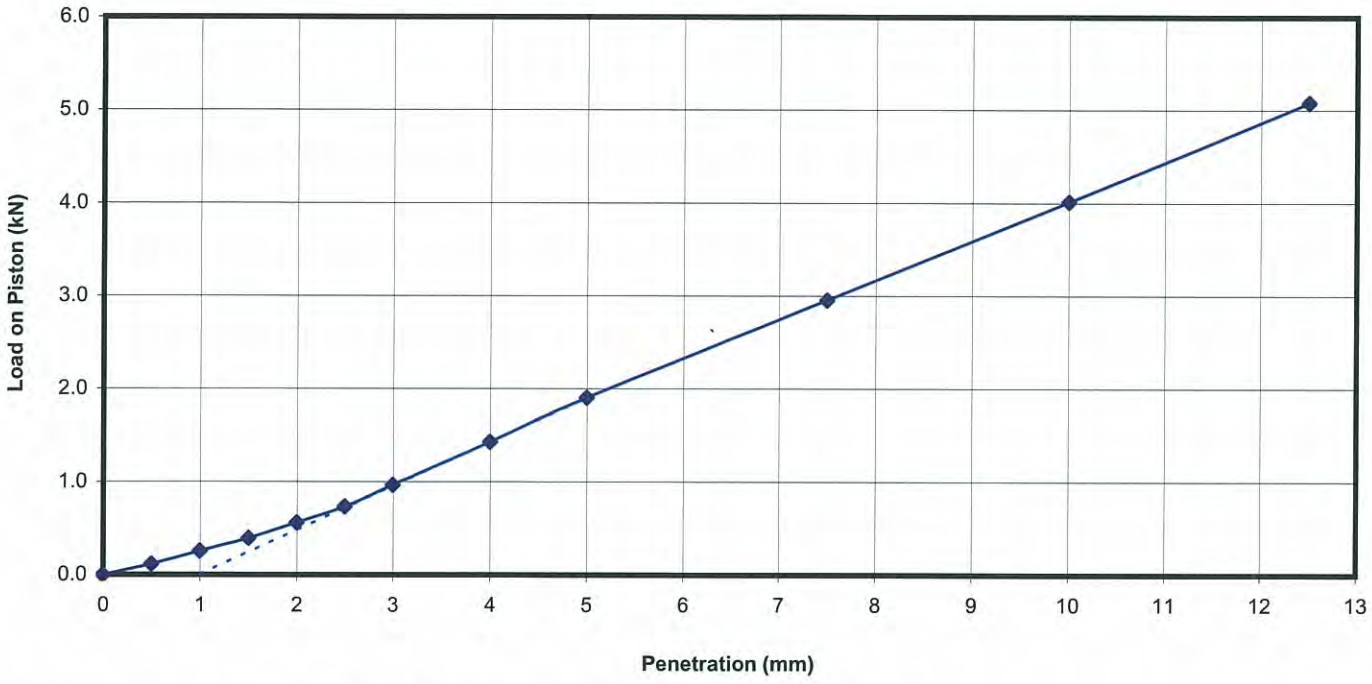
Results of California Bearing Ratio Test

Client :	TRANSPORT CONSTRUCTION AUTHORITY	**Project No. :**	72518.00
		Report No. :	S11-229 A
Project :	NORTH RYDE STATION PRECINCT	**Report Date :**	1/11/2011
		Date Sampled :	18/10/2011
Location :	NORTH RYDE	**Date of Test:**	27/10/2011
Test Location :	BH1		
Depth / Layer :	0.0 - 1.0m	**Page:**	1 of 1



Description: FILLING - dark grey silty sand filling with some gravel

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): AS 1289.1.2.1, AS 1289.1.1

Percentage > 19mm: 3.8% (Excluded)

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 102% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: -3.1%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		11.5	1.94
After soaking		13.1	2.00
After test	Top 30mm of sample	11.7	-
	Remainder of sample	12.5	-
Field values		7.6	-
Standard Compaction		11.3	1.94

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**9**
	5.0 mm	**12**

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Tested: AM
Checked: NW

Norman Weimann
Laboratory Manager

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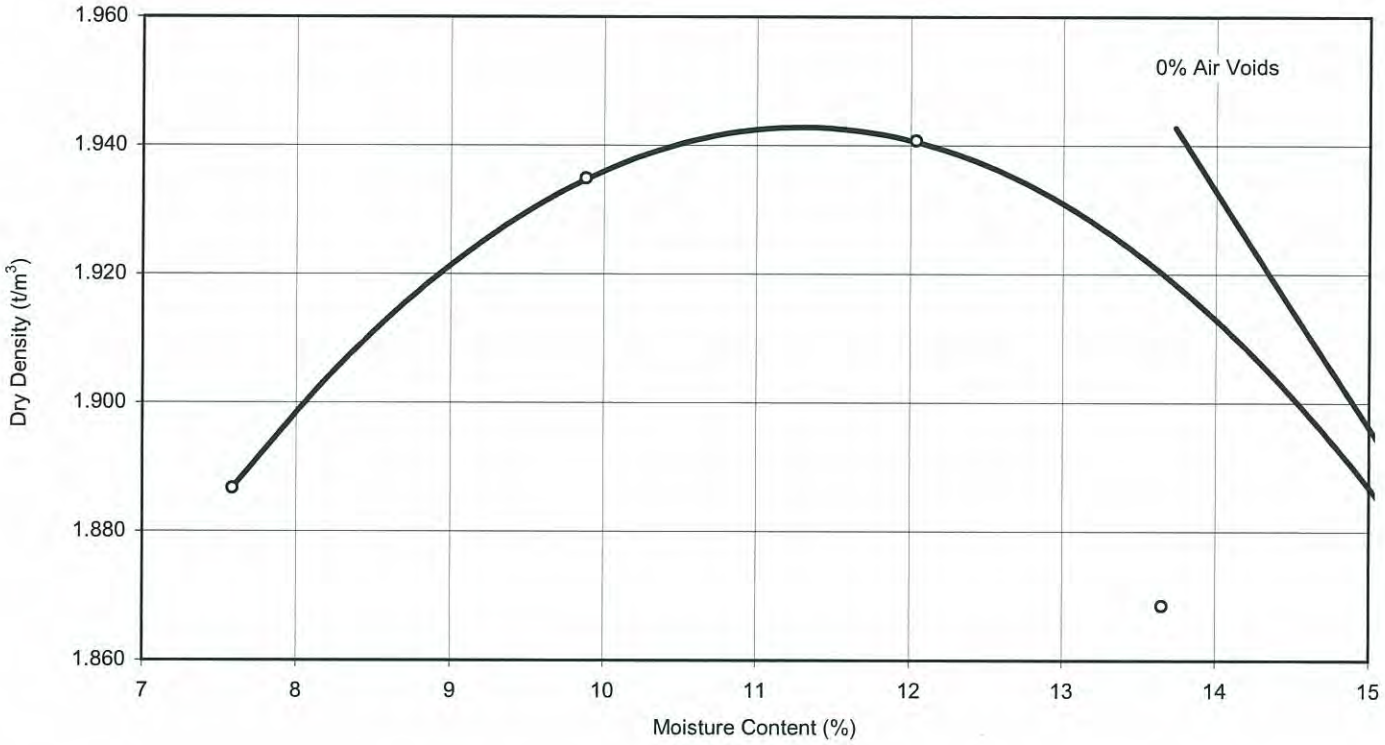
Results of Compaction Test

Client :	TRANSPORT CONSTRUCTION AUTHORITY	**Project No. :**	72518
		Report No. :	S11-229 B
Project :	NORTH RYDE STATION PRECINCT	**Report Date :**	27/10/2011
Location :	NORTH RYDE	**Date of Test:**	26/10/2011
		Page:	1 of 1



Sample Details: **Location:** BH 1
Depth: 0.0 - 1.0m

Particles > 19mm: 4%

Description: FILLING - dark grey silty sand filling with some gravel

Maximum Dry Density:	**1.94 t/m^3**
Optimum Moisture Content:	**11.5 %**

Remarks:

Test Methods: AS1289.5.1.1, AS1289.2.1.1

Sampling Methods: Sampled by Engineering Division

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Tested:	RA
Checked:	NW

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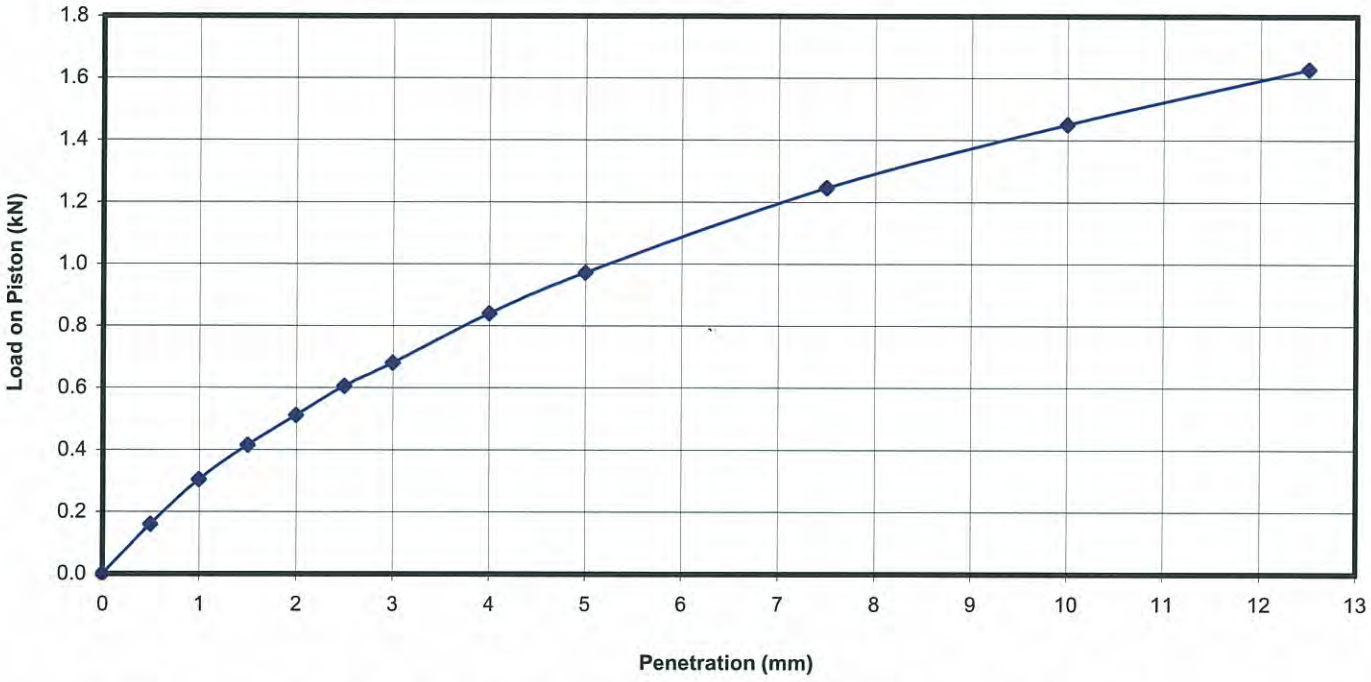
Results of California Bearing Ratio Test

Client :	TRANSPORT CONSTRUCTION AUTHORITY	**Project No. :**	72518.00
		Report No. :	S11-229 C
Project :	NORTH RYDE STATION PRECINCT	**Report Date :**	1/11/2011
		Date Sampled :	19/10/2011
Location :	NORTH RYDE	**Date of Test:**	27/10/2011
Test Location :	BH2		
Depth / Layer :	0.0 - 1.0m	**Page:**	1 of 1



Description: FILLING - dark grey and grey sandy clay and rock fragment filling

Test Method(s): AS 1289.6.1.1, AS 1289.2.1.1

Sampling Method(s): AS 1289.1.2.1, AS 1289.1.1

Percentage > 19mm: 0.0%

LEVEL OF COMPACTION: 96% of STD MDD
MOISTURE RATIO: 98% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: -0.4%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		16.6	1.71
After soaking		17.3	1.72
After test	Top 30mm of sample	19.2	-
	Remainder of sample	17.7	-
Field values		17.4	-
Standard Compaction		17.0	1.79

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**2.5 mm**	**4.5**
	5.0 mm	**5.0**

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Tested: AM
Checked: NW

Norman Weimann
Laboratory Manager

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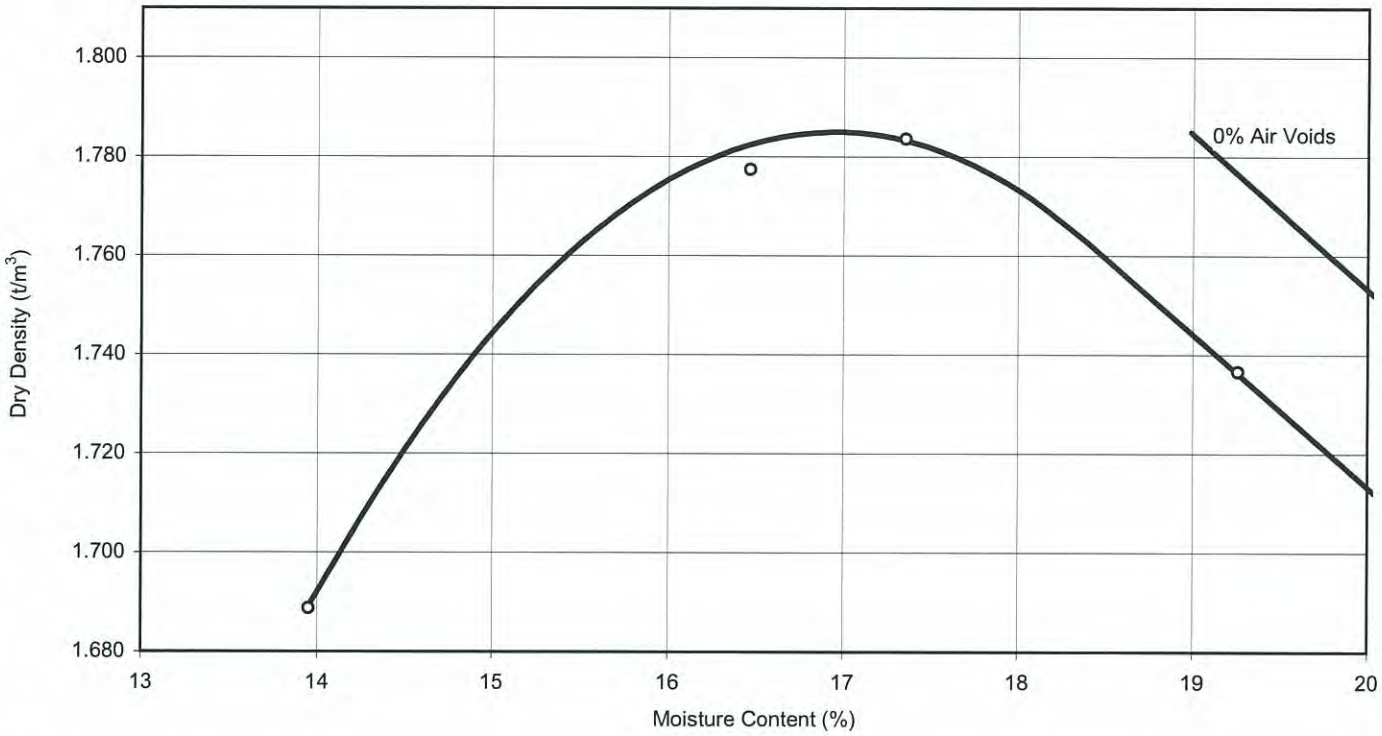
Results of Compaction Test

Client :	TRANSPORT CONSTRUCTION AUTHORITY	**Project No. :**	72518
		Report No. :	S11-229 D
Project :	NORTH RYDE STATION PRECINCT	**Report Date :**	27/10/2011
Location :	NORTH RYDE	**Date of Test:**	26/10/2011
		Page:	1 of 1



Sample Details: **Location:** BH 2
Depth: 0.0 - 1.0m

Particles > 19mm: 0%

Description: FILLING - dark grey and grey sandy clay and rock fragment filling

Maximum Dry Density:	**1.79 t/m^3**
Optimum Moisture Content:	**17.0 %**

Remarks:

Test Methods: AS1289.5.1.1, AS1289.2.1.1

Sampling Methods: Sampled by Engineering Division

NATA ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828
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Tested:	AM
Checked:	NW

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CHEMICAL CONTENT TEST RESULTS

CLIENT: TRANSPORT CONSTRUCTION AUTHORITY
PROJECT NO: 72518

PROJECT: NORTH RYDE STATION PRECINCT
LOCATION: NORTH RYDE
DATE: 8/11/2011
DATE OF TESTING: 2/11/2011

PAGE: 1 of 1

	Units	BH 2 0.0 - 1.0m	BH 3 1.5m	BH 4 1.8m	BH 7 1.5m	BH 10 1.5m
Description	-	FILLING – Dark grey and grey sandy clay and rock fragment filling	FILLING – Grey to grey brown sandy clay filling with some rock fragments	SILTY CLAY – Light grey and red/brown silty clay	SHALE – Grey shale with ironstone bands	CLAY - Red/brown clay with some ironstone gravel
pH 1:5 soil:water	pH Units	9.5	6.4	4.4	5.4	4.9
Sulphate SO_4 1:5 soil:water	mg/kg	240	270	69	74	94
Chloride Cl 1:5 soil:water	mg/kg	72	99	14	49	24

ENVIROLAB SERVICES:
Job number: 64088-1, 64088-2, 64088-3
64088-5, 64088-4

Report No. S11-229 F
Laboratory: SYDNEY

Signed: Norman Weimann
Laboratory Manager

Appendix E

Borehole Logs from Other Reports

BOREHOLE RECORD

HOLE CB30 | SHEET 1 OF 1

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	THH
		DATE/S	9.2.00/11.2.00
CONTRACTOR	APS Drilling	ANGLE	60°
DRILL MODEL	MD300	BEARING	220
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 43.25m
		LOCATION	312273 E 1259634 N

DRILLING	STRATA				MATERIAL DESCRIPTION	CONDITION		OBSERVATION
SAMPLE, TEST, BIT, SUPPORT, ETC.	R.L. AHD	DEPTH m	GROUP SYMBOL	LEGEND	SOIL TYPE Colour, Plasticity, Grain Size, Minor Components	WATER / MOISTURE	CONSISTENCY: COHESIVE VS S F ST VST H; NON COHESIVE VL L MD D VD	SOIL ORIGIN, STRUCTURE, ETC.
Casing to 1.05m					Fill: GRAVEL & COBBLES in fine grained SAND matrix			FILL
	42.38	1 1.00	CL		Sandy CLAY, orange, low-medium plasticity			RESIDUAL
	41.95	1.50			SANDSTONE, orange			BEDROCK
					Continued as cored borehole from 1.65m			
		2						
		3						
		4						
		5						
		6						
		7						

NOTES

Packer tests: 9.0 to 19.0m - aborted (equipment failure), 19.45 to 29.35m - 1.16 lugeons, 30.09 to 39.19m - 0.83 lugeons

JOB 12032/500

PARRABHSTP2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB30 | SHEET 1 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	THH
		DATE/S	9.2.00/11.2.00
CONTRACTOR	APS Drilling	ANGLE	60°
DRILL MODEL	MD300	BEARING	220
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 43.25m
		LOCATION	312273 E 1259634 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC. (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infil
								Start coring rock at 1.65m		EL VL L M H VH EH	30 10 3 1				
100%	100%	100%		0.75 D	41.82	1.65		SANDSTONE, light orange, medium grained, very well developed laminations 20 degrees, trace carbonaceous flecks	SW						
					41.09	2.49		SANDSTONE, grey, fine-medium grained, very well developed laminations 20 degrees				JN	5	-	PL, Ro3, KL
					40.77	2.86		SANDSTONE, white, medium-coarse grained, well developed laminations, occasional carbonaceous laminae							
					40.23	3.49		Core Loss				BG	20	-	PL, Ro4
					40.13	3.60		SANDSTONE, red, medium-coarse grained, very well developed laminations, occasional carbonaceous laminae	FR			BG	20	-	PL, Ro4
									FR/SW			DZ	5	20	PL, Ro4, sC
												BG	5	1	PL, Ro4, sC
												BG	5	-	PL, Ro4, KL
	96%	49%		1.38 D	39.71	4.09		SANDSTONE, red, coarse grained, well developed laminations 20 degrees, trace carbonaceous laminae & flecks							
		100%										JN	5	-	IR, R05, KL (45, 075)
		100%		2.74 D											
	100%	100%										BG	0	-	IR, R05, KL
		100%										BG	0	-	IR, R05, KL
		100%		2.29 D	38.69	7.57		SANDSTONE, orange, medium-coarse grained, well developed laminations 20 degrees, trace carbonaceous laminae							
		88%			38.02	8.35		SANDSTONE, white-grey, medium-coarse grained, well developed laminations, occasional carbonaceous laminae	SW			JN	60	-	PL, Ro4, (65, 235)
	100%											BG	10	-	PL, Ro4, KL
												BG	5	-	PL, Ro4, KL
												JN	60	ST	UN, Ro4, FE (70, 135)
		100%										BG	10	-	IR, Ro4, KL
												BG	10	-	IR, Ro4, KL
					35.14	9.36						DZ	20	30	IR, Ro4, sC

NOTES

Packer tests: 9.0 to 19.0m - aborted (equipment failure), 19.45 to 29.35m - 1.16 lugeons, 30.09 to 39.19m - 0.83 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB30 SHEET 2 OF 5

PROJECT Parramatta-Chatswood Rail Link Contract C

LOGGED BY THH

DATE/S 9.2.00/11.2.00

CONTRACTOR APS Drilling

DRILL MODEL MD300

MOUNTING Truck

ANGLE 60°

BEARING 220

DIAMETER HQ

GROUND LEVEL RL 43.25m

LOCATION 312273 E 1259634 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN. REC. (%)	ROD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%		2.05 D		10		SANDSTONE, white-grey, medium-coarse grained, well developed very thin beddings & laminations, occasional carbonaceous laminae			30 10 3 1	BG	20	-	IR, Ro4, KL
												JN	60	-	IR, Ro4, KL (50, 135)
												JN	60	-	IR, Ro4, KL, truncated (75, 135)
	100%	100%				11						CZ	25	10	IR, Ro4, RF, sC
												BG	10	-	IR, Ro4, KL
		74%										BG	15	-	IR, Ro4, KL
												BG	15	-	IR, Ro4, KL
												CZ	15	5	IR, Ro4, sC
												BG	15	-	IR, Ro4, KL
				1.95 D		12						BG	15	-	IR, Ro4, KL
					32.65	12.24						BG	15	-	IR, Ro4, KL
								SANDSTONE, yellow, medium-coarse grained, poorly developed laminations, carbonaceous flecks, iron stained	MW						
	100%	100%				13									
					31.47	13.60		SANDSTONE, grey, medium-coarse grained, well developed laminations, occasional carbonaceous laminae	SW						
												BG	20	-	PL, Ro4, KL
				1.77 D		14						BG	25	-	IR, Ro4, KL
												DZ	20	20	ST, Ro3, KL
		100%										BG	20	-	IR, Ro3, sC
						15						JN	65	-	UN, Ro3, ST (60, 330)
	100%														
												JN	65	-	UN, Ro3, ST (60, 280)
						16						BG	20	-	IR, Ro3, CB
				2.24 D								BG	20	-	IR, Ro3, KL
												BG	30	-	IR, Ro3, KL
		91%										BG	30	-	IR, Ro3, KL
								18.76m shale inclusion							
						17									
	100%	100%			28.23	17.34		SANDSTONE, grey, coarse grained, poorly developed thin beddings, occasional carbonaceous laminae				BG	30	1	PL, Ro5, CB

NOTES

Packer tests: 9.0 to 19.0m - aborted (equipment failure), 19.45 to 29.35m - 1.16 lugeons, 30.09 to 39.19m - 0.83 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

ARUP PSM

HOLE CB30 | SHEET 3 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	THH
		DATE/S	9.2.00/11.2.00
CONTRACTOR	APS Drilling	ANGLE	60°
DRILL MODEL	MD300	BEARING	220
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 43.25m
		LOCATION	312273 E 1259634 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC. (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%				18		17.49m carbonaceous lamination 2mm thick SANDSTONE, grey, coarse grained, poorly developed thin beddings, occasional carbonaceous laminae				JN	65	-	PL, Ro3, KL (70, 175)
												JN	65	-	PL, Ro3, KL (70, 175)
				1.19 D								BG	15	2	IR, Ro5, C (shale)
		92%			27.38	18.32		SANDSTONE, light grey, medium grained, well developed thick laminations 10-30 degrees	FR			BG	30	5	PL, Ro3, sC
	100%					19						BG	30	-	PL, Ro, KL
												BG	30	-	PL, Ro, KL
		100%		UCS+								BG	20	-	PL, Ro2, KL
				1.75 D		20						BG	10	-	CU, Ro4, KL
	100%	100%													
						21						BG	25	3	PL, Ro3, sC
				BZ											
					24.20	2222.00		SANDSTONE, light grey, medium grained, well developed thick laminations 10-30 degrees, trace carbonaceous flecks & laminae							
		100%		1.85 D								BG	30	2	PL, Ro3, sC, RF
						23						BG	30	-	PL, Ro2, KL
	100%														
		100%				24									
				1.75 D											
	100%	100%			21.95	24.60		SANDSTONE, light grey, medium grained, well developed very thin beddings 20-30 degrees, trace carbonaceous laminae	FR						
						25									

NOTES

Packer tests: 9.0 to 19.0m - aborted (equipment failure), 19.45 to 29.35m - 1.16 lugeons, 30.09 to 39.19m - 0.83 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB30 | SHEET 4 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	THR
		DATE/S	9.2.00/11.2.00
CONTRACTOR	APS Drilling	ANGLE	60°
DRILL MODEL	MD300	BEARING	220
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 43.25m
		LOCATION	312273 E 1259634 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC. (%)	ROD (%)	WATER	SAMPLE TEST is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
						26		SANDSTONE, light grey, medium grained, well developed very thin beddings 20-30 degrees, trace carbonaceous laminae							
								As above, but with trace fine, subrounded, quartz gravel				JN	0	-	PL, Ro5, KL
						27		26.95 to 27.20m, with coarse, rounded shale inclusions & subrounded quartz				BG	30	-	PL, Ro5, KL
					19.69	27.20		SANDSTONE, light grey, fine-coarse grained, very well developed laminations 10-30 degrees, trace carbonaceous laminae & flecks				BG	20	-	PL, Ro5, KL
				BZ								BG	15	3	PL, Ro3, C
												BG	30	1	PL, Ro4, CB
						28						BG	10	-	PL, Ro3, KL
				0.98 D								BG	30	-	PL, Ro3, KL
						29						BG	30	10	PL, Ro3, C, RF
						30		30.0m shale inclusion 50mm							
				1.45 D											
					16.97	30.35		SANDSTONE, light grey, fine-coarse grained, very well developed laminations 30.36m rounded shale inclusions up to 10mm	FR			BG	30	-	PL, Ro3, KL
						31									
												BG	30	-	PL, Ro2, KL
						32									
				1.22 D											
						33						BG	20	VN	PL, Ro2, C

NOTES

Packer tests: 9.0 to 19.0m - aborted (equipment failure), 19.45 to 29.35m - 1.16 lugeons, 30.09 to 39.19m - 0.83 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB30 | SHEET 5 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	THH
		DATE/S	9.2.00/11.2.00
CONTRACTOR	APS Drilling	ANGLE	60°
DRILL MODEL	MD300	BEARING	220
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 43.25m
		LOCATION	312273 E 1259634 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES				
CASING	RUN. REC. (%)	ROD (%)	WATER	SAMPLE TEST Is(50)	R.L	DEPTH	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION
					AHD	m				EL VL L M H VH EH	30 10 3 1				Planarity, Roughness, Coating, Infill
	100%	100%		1.19 D		34		SANDSTONE, light grey, fine-coarse grained, very well developed laminations				BG	20	-	PL, Ro3, KL
	100%	100%										BG	20	-	PL, Ro3, KL
						35						BG	20	VN	PL, Ro2, C
		100%										BG	20	-	PL, Ro3, KL
	100%			1.14 D	12.09	36									
		100%				35.98		SANDSTONE, light grey, medium grained, massive, with occasional quartz gravel	FR			BG	30	VN	PL, Ro2, C
		100%				37									
				1.54 D		38									
	100%	100%													
						39									
		100%			9.31	39.19		End of borehole at 39.19m							
						40									
						41									

NOTES

Packer tests: 9.0 to 19.0m - aborted (equipment failure), 19.45 to 29.35m - 1.16 lugeons, 30.09 to 39.19m - 0.83 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

BOREHOLE RECORD

HOLE CB31 | SHEET 1 | OF 1

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	11.2.00/15.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 58.67m
		LOCATION	312393 E 1259407 N

DRILLING	STRATA				MATERIAL DESCRIPTION	CONDITION			OBSERVATION
SAMPLE, TEST, BIT, SUPPORT, ETC.	R.L. AHD	DEPTH m	GROUP SYMBOL	LEGEND	SOIL TYPE Colour, Plasticity, Grain Size, Minor Components	WATER / MOISTURE	CONSISTENCY: COHESIVE (VS S F ST VST H)	CONSISTENCY: NON COHESIVE (VL L MD D VD)	SOIL ORIGIN, STRUCTURE, ETC.
Solid flight auger to 4.25m	58.57	0.10	SM		TOPSOIL: Silty SAND brown, fine grained, with root fibres	M			RESIDUAL
			CH		Silty CLAY: brown and red-brown, high plasticity with fine grained ironstone gravel	MC=PL			
		1			As above, but red-brown and grey				
	56.67	2 2.00			SHALE: light-grey and brown (extremely weathered, extremely low strength)				BEDROCK
					As above, but highly weathered, very low to low strength with medium strength ironstone bands				
	55.67	3 3.00			SANDSTONE: light-brown, medium grained, extremely to highly weathered, low strength with extremely low strength bands				
		4							
					Continued as cored borehole from 4.25m				
		5							
		6							
		7							

NOTES

Packer tests: from 11.1m to 21.1m - 19 lugeons; from 21.2m to 30.2m - 0.3 lugeons; from 30.7m to 41m - 0.13 lugeons

JOB

12032/500

PARRABHATP2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB31 | SHEET 1 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	11.2.00/15.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Interech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 58.67m
		LOCATION	312393 E 1259407 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC, (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
								Start coring rock at 4.25m		EL VL L M H VH EH	30 10 3 1				
				1.13 A	54.42	4.25		SANDSTONE: light-grey and brown, fine-medium grained, laminated cross beds at 0-10 degrees	SW			BG	0	ST	PL, Ro4, FE
												BG	0	ST	PL, Ro4, FE
												JN	85	ST	UN, Ro4, FE
	100%	84%			53.67	5 5.00		SHALE: dark-grey with light-grey, fine grained sandstone laminae				BG	0	4	PL, Ro3, RF
					53.32	5.35		SANDSTONE: light-grey and brown, fine-medium grained, laminated cross beds at 0-10 degrees				BG	0	5	PL, Ro3, RF
												BG	5	2	PL, Ro4, FE
				4.29 A		6		As above, but light-grey, fine grained	FR						
						7		As above, but fine-medium grained				BG	5	2	PL, Ro4, FE
	100%	100%		2.03 A	50.57	8 8.10		SANDSTONE: light-grey, fine grained, laminated cross beds at 0-20 degrees							
						9									
				2.56 A		10									
	100%	100%				11						BG	15	VN	PL, Ro3, CT
												BG	15	VN	PL, Ro3, CT
												BG	0	VN	PL, Ro3, CT
					46.87	11.80		SANDSTONE: light-grey, fine-medium grained, medium bedded							
				1.55 A		12									

NOTES

Packer tests: from 11.1m to 21.1m - 19 lugeons; from 21.2m to 30.2m - 0.3 lugeons; from 30.7m to 41m - 0.13 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB31 | SHEET 2 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	11.2.00/15.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 58.67m
		LOCATION	312393 E 1259407 N

DRILLING				STRATA			MATERIAL DESCRIPTION		DISCONTINUITIES			
CASING	RUN, REC. (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC: TYPE	SPECIFIC: ANGLE	SPECIFIC: THICKNESS (mm)	GENERAL DESCRIPTION: Planarity, Roughness, Coating, Infil
								SANDSTONE: light-grey, fine-medium grained, medium bedded	FR						
					45.87	12.80						BG	0	2	PL, Ro3, C
						13		SANDSTONE: light-grey, fine grained, laminated cross beds at 0-10 degrees							
					45.07	13.60		Partial water loss (approx. 70%)							
	100%	100%	70%					SANDSTONE: light-grey, medium grained, thinly bedded cross beds at 0-30 degrees, with subrounded to rounded shale and quartz inclusions up to 10mm diameter				BG	5	5	PL, Ro3, RF
												BG	0	ST	PL, Ro3, FE
				1.44 A		14						BG	30	-	UN, Ro4, KL
						15		As above, but coarse grained				BG	0	2	PL, Ro3, C
				1.7 A		16						BG	30	-	PL, Ro3, KL
												BG	10	4	UN, Ro4,CB
	100%	100%			42.07	16.60		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-20 degrees				BG	20	20	PL, Ro3, RF
						17									
				1.43 A		18									
	100%	100%				19						BG	15	2	PL, Ro3, C
				1.87 A		20									

NOTES

Packer tests: from 11.1m to 21.1m - 19 lugeons; from 21.2m to 30.2m - 0.3 lugeons; from 30.7m to 41m - 0.13 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB31 | SHEET 3 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	11.2.00/15.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 58.67m
		LOCATION	312393 E 1259407 N

DRILLING | STRATA | MATERIAL DESCRIPTION | DISCONTINUITIES

CASING	RUN REC. (%)	ROD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%				21		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-20 degrees	FR			BG	20	2	PL, Ro3, C
				1.64 A		22									
	100%	100%				23									
				1.39 A		24		100% water return below 24.1m							
						25						BG	0	2	PL, Ro3, C
	100%	100%				26						BG	5	2	PL, Ro3, C
				1.77 A		27						BG	15	2	UN, Ro4, CB
	100%	100%				28									
				1.54 A											

NOTES

Packer tests: from 11.1m to 21.1m - 19 lugeons; from 21.2m to 30.2m - 0.3 lugeons; from 30.7m to 41m - 0.13 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB31 | SHEET 4 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	11.2.00/15.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Interlech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 58.67m
		LOCATION	312393 E 1259407 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC. (%)	ROD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH EL VL L M H VH EH	FREQUENCY (per m) 30 10 3 1	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%			30.47	28.20		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-20 degrees	FR						
				2.1 A		29		As above, but fine grained							
						30		As above but medium grained							
	100%	100%				31									
				1.4 A		32									
						33		As above, but coarse grained with fine grained quartz gravel							
					25.37	33.30		SANDSTONE: light-grey, medium grained, medium bedded with trace of fine grained quartz gravel				BG	20	2	UN, Ro4, CB
												BG	0	2	PL, Ro3, CB
	100%	100%		1.17 A	24.47	34									
						34.20		SHALE: dark-grey, with light-grey fine grained sandstone laminae at 0-10 degrees							
				1.05 A		35									
					23.07	35.60		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-10 degrees							
						36									

NOTES

Packer tests: from 11.1m to 21.1m - 19 lugeons; from 21.2m to 30.2m - 0.3 lugeons; from 30.7m to 41m - 0.13 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB31 | SHEET 5 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	11.2.00/15.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 58.67m
		LOCATION	312393 E 1259407 N

DRILLING | STRATA | MATERIAL DESCRIPTION | DISCONTINUITIES

CASING	RUN REC. (%)	ROD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%		2.05 A		37		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-10 degrees	FR	EL VL L M H VH EH	30 10 3 1				
	100%	100%		2.16 A		38									
						39									
	100%	100%				40									
					17.67	41.00		End of borehole at 41m							
						42									
						43									
						44									

NOTES

Packer tests: from 11.1m to 21.1m - 19 lugeons; from 21.2m to 30.2m - 0.3 lugeons; from 30.7m to 41m - 0.13 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

BOREHOLE RECORD

HOLE CB32 | SHEET 1 OF 1

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	3.2.00/6.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 60.386m
		LOCATION	312759 E 1259144 N

DRILLING	STRATA				MATERIAL DESCRIPTION	CONDITION		OBSERVATION
SAMPLE, TEST, BIT, SUPPORT, ETC.	R.L. AHD	DEPTH m	GROUP SYMBOL	LEGEND	SOIL TYPE Colour, Plasticity, Grain Size, Minor Components	WATER / MOISTURE	CONSISTENCY: COHESIVE (VS, S, F, ST, VST, H); NON COHESIVE (VL, L, MD, D, VD)	SOIL ORIGIN, STRUCTURE, ETC.
Solid flight auger to 6.7m					FILL: Silty SAND light-brown, fine grained with fine to coarse grained gneous and sandstone gravels and cobbles	D		
	59.69	0.70	CH		Silty CLAY: brown, high plasticity			RESIDUAL
		1			As above, but red-brown and grey with fine to coarse grained ironstone gravel			
		2						
		3						
		4						
		5						
	54.89	5.50			SHALE: brown and grey, extremely to highly weathered, extremely to very low strength			BEDROCK
		6						
					As above, but moderately weathered, very low to low strength			
					Continued as cored borehole from 6.7m			
		7						

NOTES

Packer tests: 12.15 to 21.15m - 0 lugeons, 23.15 to 33.15m - 0 lugeons, 33.15 to 42.15m - 0.07 lugeons

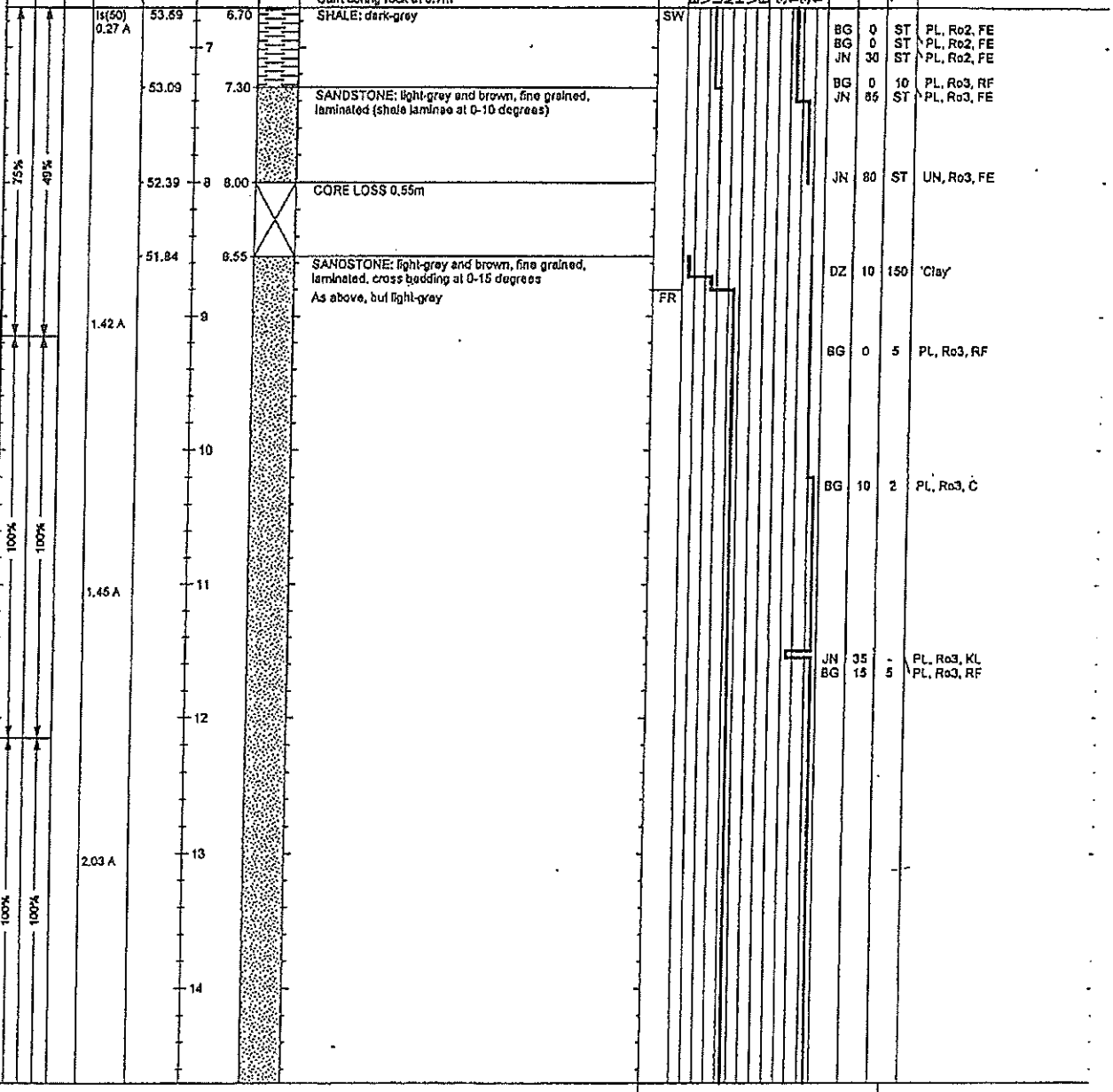
JOB 12032/500

PARRABHETP2 12032.GPJ ARUP AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB32 | SHEET 1 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	3.2.00/8.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 60.386m
		LOCATION	312759 E 1259144 N



NOTES

Packer tests: 12.15 to 21.15m - 0 lugeons, 23.15 to 33.15m - 0 lugeons, 33.15 to 42.15m - 0.07 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB32 | SHEET 2 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	3.2.00/8.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 60.386m
		LOCATION	312759 E 1259144 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING RUN, REC. (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
100%	100%		1.06 A		15		SANDSTONE: light-grey and brown, fine grained, laminated, cross bedding at 0-15 degrees	FR	EL VL L M H VH EH	30 10 3 1				
				44.39	16 16.00		SANDSTONE: light-grey, medium grained, very thinly bedded, cross beds at 0-15 degrees							
100%	100%		1.07 A		17						BG	5	3	PL, Ro4, CB
					18		Fine grained, laminated from 18.3m to 18.6m							
			1.66 A		19		Subrounded SHALE inclusions up to 40mm diameter from 19.2 to 19.4m				BG	25	-	PL, Ro3, KL
100%	100%										BG	20	-	PL, Ro3, KL
					20						BG	0	-	PL, Ro3, KL
			1.67 A		21									
100%	100%				22		As above, but laminated							

NOTES

Packer tests: 12.15 to 21.15m - 0 lugeons, 23.15 to 33.15m - 0 lugeons, 33.15 to 42.15m - 0.07 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB32 | SHEET 3 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	3.2.00/8.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Interlech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 60.386m
		LOCATION	312759 E 1259144 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC. (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH EL VL L M H VH EH	FREQUENCY (per m) 0 10 30	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
100%	100%	100%		2.06 A	23			SANDSTONE: light-grey, medium grained, very thinly bedded, cross beds at 0-15 degrees	FR						
					24							BG	10	2	PL, Ro3, C
				1.83 A	25										
100%	100%	100%			26										
												BG	15	2	UN, Ro4, C
				1.9 A	27										
					28										
100%	100%	100%			29							BG	10	2	PL, Ro3, CB
				1.22 A											
100%	100%	100%			30										
						29.99									
						30.40		SANDSTONE: light-grey, medium grained, thinly bedded, cross beds at 0-10 degrees							

NOTES

Packer tests: 12.15 to 21.15m - 0 lugeons, 23.15 to 33.15m - 0 lugeons, 33.15 to 42.15m - 0.07 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACOREDZ 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB32 SHEET 4 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	3.2.00/8.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 60.386m
		LOCATION	312759 E 1259144 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	RUN, REC. (%)	RQD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%		1.35 A		31		SANDSTONE: light-grey, medium grained, thinly bedded, cross beds at 0-10 degrees	FR	EL VL L M H VH EH	30 10 3 1				
					28.79	31.60		SANDSTONE: light-grey, fine-medium grained,medium bedded							
						32									
						33									
	100%	100%		1.02 A											
					26.84	33.55		INTERBEDDED SANDSTONE: light-grey, fine-medium grained and SHALE: dark-grey				JN	40	-	PL, Ro2, KL
						34									
												Sh	30	-	UN, Ro1, KL
												Sh	30	-	UN, Ro1, KL
						35									
	100%	100%		1.38 A	24.89	35.50		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-15 degrees							
						36									
						37									
	100%	100%		1.45 A		38									

NOTES

Packer tests: 12.15 to 21.15m - 0 lugeons, 23.15 to 33.15m - 0 lugeons, 33.15 to 42.15m - 0.07 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
CK	DYKE
DZ	DECOMPOSED ZONE
FZ	FRACTURED ZONE

JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00

CORED BOREHOLE RECORD

HOLE CB32 | SHEET 5 OF 5

PROJECT	Parramatta-Chatswood Rail Link Contract C	LOGGED BY	PL
		DATE/S	3.2.00/8.2.00
CONTRACTOR	Soilcheck Pty Ltd	ANGLE	Vertical
DRILL MODEL	Intertech 550	BEARING	-
MOUNTING	Truck	DIAMETER	HQ
		GROUND LEVEL	RL 60.386m
		LOCATION	312759 E 1259144 N

DRILLING				STRATA			MATERIAL DESCRIPTION			DISCONTINUITIES			
CASING	CORE RUN. REC. (%)	ROD (%)	WATER	SAMPLE TEST Is(50)	R.L. AHD	DEPTH m	LEGEND	ROCK TYPE Colour, Grain Size, Structure, Minor Components	WEATHERING	ESTIMATED ROCK STRENGTH	FREQUENCY (per m)	SPECIFIC TYPE	SPECIFIC ANGLE	SPECIFIC THICKNESS (mm)	GENERAL DESCRIPTION Planarity, Roughness, Coating, Infill
	100%	100%				39		SANDSTONE: light-grey, fine-medium grained, laminated cross beds at 0-15 degrees	FR	EL VL L M H VH EH	30 10 3 1				
	100%	100%		2.18 A		40									
						41									
						42									
					18.24	42.15		End of borehole at 42.15m							
						43									
						44									
						45									
						46									

NOTES

Packer tests: 12.15 to 21.15m - 0 lugeons, 23.15 to 33.15m - 0 lugeons, 33.15 to 42.15m - 0.07 lugeons

TYPE OF DISCONTINUITY

FL	FAULT
SH	SHEAR
SZ	SHEARED ZONE
BG	BEDDING PARTING
BSH	BEDDING PLANE SHEAR
JN	JOINT
CN	CONTACT
CZ	CRUSHED ZONE
DK	DYKE
DZ	DECOMPOSED ZONE
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JOB 12032/500

PARRACORED2 12032.GPJ ARUP_AUS.GDT 01/05/00