GEOTECHNICAL INVESTIGATION REPORT

PROPOSED WOLLONGONG PRIVATE HOSPITAL
360 – 364 CROWN STREET, WOLLONGONG NSW
AA CROWN HOLDINGS PTY LTD
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1 INTRODUCTION

Geo-Environmental Engineering Pty Ltd (GEE) was commissioned by The Planning Group NSW Pty Ltd (TPG), on behalf of AA Crown Holdings Pty Ltd (AA Crown), to carry out a geotechnical investigation at 360 – 364 Crown Street (Princess Highway), Wollongong New South Wales (**Figure 1**).

The investigation relates to the proposed construction of Wollongong Private Hospital and forms part of a submission to the NSW Minister for Planning for planning approval through the NSW Department of Planning (DoP). The proposed development is identified by the DoP as MP07_0070.

GEE understands that the DoP issued Director-General Environmental Assessment Requirements (DGEARs) for the proposed development and part of the DGEARs was to determine the suitability of the site for the proposal with regard to slope stability, erosion hazard, proposed earthworks and retention methods.

1.1 PROPOSED DEVELOPMENT

The Master Plan for the proposed development describes a building which will be eight stories in height with two or three basement levels, and will be used to provide for a broad range of medical and health services (Health Science, 2009).

The proposed basement is to cover the majority of the site and extend to a Reduced Level (RL) of 35m above Australian Height datum (AHD) for the two-level basement option, or RL 31m AHD for the three-level basement option. Compared with existing ground surface elevations, this equates to an excavation of between 7m and 13m for the two-level basement option, and between 11m and 17m for the three-level basement option.

1.2 OBJECTIVE AND SCOPE OF WORK

As detailed in the project brief prepared by TPG dated 8 January 2010, the objective of the geotechnical investigation was to assess the suitability of the site for the proposed development with regard to slope stability, erosion hazard, proposed earthworks and retention methods.

To satisfy the above objectives, GEE completed the following scope of work:

- ◊ Review of available geological maps and reports held within our files,
- ◊ Dial Before You Dig (DBYD) desktop search for buried services combined with on site scanning and clearance of borehole locations by an experienced sub-contractor,
- ◊ Site inspection,
- ◊ Drilling of three boreholes at accessible locations across the site to assess the nature and consistency of subsurface soils and strength of the underlying bedrock. Each borehole was extended at least 3m below the proposed three-level basement option using solid flight auger and diamond coring as appropriate,
- ◊ Installation of a PVC monitoring well within one of the three boreholes to facilitate the monitoring of the stabilised groundwater levels,
- ◊ Selective laboratory testing,
- ◊ Engineering assessment and reporting including:
    - description of surface and subsurface conditions,
    - discussion of excavation conditions for the basement,
    - recommendations for footing systems, founding depths, allowable bearing pressures,
    - preliminary design parameters for retaining wall design and shoring, and
    - location of the stabilised groundwater levels.

2 SITE INFORMATION

This section provides background information about the site obtained during a site inspection and review of readily available maps and online information.

2.1 SITE IDENTIFICATION AND DESCRIPTION

The site is located on the northern side of Crown Street (Princess Highway), and extends through to Urunga Parade, which forms the northern boundary. The legal description for the site is Lot 1 in Deposited Plan (DP) 565056 (No. 360-362 Crown Street), Lot 7 in DP 661166 (No. 364 Crown Street), Lot 53 of Section 1 in DP 5507 (No. 9 Urunga Parade) and Lot A in DP381246 (No. 11 Urunga Parade). The site is irregular in shape and covers and area of 4,986m^2.

At the time of this investigation there were two single storey brick residential houses located at the rear (northern end) of the site (9 and 11 Urunga Parade). Other significant structures on the site included the former 'Cram House', which is a two storey brick building occupying the central and southern portion of the site and a former residential cottage located in the south-eastern corner. According to the Cram Foundation website (www.cramfoundation.com.au), 'Cram House' was originally opened in 1971 as the 'Illawarra Children's Hospital' and up until it was sold in 2006, has been used for the care of post-operative and orthopaedic patients, a special purpose nursing home and as a day care centre. The cottage in the south-eastern corner of the site was also owned by the Cram Foundation and is understood to have been a school for children with disabilities.

Tha surface surrounding the existing buildings is either paved with asphalt or covered by overgrown garden beds and grassed areas.

2.2 TOPOGRAPHY

According to the Master Plan Report (Health Science, 2009), the site elevation is between 41 and 48 metres above Australian Height Datum (AHD). The highest ground is located in the central portion of the site and gently slopes down towards the north (Urunga Parade) and south (Crown Street) at a grade of between 5% and 10%.

2.3 REGIONAL GEOLOGY

The Wollongong-Port Hacking 1:100 000 Geological Series (First edition Sheet 9029-9129, NSW Department of Mineral Resources, 1985) indicates that the site is underlain by Budgong Sandstone, which is part of the Shoalhaven Group, and typically comprises '*red, brown and grey lithic sandstone*'.

A description of the actual soil and rock encountered on the site is provided in Section 4.1.

2.4 HYDROGEOLOGY

Based on the geological information, GEE anticipate that the groundwater at this site lies within an unconfined aquifer in the sandstone bedrock with the potential for perched groundwater at the soil-rock interface. Site specific information on the depth of groundwater is provided in Section 4.1.1.

3 FIELD INVESTIGATIONS

Field investigations for the geotechnical investigation were carried out between the 3rd and 12th February 2010, and comprised the:

- ◊ Drilling of 3 boreholes (BH1 to BH3) within the site boundaries,
- ◊ Installation of a groundwater monitoring well within borehole BH2 to facilitate the measurement of the stabilised groundwater level,
- ◊ Development of the groundwater monitoring well,
- ◊ Collection of representative rock samples for strength testing.

The locations of the boreholes were measured from existing features and are shown on **Figure 2**.

Each borehole was drilled between the 3rd and 5th February 2010 using a truck mounted Hydropower Scout V drilling rig, utilising solid flight augers with a tungsten carbide drilling bit, and NMLC diamond coring, as appropriate. Boreholes BH1 and BH3 were extended to the target depth of approximately between 4 m below the proposed three-level basement option and were terminated in high strength sandstone. Borehole BH2 was terminated in high to very high strength sandstone bedrock, however, was extended deeper to approximately 7.5m below the proposed three-level basement option, because of the presence of highly fractured sandstone and a volcanic (igneous) intrusion at the proposed target depth.

During drilling, the encountered fill, natural soils and bedrock were geologically logged by Stephen McCormack, and representative samples of recovered rock core submitted to Australian Soil Testing Pty Ltd (AST) for strength assessment (Refer to Section 4.2). Prior to removing samples for testing, the recovered rock core from each borehole was photographed. The photographs are provided with the borehole logs in **Appendix A**.

A groundwater monitoring well was installed within borehole BH2 in accordance with the Land and Water Biodiversity Committee (2003) *Minimum Construction Requirements for Water Bores in Australia,* using 50 mm diameter uPVC pipe, with a machine slotted screen section, 2 mm sand pack and a bentonite seal. The well was installed to a depth of 11.5m below ground surface which corresponded to the depth of the between the two-level and three-level basement options. The screen section extended 9.0m in length from the base of the well.

Development of the wells was undertaken on the 5th February 2010 using a Waterra foot valve and continued until the well was practically dry. Following development of the well, it was allowed to recharge before measurement of the stabilised water level on 12th February 2010.

4 INVESTIGATION RESULTS

4.1 SUBSURFACE CONDITIONS

The site stratigraphy, as observed in the borehole BH1 and BH3 was relatively uniform, typically comprised fill material overlying natural silty clay and clayey sand soil, which in turn was underlain by fine to medium grained sandstone bedrock. A similar profile was encountered in borehole BH3 (located in the South-western corner), however, the sandstone was highly fractured to a depth of 14.9m bgs, upon which a volcanic (igneous) rock intrusion was encountered. A summary of the stratigraphy encountered during drilling is provided below:

Filling:

The fill material was encountered at each location and extended to a depth of between 0.1m (BH2) and 1.0m (BH3). The fill predominately comprised asphaltic pavement and associated gravel base-course layer, although in borehole BH3 there was some fill comprising clayey silt and sandy gravel / gravelly sand, beneath the surface pavements.

Natural Soil:

The natural silty clay and/or sandy clay soil was encountered in each borehole and was typically red-brown, orange-brown and grey mottled, medium plasticity and inferred to be at least stiff in consistency. The natural soil extended to depths of between 0.8m and 1.3m bgs.

Bedrock: Borehole BH1 and BH3

Sandstone bedrock was encountered in each borehole at depths of 1.0m (BH1), 0.8m (BH2) and 1.3m (BH3). Within borehole BH1 and BH3, the sandstone was initially orange-brown in colour with defect spacing of less than 200mm, becoming predominately grey, with defect spacing greater than 200mm, from a depth of 5.5m and 6.2m bgs, respectively. The strength of the sandstone within BH1 and BH3 was inferred to be of very low to low strength, becoming medium and high strength below approximately 2.5m bgs (based on laboratory testing). With reference to Pells et al (1998), which was developed for the Sydney region sedimentary bedrock, the sandstone encountered at the depth of the two-level basement level (RL 35m AHD) would be equivalent to Class III sandstone. Four metres deeper, at the depth

of the three-level basement (RL 31m AHD) the sandstone would be equivalent to Class II sandstone.

Borehole BH2

The sandstone encountered in borehole BH2 was of similar strength to the sandstone from borehole BH1 and BH3 (based on laboratory tests), however, the sandstone was highly fractured (defect spacing typically less than 60mm) and predominately orange-brown in colour to a depth of 14.9m bgs (approximately RL 29.1 m AHD, which is below the proposed depth of excavation). GEE notes that there are some steeply inclined fractures present within the fractured rock (some coated in talc), which may result in 'wedge' or 'block' type failures during excavation.

Below 14.9m depth, the borehole encountered a volcanic intrusion comprising a black/dark grey vesicular latite (volcanic intrusion), which was also highly fractured, resulting in limited recovery of cobble size rock from the core drill barrel. The volcanic intrusion was approximately 1.9m thick vertically and underlain by sandstone which was initially heavily iron-stained, before grading into fine to medium grained, medium to very high strength, grey sandstone from 17.75m bgs.

With reference to Pells et al (1998), the fractured sandstone in borehole BH2 at the depth of both the two-level and three level basement options would be equivalent to Class V (<60mm fracture spacing)/IV sandstone (60 – 200mm fracture spacing). GEE notes that this classification is entirely based on the fracture spacing. If based solely on the strength of the rock then a higher classification would result.

More detailed information on the subsurface conditions at each borehole location is provided in the borehole logs presented in **Appendix B**.

4.1.1 Groundwater

Groundwater seepage was not encountered during auger drilling of each borehole and at greater depth, measurements could not be taken because the drilling method (i.e diamond coring) required the use of water as a drilling fluid. Stabilised groundwater level measured in the well installed within borehole BH2 was 4.05m bgs.

4.2 LABORATORY TEST RESULTS

To assess the strength of the encountered bedrock, representative samples of recovered rock core was collected from each borehole and submitted to AST for NATA accredited point load index (I_{s50}) and Unconfined Compressive Strength (UCS) testing.

Point load tests were conducted at approximately 1m intervals, while UCS tests were undertaken at approximately 4 m intervals.

Point load tests are a simple and economical test for estimating of the strength of a rock and the tests results are routinely multiplied by a factor of 20 to estimate a UCS value, although the correlation is known to vary significantly. For this reason, GEE supplemented the point load tests with UCS tests to provide and when compared to the axial point load test results conducted on similar sections of recovered rock core, the multiplication factors varied from 10 and 29 with an average of 15. Therefore, for the purpose of this investigation a multiplication factor of 15 was adopted for estimating the UCS value from the point load test.

For point load testing, the recovered rock core samples were loaded until failure and the failure load recorded. For each sample the core sample was loaded diametrally and axially and the failure loads for each recorded. A total of 40 point load test results were undertaken and the results for core samples loaded axially ranged from 0.11MPa to 4.10MPa with an average of 1.33MPa, while the diametrally loaded samples ranged from 0.03MPa to 4.89MPa with an average of 1.22MPa.

The diametrally loaded samples recorded slightly lower results which are attributed to the core failing along thin carbonaceous lenses or on bedding defects. Considering that foundations load the bedrock in a similar direction as the axial loaded point load tests, then more emphasis is placed on these results.

Assuming a UCS/Is50 correlation factor of 15, the inferred the inferred UCS values for the point load test results, when loaded axially, is estimated to be approximately 1.7MPa to 61.5MPa, with an average of approximately 20MPa.

Actual UCS test results ranged from 0.1MPa to 28.2MPa with an average of 12.5MPa.

A summary of the tests results is provided in **Table 1**, while a copy of the test report is provided in **Appendix B**.

Table 1: Point Load and UCS Test Results

Location	Depth (m bgs)	Depth (m AHD)[1]	Point Load Test (Is50) Diametral MPa	Point Load Test (Is50) Axial MPa	UCS Test MPa
BH1	4.70	42.60	0.63	1.18	
	5.06	42.24	1.49	1.50	
	6.00	41.30	2.03	1.62	
	7.00	40.30	--	--	6.10
	8.00	39.30	0.03	0.67	
	9.00	38.30	1.12	1.21	
	10.10	37.20	0.68	0.61	
	11.00	36.30	--	--	11.70
	12.00	35.30	2.48	2.30	
	13.00	34.30	1.24	1.08	
	14.00	33.30	0.94	1.20	
	15.07	32.23	2.40	2.18	
	16.00	31.30	--	--	18.20
	17.00	30.30	0.74	0.95	
	18.00	29.30	1.33	1.27	
	19.05	28.25	1.07	--	
	20.00	27.30	--	--	20.30
BH2	5.00	39.00	0.25	0.51	
	6.28	37.72	1.72	--	28.20
	7.16	36.84	4.58	4.10	
	8.19	35.81	0.11	0.41	
	8.55	35.45	0.18	0.39	
	9.05	34.95	--	--	0.10
	9.77	34.23	0.13	0.31	
	10.50	33.50	1.38	1.39	
	11.84	32.16	0.34	0.11	
	12.74	31.26	0.26	0.53	
	13.27	30.73	--	--	2.00
	13.83	30.17	4.89	4.10	
	17.11	26.89	0.11	0.35	
	17.68	26.32	0.18	--	
	18.30	25.70	0.13	0.31	
	19.00	25.00	0.68	--	19.80
	20.00	24.00	2.35	3.30	

[1] Estimated from elevations provided in the Health Science (2009) Master Plan Report.

Table 1 (Continued)

Location	Depth (m bgs)	Depth (m AHD)[2]	Point Load Test (Is50) Diametral MPa	Point Load Test (Is50) Axial MPa	UCS Test MPa
BH3	3.50	41.80	1.88	2.39	23.50
	4.00	41.30	3.05	2.93	
	5.00	40.30	--	--	0.50
	6.00	39.30	1.04	1.45	
	7.06	38.24	0.35	0.29	
	8.00	37.30	0.93	0.85	9.10
	9.28	36.02	2.67	2.50	
	10.40	34.90	0.81	0.74	
	11.81	33.49	1.05	1.15	
	12.78	32.52	0.69	0.62	
	13.78	31.52	--	--	8.20
	14.86	30.44	0.61	1.05	
	15.73	29.57	1.01	1.15	
	16.45	28.85	--	--	14.90
	17.80	27.50	1.31	1.28	

A graph of the axial point load test results versus depth is provided for reference in **Figure 3**. Also included on the graph are the estimated axial point load results from UCS test data using a multiplication factor of 1/15.

[2] Estimated from elevations provided in the Health Science (2009) Master Plan Report.

5 DISCUSSIONS

5.1 GEOTECHNICAL SITE APPRAISAL

GEE considers there to be no significant geotechnical constraint which would prevent construction of the proposed development as described in Section 1.1. Given the site topography and subsurface conditions, slope stability is not considered to be an issue and there is no likely erosion hazard.

Excavation on the site is expected to extend to within close proximity of the site boundaries, therefore temporary and permanent retention / shoring will be required to protect adjoining properties. Further discussion is provided in Section 5.3.

Vibration induced by excavation works will also require management as they have the potential to cause damage to adjoining structures. Further discussion is provided in Section 5.2.1.

5.2 EARTHWORKS

As mentioned in Section 1.1, excavation to RL 35m AHD or RL31m AHD is required for construction of the two or three level basement. This equates to maximum excavation depths of between 13m and 17m, depending on the number of basement levels.

Based on the subsurface conditions encountered in the boreholes, the excavation will encounter a filling and natural soil to a depth of approximately 1.0m, before encountering sandstone rock. Additionally, there was a volcanic intrusion in the south-western corner of the site which was intercepted by borehole BH2. The volcanic intrusion was encountered below the depth of the proposed basement, however, it may be present at a shallower depth elsewhere beneath the site.

GEE notes that the excavation of rock is not only dependant on the rock mass strength, but also influenced by the defect spacing, the orientation of defects, the equipment used and the experience of the equipment operator. However, at this preliminary stage, GEE considers that the excavation of the fill, natural soil and upper very low to low strength rock to depths of approximately 2.5m across the majority of the site, and up to approximately 4.5m locally in the south-western corner (BH2), should be readily achieved using conventional excavation equipment such as excavators. Similarly, the highly fractured rock encountered in the south-western corner of the site (BH2), throughout the depth of the

proposed excavation, may also be removed using conventional excavation equipment, although the assistance of a light rock hammer may be required.

The medium to high strength rock encountered in boreholes BH1 and BH3 below approximately 2.5m bgs, is likely to require heavy rock breaking or the use of a rock saw and/or milling head, particularly if unfavourable rock defect geometry is encountered.

As mentioned in Section 4.1, there were some moderately to steeply inclined fractures within rock from borehole BH2 which have the potential to cause wedge or block type failures during excavation. Allowance will need to be made for the support of the fractured rock and GEE recommends mapping of the rock during excavation by an experienced engineering geologist.

5.2.1 Excavation Induced Vibrations

It is noted that excavation of rock using hydraulic rock hammers will cause vibrations to be transmitted through the ground and potentially impact on adjoining structures, particularly given the presence of shallow bedrock which is likely to be continuous across the site boundaries. Use of other techniques not involving impact (*e.g.* rock saws), although less productive, would reduce or possibly eliminate risks of damage due to vibrations. Given the proximity of the proposed excavation to adjoining structures including buried services along Crown Street and Urunga Parade, GEE recommends that a rock saw be used.

On-site guidance by a vibration specialist is recommended during the early part of excavation. This should include vibration characterisation trials which are used to define vibration levels for the selected equipment.

Peak Particle Velocity (PPV) is usually the adopted measure of ground vibration and the safe limits depend on the sensitivity of the adjoining structures and services. Ideally, safe limits should be determined by a specialist vibration consultant, however as a preliminary guide and considering the type of adjoining structures present, GEE recommend a maximum PPV of 10mm/sec (measured at the foundations of adjoining structures) to minimise the possibility of cosmetic and structural damage.

Alternatively, consideration should be given to adopting more stringent vibration limits recommended for human amenity because human discomfort levels caused by vibration are typically less than the levels that are likely to cause cosmetic or structural damage to structures. Therefore, complaints may be lodged by neighbours before any cosmetic or structural damage occurs.

Acceptable vibration limits for human comfort caused by construction and excavation equipment are provided in DEC (2006) *Assessing vibration: a technical guideline.* Specifically maximum acceleration limits as specified in Table 2.2 of the guideline should be adopted.

During excavation, vibration monitoring and record keeping is recommended for the adjoining structures to confirm that vibrations are within safe limits. Additionally, at all times, the excavation equipment must be operated by experienced personnel, according to the manufacturer's instructions, and in a manner consistent with minimising vibration effects.

To confirm that the excavation works are not causing damage, dilapidation surveys should be carried out on neighboring buildings prior to commencing excavation. Preferably these surveys should be agreed to, and the report signed, by the owners of the adjacent building prior to work commencing.

5.2.2 Waste Disposal

It is noted that prior to removal of any soil from the site, waste classification will be required in accordance with DECC (2009) *Waste Classification Guidelines - Part 1: Classifying Waste.*

5.2.3 Groundwater Inflow

The stabilised groundwater level recorded within borehole BH2 was 4.05m bgs. Considering that the proposed excavation will extend below this depth, then groundwater inflow is likely.

Groundwater movement through rock occurs through open fractures of the bedrock and will increase following rainfall events. The highly fractured rock encountered in the south-western corner will have a considerable influence on the amount of water inflow. Based on the relatively slow recharge rate during development of the well in this part of the site, then the inflow of water is likely to be adequately controlled by pumping during excavation. In the long-term, consideration should be given to drainage behind the perimeter walls and below the basement floor slab.

5.3 RETAINING WALLS / EXCAVATION SUPPORT

Based on the master plan report (Health Science, 2009), the excavation of the basement will extend to within close proximity of the site boundaries (although the exact distances have not yet been finalised), as such either temporary shoring or the early construction of permanent walls designed to shore up the boundaries, will be required. Additionally, considering that the excavation will potentially encroach on the zone of influence of foundations for the adjoining buildings and/or services, it will be necessary to determine the type and depth of these footings to assess the requirements (if any) for underpinning.

The fill material, natural soil and very low to low strength rock will require full support during excavation. Additionally, the highly fractured rock present in the south-western corner, and extending below the proposed depth of the basement, will also require support. Elsewhere, the medium to high strength, slightly fractured rock encountered below approximately 2.5m depth in boreholes BH1 and BH3 is likely to be self-supporting provided adverse jointing is not present within the excavation faces and disturbance during excavation is minimal. However, this will require regular inspections by an experienced engineering geologist during bulk excavation works.

At this preliminary stage, options for shoring include the use of soldier piles or contiguous piling. Open bored piles or CFA piles are considered feasible and should be socketed into the underlying Class III and possibly Class II strength sandstone, depending on the type of pile adopted and capacity of the rig. To achieve this in the south-western corner of the site, it will be necessary to penetrate approximately 14 metres of class V/IV bedrock. As previously mentioned, this class V/IV is based on the highly fractured nature of the rock and the lab testing indicate that the rock strength varies predominately from medium to high strength with some very high strength bands. GEE recommends that the piling contractor complete any investigation necessary to determine the drillability of the rock. If a suitable socket cannot be achieved, and if the piles are founded above the depth of excavation, anchors will need to be installed in the toe of each pile to provide lateral restraint.

Design of the shoring piles may be undertaken in accordance with AS 4678-2002 *Earth Retaining Structures* and should consider the short and long term configurations. In the short term, should the shoring walls be cantilevered or supported by a single row of anchors and some wall movements can be tolerated (flexible wall), the pressure acting on the wall can be estimated on the basis of a triangular earth pressure distribution with the following soil parameters:

- ◊ Active Earth Pressure Coefficient (Ka) – 0.35
- ◊ Bulk Unit Weight, Y (kN/m^3) - 20

When internal props, such as the basement and first floor slab, restrain retaining wall movement, or where significant movements cannot be tolerated (rigid wall), an 'at-rest' earth pressure coefficient (Ko) of 0.5 should be adopted with either a uniform or trapezoidal pressure distribution. It should be noted that shoring which is designed for this 'at rest' coefficient will still undergo some lateral movements, depending on the final configuration of the wall and construction sequence.

The design of any retaining structures should make allowance for all applicable surcharge loadings including construction activities around the perimeter of the excavation and adjacent buildings. Consideration should be given to the possibility of a hydrostatic pressure due to build-up of water behind the wall (*e.g.* from broken services), unless permanent subsurface drainage can be provided.

The alignment (strike) and dip of the volcanic dyke intersected in BH2 should be verified during construction to assess whether this feature of the rock structure has any influence on the excavation support system, and whether there are multiple dykes or dyke swarms.

Finally, computer aided analysis may be carried out to assess potential ground movements based on different wall designs and construction sequence, so as to control deflections to within tolerable limits. It is also considered prudent to carry out surveys before and after installation to measure the actual movement of the wall or soil.

5.4 FOUNDATIONS

Following excavation of the basement, the bulk excavation level will comprise sandstone, although there is a volcanic (igneous) intrusion present beneath the basement level in the south-western portion of the site.

At the preliminary stage, with limited borehole information, the exposed sandstone at the base of the excavation will vary from Class V/IV sandstone in the south-western corner (as depicted by borehole BH2), to Class III or Class II sandstone as depicted by borehole BH1 and BH3 (depending on the depth of the basement. GEE recommends that all footings be founded on the Class III or Class II sandstone which will require penetration of the volcanic intrusion in the south-western corner of the site.

The alignment (strike) and dip of the volcanic dyke intersected in BH2 should be verified during construction to assess whether this feature of the rock structure has any influence on the foundations.

Design serviceability bearing pressures, and ultimate shaft adhesion, for the various equivalent classes of sandstone, based on the recommendations of Pells et al (1998), are given in **Table 2**.

Table 2: Preliminary Foundation design Parameters

Founding Medium	**Serviceability End Bearing Pressure (MPa)**	**Ultimate Shaft Adhesion (kPa)**
Sandstone Class III (Medium to high strength sandstone)	3500	800
Sandstone Class II (high to very high strength)	6000	1500

The above design parameters assume that the piles are socketed at least 0.3m into the desired sandstone class.

6 CONCLUSION AND RECOMMENDATIONS FOR FURTHER WORK

Based on the review of the proposed development plans and the completed field investigations described herein, GEE concludes that the site is suitable for the proposed development with regard to slope stability, erosion hazard, proposed earthworks and retention methods. The existing rock formation and substrata on the site is expected to be capable of withstanding the proposed loads to be imposed, and standard shoring works (provided they are designed by a structural engineer), will ensure the stability of the excavation and provide protection and support of adjoining properties.

Although, the investigation was adequate for characterising the subsurface site conditions beyond the depth of the proposed excavation, due to the variability encountered in the three test locations, it is recommended that further investigations (preferably post demolition) be undertaken to more accurately define the rock profile and minimise the uncertainty for earthworks contractors and structural design engineers.

Of particular interest and relevance to the excavation, footings and groundwater, the volcanic dyke intersected in BH2 requires to be defined in more detail, including whether there are multiple dykes or swarms. Additionally, with regard to footings, it is recommended that the preferred founding medium (either class III or class II sandstone) be more accurately defined.

Regardless of the additional investigations, the presence of moderately to steeply inclined fractures within rock from borehole BH2 has the potential to cause wedge or block type failures during excavation. Therefore, allowance will need to be made for mapping of the rock during excavation by an experienced engineering geologist.

7 LIMITATIONS

This report is based on limited information, although is sufficient for determining the general subsurface conditions across the site and determining the suitability of the proposed development as described in the master plan report (Health Sciences, 2009). GEE notes that the information contained in the report may not necessarily apply if the development or location of the proposed building is changed.

8 REFERENCES

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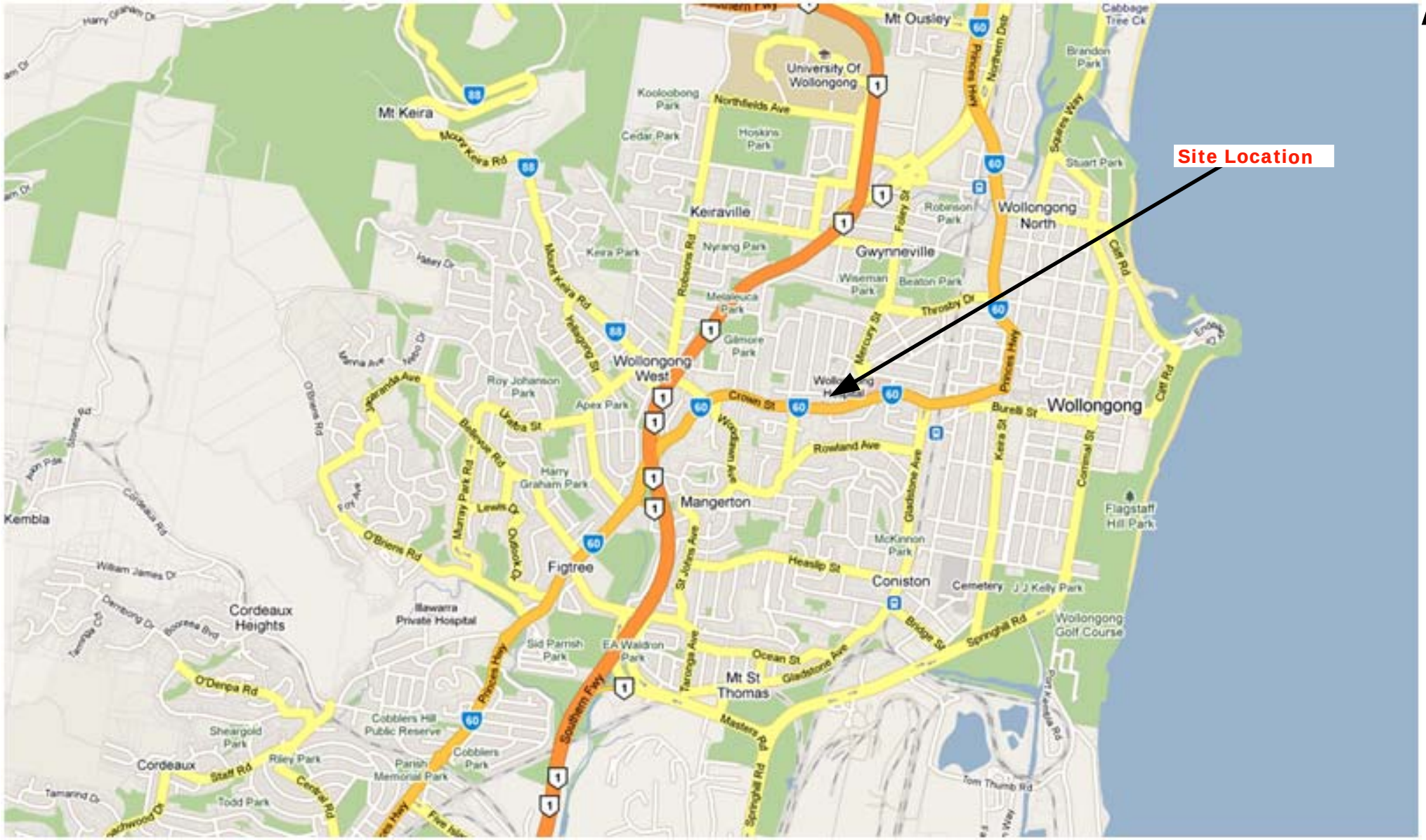
FIGURES

Note: ©2009 Google - Map © 2009 MapData Sciences Pty Ltd

North



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TITLE	Date	Project ID	
Site Location Map - 360 - 364 Crown Street, Wollongong NSW	20 Feb 2010	G10002TPG	FIGURE 1

Photo Source: ©2010 Sinclair Knight Merz (Google Earth) - Map © 2010 MapData Sciences Pty Ltd

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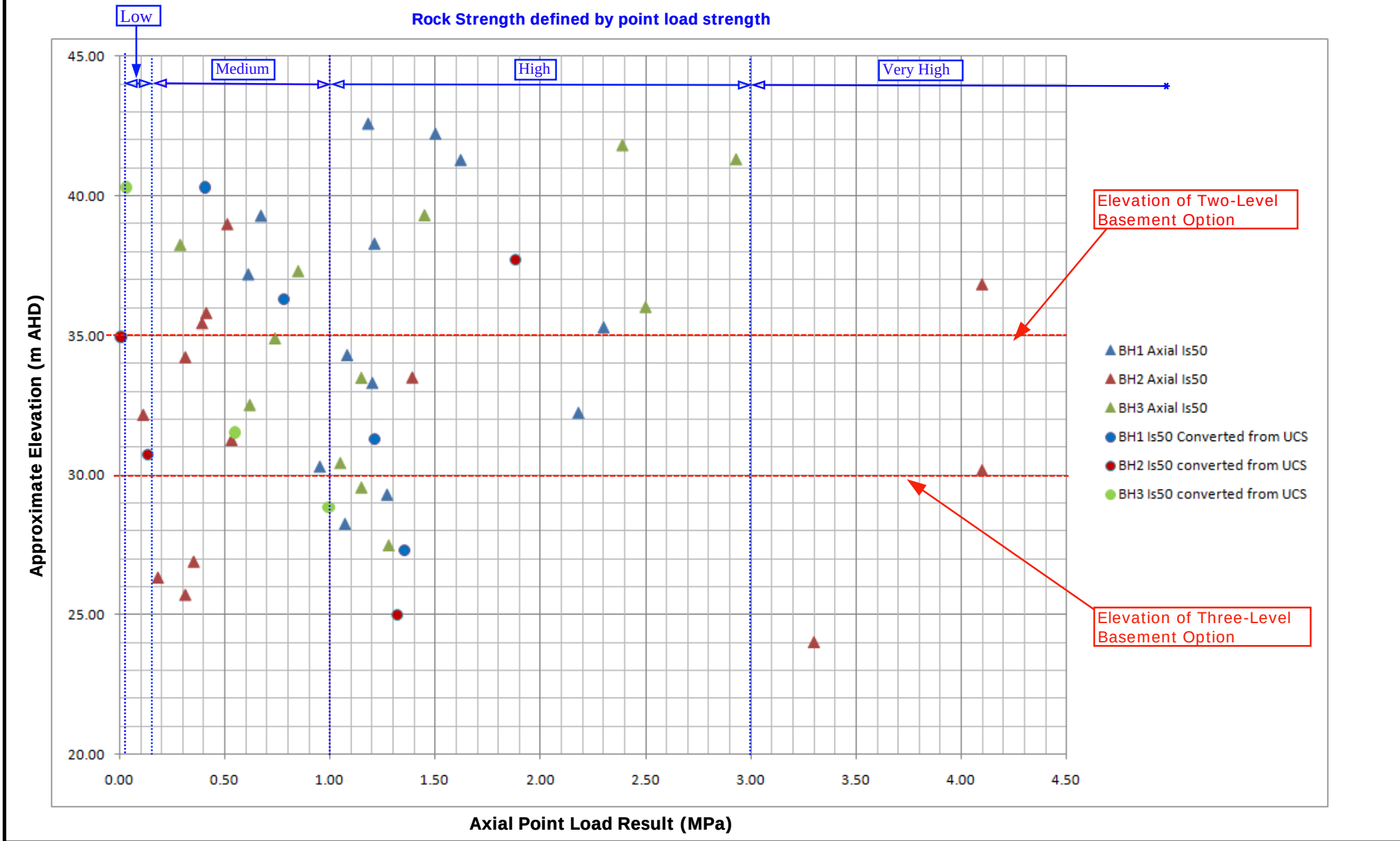
TITLE	Date	Project ID	
Site Plan Showing the Location of Boreholes	20 Feb 2010	G10002TPG	FIGURE 2



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TITLE	Date	Project ID	FIGURE
Axial Point Load Test Data V's Depth	20 Feb 2010	G10002TPG	3

APPENDIX A

Borehole Logs and Rock Core Photographs

Borehole Log Report

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Hole ID. **BH1**
Hole Depth: **20.65 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **3/02/2010** Ground Level: **RL47.3m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **3/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Observations / Comments	Casing & Core Lifts
							Surface: Asphalt			
Solid Flight Auger - TC Bit		0.0	47.3			Fill	**FILL** - Asphalt / Roadbase.			
		0.5	46.8		CL	R.Soil	**Silty CLAY** - dark brown / red brown, stiff, medium plasticity, trace of fine to coarse sand and gravel.	M		
		1.0	46.3			Bedrock	**SANDSTONE, extremely weathered** - grey / red brown, medium to coarse grained, frequent Sandy CLAY / Clayey SAND bands, inferred Class V bedrock.			
		1.5	45.8				becoming hard from 1.7m.		Weight added to auger.	
		2.0	45.3							
		2.5	44.8							
		3.0	44.3				predominantly red / brown, becoming harder form 2.8, inferred Class IV to III bedrock.			
		3.5	43.8							
		4.0	43.3							
		4.5	42.8				*BH1 continued as cored hole from 4.5m*			
		5.0	42.3							
		5.5	41.8							
		6.0	41.3							

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Stephen McCormack** Date: **3/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE BH LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:31:22 PM

Borehole Log Report

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Hole ID. **BH1**
Hole Depth: **20.65 m**
Sheet: **2 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **3/02/2010** Ground Level: **RL47.3m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **3/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Depth (m)	RL (m)	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Defect Description (type, inclination, thickness, shape, roughness, coating)	Core Photo
4.5	43.0	*Continued from non-cored borehole from 4.5m*							
4.5–5.0	42.5–42.0	**SANDSTONE** - red / brown, medium to coarse grained.	DW		D=0.63 A=1.18	92		JT, HZ, PLN, RF, CN; SM CLAY, <5mm; JT, HZ, PLN, RF, CN; JT, HZ, PLN, RF, CN; JT, HZ, PLN, RF, CN	
5.0–5.5	42.0–41.5		SW		D=1.49 A=1.5				
5.5–6.0	41.5–41.0	becoming light grey, with occasional orange / brown bands, fine to medium grained, with occasional black carbonaceous / siltstone inclusions.	DW					JT, 10°, PLN, CN, RF	
6.0–6.5	41.0–40.5		SW		D=2.03 A=1.62			JT, HZ, IR, RF, CN	
6.5–7.0	40.5–40.0					97		JT, IR, FE, RF; JT, 10°, IR, FE, RF	
7.0–7.5	40.0–39.5	orange / brown.	DW					JT, 10°, IR, CN, RF	
7.5–8.0	39.5–39.0	light grey, with occasional orange / brown bands, fine to medium grained, with occasional black carbonaceous / siltstone inclusions.	SW-FR		D=0.3 A=0.67			JT, 10°, IR, CN, RF	
8.5–9.0	38.5–38.0	**SANDSTONE** - light grey, fine to medium grained, with occasional black carbonaceous / siltstone inclusions.	FR		D=1.12 A=1.21	100		JT, 70°, PLN, CN, RF	
9.5–10.0	37.5								

Method: Diamond Drilling; Material Type: Bedrock; Graphic Log: GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:28 PM

Core Photo: 5.5, 8.5

Additional Comments

Logged By: **Stephen McCormack** Date: **3/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

Borehole Log Report

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Hole ID. **BH1**
Hole Depth: **20.65 m**
Sheet: **3 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **3/02/2010** Ground Level: **RL47.3m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **3/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Depth (m)	RL (m)	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Defect Description (type, inclination, thickness, shape, roughness, coating)	Depth (m)	Core Photo	Casing & Core Lifts
					EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	D=diametral A=axial		20 60 200 600 2000	Specific / General			
Diamond Drilling	10.5	37.0	**SANDSTONE** - light grey, fine to medium grained, with occasional black carbonaceous / siltstone inclusions.	FR		D=0.68 A=0.61	100		JT, HZ, IR, CN, RF	10.5		
	11.0	36.5								11.0		
	11.5	36.0								11.5		11.55
	12.0	35.5	increasing dark grey / black lenses / bands, and siltstone inclusions.			D=2.48 A=2.3	100		JT, 45°, PLN, CN, RF	12.0		
	12.5	35.0							JT, 30°, PLN, CN, RF	12.5		
	13.0	34.5				D=1.24				13.0		
	13.5	34.0				A=1.08				13.5		
	14.0	33.5	**SANDSTONE** - pale grey, fine to medium grained, with black siltstone / carbonaceous inclusions.			D=0.94 A=1.2				14.0		
	14.5	33.0							JT, IR, FE, RF	14.5		14.6
	15.0	32.5					100		JT, 45°, PLN, RF	15.0		
	15.5	32.0				D=2.4 A=2.18			JT, 45°, PLN, FE, RF	15.5		
	16.0	31.5							JT, 45°, PLN, FE, RF	16.0		

Bedrock

Additional Comments

Logged By: **Stephen McCormack** Date: **3/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:28 PM

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Hole ID. **BH1**
Hole Depth: **20.65 m**
Sheet: **4 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **3/02/2010** Ground Level: **RL47.3m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **3/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	RQD %	Rock Mass Defects: Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating: Specific / General	Depth (m)	Core Photo	Casing & Core Lifts
Diamond Drilling		16.5 / 17.0 / 17.5 / 18.0 / 18.5 / 19.0 / 19.5 / 20.0 / 20.5	31.0 / 30.5 / 30.0 / 29.5 / 29.0 / 28.5 / 28.0 / 27.5 / 27.0		Bedrock	Pyrite inclusion at 15.9m. **SANDSTONE** - pale grey, fine to medium grained, with black siltstone / carbonaceous inclusions.	FR		D=0.74 A=0.95 D=1.33 A=1.27	100		JT, 60°, PLN, RF, CN JT, 45°, IR, CN, RF	16.5 / 17.0 / 17.5 / 18.0 / 18.5 / 19.0 / 19.5 / 20.0 / 20.5		17.6
						SILTSTONE - dark grey, with red / brown lenses. **SANDSTONE** - grey, fine to medium grained, with occasional dark grey bands / lenses of siltstone.			D=1.07	100		JT, 35°, PLN, FE, RF BP, HZ, PLN, CN, SO JT, 40°, IR, CN, RF JT, VT, IR, CN, TI (Closed)			20.65
		21.0 / 21.5 / 22.0	26.5 / 26.0 / 25.5			**Hole Terminated at 20.65 m**							21.0 / 21.5 / 22.0		

Additional Comments

Logged By: **Stephen McCormack** Date: **3/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

Borehole BH1: Start of Core (4.5m) to 9.0m

Borehole BH1: 9.0m to 14.0m

Borehole BH1: 14.0m to 20.65m (End)

Borehole Log Report

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Hole ID. **BH2**
Hole Depth: **20.55 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL44.0m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **4/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Observations / Comments	Casing & Core Lifts
							Surface: Asphalt			
Solid Flight Auger		0.5	43.5		CL	Residual Soil	**FILL** - Asphalt / Roadbase. **Sandy CLAY** - red / brown, grey mottled, low to medium plasticity, medium to coarse grained sand (EW Sandstone).	M		
		1.0	43.0			Bedrock	**SANDSTONE** - red / brown, grey mottled, medium to coarse grained, very low to low strength.			
		1.5	42.5							
		2.0	42.0							
		2.5	41.5				some bands of low to medium strength Sandstone chips present from 2.5m.			
		3.0	41.0							
		3.5	40.5							
		4.0	40.0							
		4.5	39.5				*BH2 continued as cored hole from 4.5m*			
		5.0	39.0							
		5.5	38.5							
		6.0	38.0							

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **1/03/2010**

GEE BH LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 01/03/10 11:15:28 AM

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
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Hole ID. **BH2**
Hole Depth: **20.55 m**
Sheet: **2 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL44.0m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **4/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Defect Description (type, inclination, thickness, shape, roughness, coating)	Depth (m)	Core Photo	Casing & Core Lifts
		4.5	39.5			*Continued from non-cored borehole from 4.5m*							4.5		
						CORE LOSS.									
Diamond Drilling		5.0	39.0		Bedrock	**SANDSTONE** - orange / brown, dark grey to black carbonaceous lenses, fine to coarse grained, up to gravel size, laminated, with intermittent and irregular Siltstone lenses / inclusions, occasional clay seams.	DW		D=0.25 A=0.51	84		JT,HZ,IR,CN,RF JT,10°,IRF,FE,RF FZ JT,30°,IR,FE,RF JT,45°,IR,FE,RF JT,10°,IR,FE,RF	5.0		
		5.5	38.5									JT,20°,IR,FE,RF JT,20°,IR,FE,RF JT,HZ,40°,FE,RF JT,20°,PLN,FE,RF JT,45°,PLN,FE,RF JT,HZ,IR,FE,RF SM,CLAY,HZ,5mm JT,10°,IR,FE SM,CLAY,10mm JT,HZ,FE,PLN ST,45°,CLAY,SO.PLN	5.5		5.6
		6.0	38.0										6.0		
		6.5	37.5						D=1.72	100		JT,45°,FE,PLN	6.5		
		7.0	37.0						D=4.58 A=4.1			SM,70°,CLAY JT,HZ,IR,FE,RF JT,HZ,IR,FE,RF SM, CLAY, HZ SM,70°,CLAY JT,70°,PLN,FE,CLAY	7.0		
		7.5	36.5									SM,80°,FE/CLAY,IR	7.5		7.45
		8.0	36.0						D=0.11 A=0.41	100		JT,80°,IR,FE,Closed JT,HZ,IR,CN JT,45°,IR,CN JT,45°,IR,CN JT,HZ,IR,CLAY JT,HZ,IR	8.0		
		8.5	35.5						D=0.18 A=0.39			JT,VT,IR,FE,Closed	8.5		8.65
		9.0	35.0			**SANDSTONE** - orange / brown, with some red lenses / bands throughout, fine to medium grained.				100		JT,45°,PLN,FE JT,10°,CN,IR,RF JT,10°,CN,IR,RF JT,10°,CN,IR,RF JT,HZ,IR,CN JT,10,PLN,FE SM,HZ,CLAY,20mm SM,HZ,CLAY,20mm FZ SM,HZ,CLAY,5mm JT,10°,CLAY,IR SM,HC,CLAY,5mm JT,HZ,IR,CL	9.0		
		9.5	34.5			SILTSTONE band 10mm thick at 9.31m. becoming red / orange / grey from 9.5m.							9.5		
		10.0	34.0						D=0.13 A=0.31				10.0		

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **1/03/2010**

Borehole Log Report

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Hole ID. **BH2**
Hole Depth: **20.55 m**
Sheet: **3 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL44.0m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **4/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Rock Mass Defects: Defect Description (type, inclination, thickness, shape, roughness, coating) Specific / General	Depth (m)	Core Photo	Casing & Core Lifts
Diamond Drilling		10.5	33.5		Bedrock	**SANDSTONE** - orange / brown, with some red lenses / bands throughout, fine to medium grained.	DW		D=1.38 A=1.39	100		JT,HZ,IR,CN,RF JT,10°,IR,CN JT,VT,FE,IR,Closed JT,10°,IR,FE	10.5		
		11.0	33.0									JT,10°,IR,FE JT,30°,IR,FE JT,45°,IR,FE JT,30°,IR,FE JT,45°,FE,PLN JT,45°,CLAY,PLN JT,45°,FE,PLN	11.0		
		11.5	32.5									JT,45°,FE,PLN SM,45°,CLAY	11.5		11.65
							DW			100		JT,HZ,PLN,CLAY FZ			
		12.0	32.0				SW		D=0.34			SM,HZ,CLAY,5mm	12.0		
							SW		A=0.11			JT,HZ,IR,CN			
		12.5	31.5									JT,45°,PLN,FR JT,20°,PLN,FR	12.5		
												JT,45°,PLN,FE,Closed			
		13.0	31.0						D=0.26	100		JT,HZ,IR,FE	13.0		
							SW		A=0.53			SM,HZ,CLAY,10mm			
		13.5	30.5				SW					FZ JT,HZ,IR,CN JT,HZ,IR,CN JT,10°,PLN,FE JT,10°,PLN,CN	13.5		13.7
		14.0	30.0			predominantly grey with red streaks from 13.7m.			D=4.89 A=4.1			FZ,IR,FE	14.0		
		14.5	29.5			**SANDSTONE** - orange / brown, red / brown and grey, highly fractured, some calcite deposits.	SW			38		JT,75°,PLN,white coating,Calcite? JT,50°,PLN,white coating,Calcite? JT,60°,PLN,white coating,Calcite? FZ, some FE,white infilling / coating	14.5		14.5
		15.0	29.0			***CORE LOSS.***				0			15.0		15.27
		15.5	28.5			**VESICULAR LATITE** - dark grey to black, with some orange / brown and red staining, highly fractured, cobble size rock recovery, (Volcanic intrusion).	SW			0		FZ	15.5		15.6
						CORE LOSS.	SW			0		FZ			
		16.0	28.0			**VESICULAR LATITE** - dark grey to black, with some orange / brown and red staining, highly fractured, cobble							16.0		16

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **1/03/2010**

Borehole Log Report

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Hole ID. **BH2**
Hole Depth: **20.55 m**
Sheet: **4 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL44.0m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **4/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Depth (m)	RL (m)	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Defect Description (type, inclination, thickness, shape, roughness, coating)	Depth (m)	Core Photo	Casing & Core Lifts
					EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	D=diametral A=axial		20 60 200 600 2000	Specific / General			
Tricone	16.5	27.5	size rock recovery, (Volcanic intrusion). ***CORE LOSS.*** *Rock drilling using Tri-Cone bit, no recovery*						FZ (?)	16.5		
Diamond Drilling	17.0	27.0	**SANDSTONE / IRONSTONE** - red / brown, with some grey inclusions, fine to medium grained, some calcite deposits present.	SW		D=0.1 A=0.35	100		JT,70°,PLN,CLAY/FE	17.0		
	17.5	26.5				D=0.18			VN,VT,FE,IR,Closed	17.5		17.6
	18.0	26.0	**SANDSTONE** - grey, with minor dark grey / black lenses, fine to medium grained, massive.	SW					JT,45°,IR,CN JT/SM,30°,IR,CLAY	18.0		
	18.5	25.5				D=0.13 A=0.31			SM,CLAY,70°,TI,white coating	18.5		
	19.0	25.0				D=0.68	100		JT,60°,IR,CN JT,45°,IR,CN	19.0		
	19.5	24.5								19.5		
	20.0	24.0		FR		D=2.35 A=3.3				20.0		
	20.5	23.5								20.5		20.55
	21.0	23.0	**Hole Terminated at 20.55 m**							21.0		
	21.5	22.5								21.5		
	22.0	22.0								22.0		

Graphic Log / Material Type: Bedrock

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **1/03/2010**

Borehole BH2: Start of Core (4.5m) to 9.0m

Borehole BH2: 9.0m to 14.0m

Borehole BH2: 14.0m to 20.55m (End)

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
Kingsgrove NSW 2208
T 02 9592 0218

geo-environmental ENGINEERING

Hole ID. **BH3**
Hole Depth: **18.00 m**
Sheet: **1 of 4**

Project Name: **Geotechnical Investigation** Project Number: **G10002TPG**
Location / Site: **360-364 Crown Street, Wollongong NSW** Client: **TPG**

Drilling Company: **Macquaire Drilling** Date Started: **4/02/2010** Ground Level: **RL45.3m** approx
Drill Method: **Solid Flight Auger / Diamond Drilling** Date Completed: **5/02/2010** Easting: ----------
Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Observations / Comments	Casing & Core Lifts
							Surface: Asphalt		
Solid Flight Auger - TC Bit		0.0	45.0			Fill	**FILL** - Asphalt / Roadbase.		
							FILL - Sandy Gravel / Gravelly Sand, red / brown, medium to coarse grained.		
		0.5	44.5				**FILL** - Clayey Silt (topsoil), dark brown, low plasticity.		
		1.0	44.0		CL	R.Soil	**Silty CLAY** - red / brown, orange / brown and grey mottled, stiff, medium plasticity, with some fine to coarse sandstone gravel.		
		1.5	43.5			Bedrock	**SANDSTONE, extremely to highly weathered** - orange / brown, medium to coarse grained.		
		2.0	43.0						
		2.5	42.5				harder from 2.5m.		
		3.0	42.0						
		3.5	41.5				*BH3 continued as cored hole from 3.5m*		
		4.0	41.0						
		4.5	40.5						
		5.0	40.0						
		5.5	39.5						
		6.0							

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE BH LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:31:24 PM

Borehole Log Report

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Hole ID. **BH3**
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Sheet: **2 of 4**

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Equipment: **Hydropower Scout V** Northing: ----------

Method	Depth (m)	RL (m)	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Defect Description (type, inclination, thickness, shape, roughness, coating)	Depth (m)	Core Photo	Casing & Core Lifts
	3.5	42.0	*Continued from non-cored borehole from 3.5m*							3.5		
Diamond Drilling	4.0	41.5	**SANDSTONE** - orange / brown, fine to medium grained, some dark grey / black lenses and inclusions.	SW		D=1.88 A=2.39	92		JT, HZ, IR, CN BP, HZ, PLN, CN	4.0		
	4.5	41.0	some grey bands present from.			D=3.05 A=2.93			JT, 70°, PLN, Clay, RF JT, HZ, IR, CN	4.5		
	5.0	40.5		XW SW XW SW XW					SM, Clay, 20°, 50mm SM, Clay, 80mm, HZ SM, Clay	5.0		
	5.5	40.0		DW XW DW SW SW					SM, Clay, HZ	5.5		5.4
	6.0	39.5				D=1.04 A=1.45			JT, 10°, IR, CN	6.0		
Bedrock	6.5	39.0	**SANDSTONE** - grey, fine to medium grained, dark grey / black inclusions.	SW			100		JT, 10°, PLN, CN JT, 10°, PLN, FE JT, 10°, PLN, FE	6.5		
	7.0	38.5				D=0.35 A=0.29				7.0		
	7.5	38.0							JT, 10°, IR, CN	7.5		
	8.0	37.5				D=0.93 A=0.95			JT, HZ, IR, Clay	8.0		
	8.5	37.0								8.5		8.6
	9.0	36.5					100		JT, 20°, FE, PLN	9.0		

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:35 PM

Borehole Log Report

Geo Environmental Engineering
275A Stoney Creek Road
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Hole ID. **BH3**
Hole Depth: **18.00 m**
Sheet: **3 of 4**

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Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa)	$Is_{(50)}$ MPa	RQD %	Defect Spacing (mm)	Defect Description (type, inclination, thickness, shape, roughness, coating)	Depth (m)	Core Photo	Casing & Core Lifts
Diamond Drilling		9.5	36.0		Bedrock	**SANDSTONE** - grey, fine to medium grained, dark grey / black inclusions.	SW		D=2.67 A=2.5	100		JT, HZ, IR, FE	9.5		
		10.0	35.5			some coarse grained sand and fine gravel between 9.55 and 10.0m.							10.0		
		10.5	35.0						D=0.81 A=0.74				10.5		
		11.0	34.5										11.0		11.05
		11.5	34.0			**SILTSTONE** - dark grey.						BP, HZ, IR, CN	11.5		
		12.0	33.5			**SANDSTONE** - grey, with minor dark grey siltstone lenses.			D=1.05 A=1.15	100		BP, 10°, CN	12.0		
		12.5	33.0									JT, HZ, IR, Clay	12.5		
		13.0	32.5						D=0.69 A=0.62				13.0		
		13.5	32.0									BP, HZ, IR, CN	13.5		
		14.0	31.5										14.0		14.1
		14.5	31.0							100			14.5		
		15.0	30.5						D=0.61				15.0		

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
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Equipment: **Hydropower Scout V** Northing: ----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	$Is_{(50)}$ MPa D=diametral A=axial	RQD %	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating Specific / General	Depth (m)	Core Photo	Casing & Core Lifts
Diamond Drilling		15.5 16.0 16.5 17.0 17.5 18.0	30.0 29.5 29.0 28.5 28.0 27.5		Bedrock	**SANDSTONE** - grey, with minor dark grey siltstone lenses.	SW		A=1.05 D=1.01 A=1.15 D=1.31 A=1.28	100 100			15.5 16.0 16.5 17.0 17.5 18.0		17.1 18
		18.5 19.0 19.5 20.0 20.5 21.0	27.0 26.5 26.0 25.5 25.0 24.5			**Hole Terminated at 18.00 m**							18.5 19.0 19.5 20.0 20.5 21.0		

Additional Comments

Logged By: **Stephen McCormack** Date: **4/02/2010**
Checked By: **Stephen McCormack** Date: **24/02/2010**

GEE CORE LOG G10002TPG WOLLONGONG.GPJ GEE LOG 2.GDT 24/02/10 2:26:36 PM

Borehole BH3: Start of Core (3.5m) to 8.0m

Borehole BH3: 8.0m to 13.0m

Borehole BH3: 13.0m to 18.0m (End)

APPENDIX B

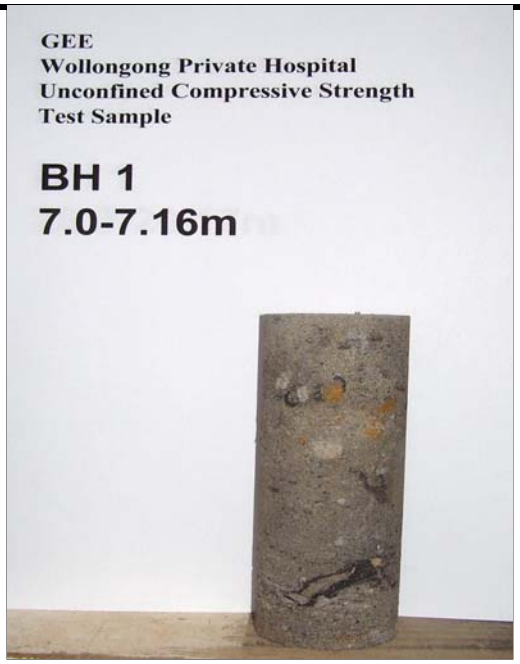
Laboratory Report

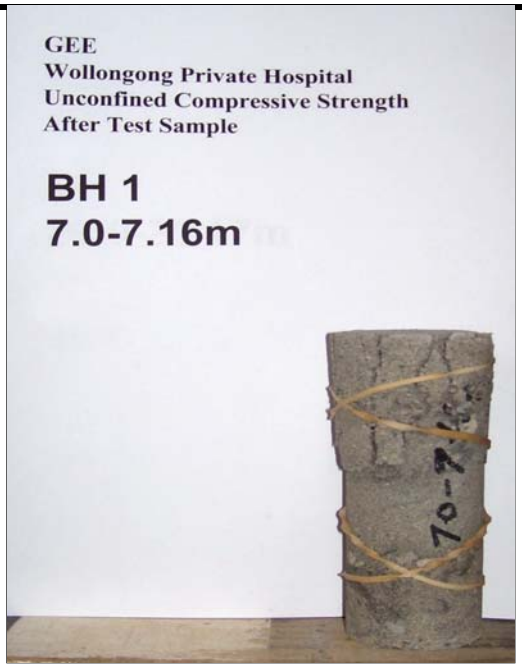
AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56484
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	4.02.10
Sample Id:	**BH1**	**Test Type:**	Compressive Str.
Sample No:		**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.7		
Dry Density (t/m^3):	2.46	**Depth (m):**	7.0-7.16m
Moisture Content (%):	5.4		





UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 6.1

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Manager Date: 04.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

4(a)(i) Length to diameter ratio may not conform to 2.5 due to the length of suitable sample available. The diameter of the specimen may not be ten times the size of the largest grain in the rock.

4(a)(ii) Ends of the specimen may not be parallel to within 0.05mm in 50mm due to the end preparation technique.

4(a)(iii) Ends of the specimen may not be flat to 0.02mm due to irregularities within the sample, such as solution cavities.

4(a)(iv) The sides of the specimen may not be smooth, free of abrupt irregularities and straight to within 0.3mm over the full length of the specimen. This is due to the drilling process and irregularities within the sample, such as solution cavities.

4(c) Samples were tested in the "As Received" condition. They were not conditioned in a uniform temperate and humidified environment for five or more days.

5(a) Specimens were loaded at a constant rate of load to achieve failure within 5 to 15 minutes of loading. The rate of loading was based on an initial estimate of the UCS strength. However in some cases, failure occurred before 5 minutes loading, due to lower than estimated strength.

7(i) Prior to testing, the cores were stored as received from site. ie the cores were wrapped in plastic

TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56488
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	4.02.10
Sample Id:	**BH1**	**Test Type:**	Compressive Str.
Sample No:		**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.5		
Dry Density (t/m^3):	2.43	**Depth (m):**	11.0-11.16m
Moisture Content (%):	5.2		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 11.7

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Manager Date: 04.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

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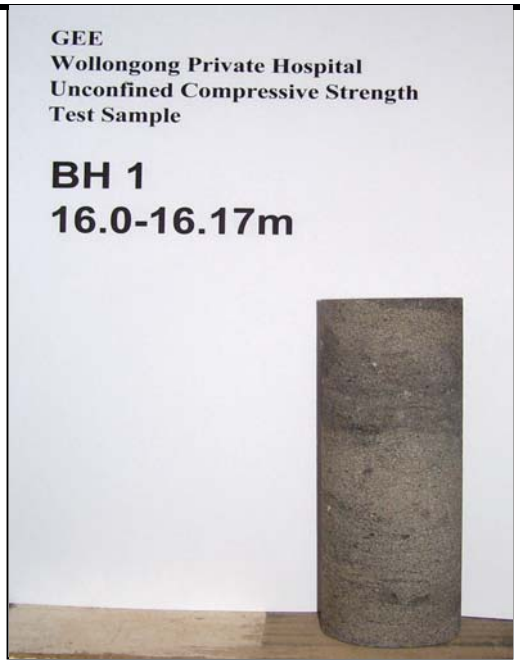
COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56493
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	4.02.10
Sample Id:	**BH1**	**Test Type:**	Compressive Str.
Sample No:		**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.8		
Dry Density (t/m^3):	2.46	**Depth (m):**	16.0-16.17m
Moisture Content (%):	4.7		



UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 18.2

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Manager Date: 04.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

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TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56497
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	4.02.10
Sample Id:	**BH1**	**Test Type:**	Compressive Str.
Sample No:		**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.5		
Dry Density (t/m^3):	2.44	**Depth (m):**	20.0-20.17m
Moisture Content (%):	4.6		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 20.3

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Manager Date: 04.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56595
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH2**	**Test Type:**	Compressive Str.
Sample No:	**BH2**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.9		
Dry Density (t/m^3):	2.25	**Depth (m):**	6.28-6.48m
Moisture Content (%):	5.0		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 28.2

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56596
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH2**	**Test Type:**	Compressive Str.
Sample No:	**BH2**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.4		
Dry Density (t/m^3):	1.86	**Depth (m):**	9.05-9.19m
Moisture Content (%):	16.5		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 0.1

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed:

Name: Chris Lloyd

Title: Lab Manager

Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

4(a)(i) Length to diameter ratio may not conform to 2.5 due to the length of suitable sample available. The diameter of the specimen may not be ten times the size of the largest grain in the rock.

4(a)(ii) Ends of the specimen may not be parallel to within 0.05mm in 50mm due to the end preparation technique.

4(a)(iii) Ends of the specimen may not be flat to 0.02mm due to irregularities within the sample, such as solution cavities.

4(a)(iv) The sides of the specimen may not be smooth, free of abrupt irregularities and straight to within 0.3mm over the full length of the specimen. This is due to the drilling process and irregularities within the sample, such as solution cavities.

4(c) Samples were tested in the "As Received" condition. They were not conditioned in a uniform temperate and humidified environment for five or more days.

5(a) Specimens were loaded at a constant rate of load to achieve failure within 5 to 15 minutes of loading. The rate of loading was based on an initial estimate of the UCS strength. However in some cases, failure occurred before 5 minutes loading, due to lower than estimated strength.

7(i) Prior to testing, the cores were stored as received from site. ie the cores were wrapped in plastic

TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56597
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH2**	**Test Type:**	Compressive Str.
Sample No:	**BH2**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.7		
Dry Density (t/m^3):	1.68	**Depth (m):**	13.27-13.42m
Moisture Content (%):	21.6		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 2.0

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

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Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

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Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56598
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH2**	**Test Type:**	Compressive Str.
Sample No:	**BH2**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.9		
Dry Density (t/m^3):	2.54	**Depth (m):**	19.00-19.22m
Moisture Content (%):	3.3		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 19.8

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

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TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56603
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH3**	**Test Type:**	Compressive Str.
Sample No:	**BH3**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.6		
Dry Density (t/m^3):	2.09	**Depth (m):**	3.5-3.72m
Moisture Content (%):	9.2		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 23.5

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

4(a)(ii) Ends of the specimen may not be parallel to within 0.05mm in 50mm due to the end preparation technique.

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TEST EQUIPMENT

Test Equipment: ELE Compact 1000 Hydraulic Compression Test Machine.

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56605
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH3**	**Test Type:**	Compressive Str.
Sample No:	**BH3**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.4		
Dry Density (t/m^3):	1.95	**Depth (m):**	5.0-5.20m
Moisture Content (%):	17.1		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 0.5

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed:

Name: Chris Lloyd

Title: Lab Manager

Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56608
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH3**	**Test Type:**	Compressive Str.
Sample No:	**BH3**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.7		
Dry Density (t/m^3):	2.45	**Depth (m):**	8.0-8.25m
Moisture Content (%):	4.7		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 9.1

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

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TEST EQUIPMENT

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56613
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH3**	**Test Type:**	Compressive Str.
Sample No:	**BH3**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.6		
Dry Density (t/m^3):	2.45	**Depth (m):**	13.78-14.0m
Moisture Content (%):	5.0		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 8.2

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

TEST STANDARD : AS4133.4.2-1993. Methods of Testing Rocks for Engineering purposes. Method 4.2 - Rock Strength Tests - Determination of uniaxial compressive strength.

SAMPLE PREPARATION AND TESTING PROCEDURE

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COMPRESSIVE STRENGTH
REPORT CERTIFICATE

AS 4133.4.2

CLIENT:	**Geo Environmental Engineering**	**JOB NO. :**	174-012
PROJECT:	**G10002 TPG**	**LAB NO. :**	56616
LOCATION:	**Wollongong Private Hospital**	**Date Tested:**	09.02.10
Sample Id:	**BH3**	**Test Type:**	Compressive Str.
Sample No:	**BH3**	**Sample Type:**	Core
Initial Specimen:		**Rock Type**	Sandstone
Length/ Diameter Ratio:	2.8		
Dry Density (t/m^3):	2.48	**Depth (m):**	16.45-16.62m
Moisture Content (%):	4.5		

UNIAXIAL COMPRESSIVE STRENGTH
U.C.S. (MPa) = 14.9

Notes on testing: Specimen tested at the moisture condition as received.

Specimen supplied by client.

Bulk density value was detmined by vernier calliper method.

Form C:\excelreports\uniaxial compressive strength test report certificate, Issue 1, September 2006 CL

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 09.02.10

UNIAXIAL COMPRESSION TEST REPORT

Test Method: AS 4133.4.2 - 1993

COMPRESSIVE STRENGTH TEST DEVIATIONS FROM THE TEST STANDARD AND TEST EQUIPMENT

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Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: **Geo Environmental Engineering**
275a Stoney Creek Road, Kingsgrove NSW 2208

PROJECT: **Wollongong Private Hospital Project No: G10002 TPG**

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH
			DIAM	HEIGHT			
	BH 3		(mm)	(mm)		Is (MPa)	$Is_{(50)}$ (MPa)
56603	3.5-3.72m	Sandstone	52	25	Diametral Axial	1.85 2.62	1.88 2.39
56604	4.0-4.2m	Sandstone	52	45	Diametral Axial	3.00 2.82	3.05 2.93
56606	6.0-6.10m	Sandstone	52	43	Diametral Axial	1.02 1.41	1.04 1.45
56607	7.06-7.18m	Sandstone	52	41	Diametral Axial	0.34 0.28	0.35 0.29
56608	8.0-8.25m	Sandstone	52	43	Diametral Axial	0.91 0.82	0.93 0.85
56609	9.28-9.48m	Sandstone	52	43	Diametral Axial	2.63 2.42	2.67 2.50
56610	10.4-10.6m	Sandstone	52	38	Diametral Axial	0.80 0.74	0.81 0.74
56611	11.81-12.0m	Sandstone	52	39	Diametral Axial	1.03 1.15	1.05 1.15

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Soaked

Sampled by: Client

Job Number: 174-012

Date Tested: 09.02.10

Test method: AS 4133.4.1 2007

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

Signed: Name: Chris Lloyd

Title: Chris Lloyd Date: 11.02.10

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: **Geo Environmental Engineering**
275a Stoney Creek Road, Kingsgrove NSW 2208

PROJECT: **Wollongong Private Hospital Project No: G10002 TPG**

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH
			DIAM	HEIGHT			
	BH 3		(mm)	(mm)		Is (MPa)	$Is_{(50)}$ (MPa)
56612	12.78-12.95m	Sandstone	52		Diametral	0.68	0.69
				34	Axial	0.64	0.62
56614	14.86-15.00m	Siltstone	52		Diametral	0.60	0.61
				46	Axial	1.00	1.05
56615	15.73-15.88m	Siltstone	52		Diametral	0.99	1.01
				39	Axial	1.14	1.15
56617	17.8-17.94m	Siltstone	52		Diametral	1.29	1.31
				41	Axial	1.25	1.28

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Soaked

Sampled by: Client

Job Number: 174-012

Date Tested: 09.02.10

Test method: AS 4133.4.1 2007

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 10.02.10

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
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POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: **Geo Environmental Engineering**
275a Stoney Creek Road, Kingsgrove NSW 2208

PROJECT: **Wollongong Private Hospital Project No: G10002 TPG**

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH
			DIAM	HEIGHT			
	BH 1		(mm)	(mm)		Is (MPa)	$Is_{(50)}$ (MPa)
56481	4.7-4.82m	Sandstone	51.7	38	Diametral Axial	0.62 1.18	0.63 1.18
56482	5.06-5.23m	Sandstone	51.7	42.5	Diametral Axial	1.47 1.47	1.49 1.50
56483	6.0-6.17m	Sandstone	51.7	35	Diametral Axial	2.00 1.65	2.03 1.62
45485	8.0-8.15m	Sandstone	51.7	40	Diametral Axial	0.30 0.66	0.30 0.67
45486	9.0-9.14m	Sandstone	51.8	44.4	Diametral Axial	1.10 1.17	1.12 1.21
45487	10.10-10.27m	Sandstone	51.7	46.7	Diametral Axial	0.67 0.58	0.68 0.61
45489	12.0-12.10m	Sandstone	51.8	44.7	Diametral Axial	2.44 2.21	2.48 2.30
45490	13.0-13.3m	Sandstone	51.7	49.8	Diametral Axial	1.22 1.04	1.24 1.08

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled by: Client

Job Number: 174-012

Date Tested: 4.02.10

Test method: AS 4133.4.1 2007

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

Signed: Name: Chris Lloyd

Title: Manager Date: 5.02.10

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
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POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: **Geo Environmental Engineering**
275a Stoney Creek Road, Kingsgrove NSW 2208

PROJECT: **Wollongong Private Hospital Project No: G10002 TPG**

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH
			DIAM	HEIGHT			
	BH 1		(mm)	(mm)		Is (MPa)	Is $_{(50)}$ (MPa)
56491	14.0-14.13m	Sandstone	51.7	41.8	Diametral Axial	0.93 1.17	0.94 1.20
56492	15.07-15.22m	Sandstone	51.7	47.6	Diametral Axial	2.36 2.07	2.40 2.18
56494	17.0-17.16m	Sandstone	51.7	44.7	Diametral Axial	0.73 0.92	0.74 0.95
56495	18.0-18.15m	Sandstone	51.7	43.1	Diametral Axial	1.31 1.23	1.33 1.27
56496	19.05-19.24m	Sandstone	51.7	*	Diametral Axial	1.06 *	1.07 *

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled by: Client

Job Number: 174-012

Date Tested: 4.02.10

Test method: AS 4133.4.1 2007

* Unable to test axial due to failure type.

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

Signed: Name: Chris Lloyd

Title: Manager Date: 5.02.10

AUSTRALIAN SOIL TESTING PTY LTD. A.B.N. 79 003 493 623
24 Bermill Street, Rockdale, NSW, 2216 P.O. Box 2014, Rockdale D.C. NSW 2216
Tel: 9597 5599, 9597 3286 Fax: 9597 3442 Email: austst@bigpond.com

POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: **Geo Environmental Engineering**
275a Stoney Creek Road, Kingsgrove NSW 2208

PROJECT: **Wollongong Private Hospital Project No: G10002 TPG**

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH
			DIAM	HEIGHT			
	BH 2		(mm)	(mm)		Is (MPa)	Is $_{(50)}$ (MPa)
56589	12.74-12.88m	Sandstone	51	34	Diametral Axial	0.25 0.54	0.26 0.53
56590	13.83-13.93m	Sandstone	52	40	Diametral Axial	4.80 4.05	4.89 4.10
56591	17.11-17.23m	Sandstone	52	46	Diametral Axial	0.10 0.33	0.11 0.35
56592	17.68-17.85m	Sandstone	52	*	Diametral Axial	0.18 *	0.18 *
56593	18.30-18.42m	Sandstone	52	35	Diametral Axial	0.13 0.32	0.13 0.31
56594	20.0-20.2m	Sandstone	52	44	Diametral Axial	2.31 3.19	2.35 3.30
56595	6.28-6.48m	Sansstone	52	*	Diametral Axial	1.69 *	1.72 *
56598	19.00-19.22m	Sandstone	52	*	Diametral Axial	0.67 *	0.68 *

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled by: Client

Job Number: 174-012

Date Tested: 8.02.10

Test method: AS 4133.4.1 2007

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

Signed: Name: Chris Lloyd

Title: Manager Date: 10.02.10

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POINT LOAD STRENGTH INDEX TEST REPORT

CLIENT: **Geo Environmental Engineering**
275a Stoney Creek Road, Kingsgrove NSW 2208

PROJECT: **Wollongong Private Hospital Project No: G10002 TPG**

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH
			DIAM	HEIGHT			
	BH 2		(mm)	(mm)		Is (MPa)	$Is_{(50)}$ (MPa)
56581	5.0-5.14m	Sandstone	52	35	Diametral Axial	0.24 0.52	0.25 0.51
56582	7.16-7.32m	Sandstone	52	40	Diametral Axial	4.50 4.05	4.58 4.10
56583	8.19-8.30m	Sandstone	52	38	Diametral Axial	0.10 0.41	0.11 0.41
56584	8.55-8.65m	Sandstone	52	38	Diametral Axial	0.18 0.39	0.18 0.39
56585	9.77-9.89m	Sandstone	52	35	Diametral Axial	0.13 0.32	0.13 0.31
56587	10.50-10.62m	Sandstone	52	47	Diametral Axial	1.35 1.32	1.38 1.39
56588	11.84-12.00m	Sandstone	51	34	Diametral Axial	0.34 0.11	0.34 0.11

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled by: Client

Job Number: 174-012

Date Tested: 08.02.10

Test method: AS 4133.4.1 2007

Form R04 File C:\Excel Reports\Point Load Strength Index Issue 4 September 2001 CWS

Signed: Name: Chris Lloyd

Title: Lab Manager Date: 10.02.10