REPORT

TO

COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED INDUSTRIAL DEVELOPMENT

AT

24 MUIR ROAD, CHULLORA, NSW

24 February 2010

Ref: 23692Zrpt2

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1 INTRODUCTION

This report presents the results of a geotechnical investigation undertaken for the proposed industrial development at 24 Muir Road, Chullora, NSW. The investigation was commissioned in two stages by Mr Daniel Galea of Commercial & Industrial Property Pty Ltd (CIP). The initial commission was on the basis of our proposal (Ref: P31864Zemail2) dated 13 January 2010, but with some adjustments to the number of boreholes and depths of drilling with a subsequent commission based on our proposal (Ref: P23692Zemail) dated 8 February 2010. This report confirms and amplifies our geotechnical report dated 12 February 2010.

Based on the provided site plan (Ref: 2-14-004-MR-FS-06-002, Rev A) and discussions with CIP, we understand that a 15,000m^2 warehouse with adjacent three storey office building and associated hardstand, driveways and parking areas are proposed. The warehouse will be a cladded structural steel building, whilst the office building will be of reinforced concrete framed construction. Maximum column loads of 500kN and 1,400kN have been estimated by CIP for the warehouse and office buildings respectively. Bulk earthworks will be carried out and maximum cut depths and fill heights of 4m and 3.5m respectively, will be required to achieve the earthworks platform reduced level (RL) at 39m.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions as a basis for comments and recommendations on earthworks, retaining walls, footings, on-grade floor slabs and pavements.

2 INVESTIGATION PROCEDURE

The fieldwork for the investigation comprised the auger drilling of 20 boreholes (BH1 to BH19 and BH21) to depths between 4.5m and 13.5m, using our track mounted JK300 rig and our truck mounted JK500 rig. We note that BH20 was not drilled. The borehole locations, as indicated on attached Figure 1, were set out using measuring wheel and compass techniques from apparent site boundaries, and were electromagnetically scanned for buried services prior to drilling commencing. The surface RLs at the borehole locations, were estimated by interpolation between spot heights and ground contours, indicated on the provided survey plan (Ref: 74014, dated 19/1/2010) prepared by Rygate & Company Pty Ltd, and are therefore approximate. The survey datum is the Australian Height Datum (AHD).

The nature and composition of the subsurface soils and rocks were assessed by logging the materials recovered during drilling. The relative compaction/strength of the subsoils was assessed by interpretation of the Standard Penetration Test (SPT) 'N' value, augmented by hand penetrometer readings on clay samples recovered in the SPT split tube sampler. The strength of the underlying bedrock was assessed by observation of drilling resistance when using a tungsten carbide (TC) bit, examination of the recovered rock chip samples, and subsequent correlation with laboratory moisture content testing. Insitu borehole infiltration tests were carried out in BH10 and BH11. Groundwater observations were made during and on completion of drilling individual boreholes. Longer term groundwater monitoring was not carried out. However, slotted PVC standpipes were installed into BH5 and BH21 to allow for future groundwater monitoring by others. For further details on the investigation procedure adopted, reference should be made to the attached Report Explanation Notes.

Our geotechnical engineers were present full time on site during the fieldwork and set out the borehole locations, directed electromagnetic scanning, nominated sampling and testing, and logged the subsurface profile. The borehole logs are presented with this report together with a glossary of logging terms and symbols used.

Selected soil and rock chip samples were recovered from site and submitted to a NATA registered laboratory (Soil Test Services Pty Ltd) for moisture content, Atterberg Limit, linear shrinkage, Emerson Class Number, Standard compaction and four-day soaked CBR testing. The laboratory test results are presented in attached Tables A, B and C. Soil samples were also submitted to the NATA registered Envirolab Services for soil pH, chloride and sulphate analyses. These results are summarised in Table D. An environmental investigation of the site had previously been carried out by others.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located in gently undulating topography, covers an area of about 64,000m^2, and has a southern frontage onto Muir Road.

The site itself comprises a shallow east to west trending spur, which grades down to the north, north-east and south-east, at between 2° and 10°. At the time of the investigation, the site was vacant and grass covered with scattered small shrubs.

Just beyond the northern and western site boundaries was a goods train track. Along the east and south-east was a tree lined driveway, and beyond the driveway some 100m to the south-east, was a large industrial type building. To the north-east, ground levels sloped steeply down to a dam/pond which was located some

50m from the site boundary. Erosion rills and sink holes were evident in the area just within the northern site boundary.

3.2 Subsurface Conditions

The published 1:100,000 geological map of Sydney indicates that the site is underlain by Bringelly Shales. The investigation has revealed a generalised subsurface profile comprising a variable thickness of fill over residual silty clays, with weathered shale bedrock present at shallow and moderate depth. For detailed subsurface conditions at specific locations, reference should be made to the attached borehole logs. A graphical borehole summary is presented in Figure 2 and a summary of the subsurface conditions as encountered is presented below:

- Fill comprising medium and high plasticity silty clay with igneous, ironstone and shale gravel, and slag inclusions, was encountered from the surface of all boreholes, and extended to depths between 0.4m (BH5) and 7.5m (BH3). The fill was generally assessed to be well compacted based on the SPT results, with some areas of moderate compaction.
- Residual silty clay was encountered below the fill in all boreholes, except BH3 and BH4. The silty clays were generally of medium to high plasticity and very stiff to hard strength. However, some firm or stiff silty clays were also encountered, and sandy clays were encountered in BH5 and BH6.
- Weathered shale bedrock was encountered in all boreholes at depths between 2.6m (BH5) and 11.8m (BH10). The shale on first contact was generally of extremely low strength and improved to very low or low to medium strength with depth.
- Most of the boreholes were ‘dry’ on completion of drilling. However, a groundwater level was encountered at 7.9m on completion of drilling BH3, at 7.6m on completion of drilling BH9, at 9.4m on completion of drilling BH13, at

10.2m on completion of drilling BH14, at 8.4m on completion of drilling BH18, at 10.5m on completion of drilling BH19, and at 4.5m on completion of drilling BH21. A groundwater level was measured at a depth of 8m approximately 1.5 hours after completion of drilling BH13, 7.2m approximately 2.25 hours after completion of drilling BH14, 6.4m approximately 3.25 hours after completion of drilling BH18, and 6.1m approximately 5.25 hours after completion of drilling BH19. We note that the groundwater levels may not have stabilised during the limited observation period. Longer term groundwater monitoring was not carried out.

3.3 Laboratory Test Results

The moisture content and Atterberg Limit test results have confirmed our field assessed soil classification properties. The linear shrinkage and plasticity index results indicate that the silty clay fill and residual soils have moderate and high shrink-swell reactivities.

The Emerson Class Numbers indicate that the two silty clay fill samples from BH17 are highly and non dispersive, respectively.

The four-day soaked CBR testing on the sampled silty clay fill returned results between 2.5% and 6%. It is likely that the testing was affected by the gravel content in the fill. The insitu moisture content of the samples was generally 'drier' than their respective Standard Optimum Moisture Contents.

The moisture content of the rock chip samples correlated reasonably well with our field assessed rock strengths.

The soil chemical results indicated near neutral pH with low sulphate and chloride contents.

3.4 Borehole Infiltration Testing

Modified falling head infiltration tests were conducted over the upper 1.5m of the soil profile adjacent to BH10 and BH11, to estimate the mass permeability of the subsoils. The standpipes were filled with water and the rate of falling water level recorded. Using established seepage formulae, an approximate insitu permeability coefficient for the subsoil was calculated. The analysis indicated a low permeability for the soils with a calculated coefficient of permeability of $4x10^{-7}m/sec$.

4 COMMENTS AND RECOMMENDATIONS

4.1 Earthworks

The comments and recommendations which follow should be supplemented by reference to AS3798.

4.1.1 Subgrade Preparation

Stripping of Vegetation and Topsoil

Subgrade preparation will require the stripping of all vegetation as well as root affected soil (topsoil) down to nominal depths of around 0.15m. We note that it is difficult to estimate the topsoil depth within a 80mm diameter borehole. Should the stripping of topsoil be a significant contractual issue, then we recommend that a number of test pits be excavated to more accurately estimate the topsoil depth. Alternatively, a geotechnical engineer can be present during the stripping process to confirm the topsoil thickness and to reduce unnecessary stripping depths.

Existing Fill

Following the above stripping, the site will expose an overlay of fill which varies considerably in depth across the site. Based on the SPT tests within the fill, it appears that it has generally been effectively compacted. However, the SPT tests do not give a precise determination of insitu densities since they are affected by friction during driving, the presence of gravel within the fill, and the moisture content of the fill. Nevertheless, the SPT tests provide a qualitative guide. We therefore expect that the site was originally compacted, although its uniformity and extent is a little uncertain. We recommend you obtain the earthworks control testing records to satisfy yourself that the fill compaction was undertaken in an appropriate manner with conforming density tests. If there are no records of earthworks control testing, then this obviously places some doubt on the integrity of the fill. On the basis of our investigation, it would appear that the fill is adequate to support pavement and on-grade floor slab loads as well as concentrated building loads, associated with a flexible building. Heavy concentrated building loads, for example, for the office block founded directly in the fill, are not recommended.

Excavation

The site must be excavated to suit the design subgrade levels for the development (refer to Section 4.2 below). Bulk excavations to a maximum depth of approximately 4m will be concentrated over the western portion of the site and, based on the investigation results, will encounter the soil profile and will extend into the underlying weathered shale bedrock.

Proof-Rolling

The exposed subgrade at design level should be proof-rolled using a 10 tonne minimum, dead-weight, smooth drum vibratory roller. Proof-rolling should be carried out under the direction of an experienced earthworks superintendent or geotechnical engineer, to assist in the detection of unstable areas which were not disclosed by this investigation. Any unstable areas identified during proof-rolling should be locally excavated down to a competent base and replaced with engineered fill, as described in Section 4.1.2 below. Where shrinkage cracking is exposed, the subgrade should be moistened and rolled until the shrinkage cracks are no longer visible.

Other Issues

Over the extreme north-eastern portion of the site, excessive erosion as well as sinkholes, were observed. We recommend that this area be investigated to identify the cause of the erosion. It is possible that the buried sewer in this area is leaking with the result that erosion into the pipe is occurring. Alternatively, subsoil erosion towards the existing detention ponds may be taking place. We note the highly dispersive nature of the upper fill horizons in this area, as indicated by the laboratory Emerson Class Number.

4.1.2 Engineered Fill

The existing silty clays may be reused as engineered fill, provided unsuitable ('over-wet' and 'over-size') material and any organics or building rubble are excluded. The fill for earthworks platforms should be compacted in layers of not greater than 200mm loose thickness to a density strictly between 98% and 102% of Standard Maximum Dry Density (SMDD) and within 2% of Standard Optimum Moisture Content (SOMC). Some moisture conditioning will probably be required as the insitu moisture content of the upper clay fill, as shown by the laboratory testing, was more than 2% dry of SOMC.

All compacted fill should be retained or, alternatively, battered to a permanent slope no steeper than 1 Vertical (V) in 2 Horizontal (H), and possibly flatter to facilitate maintenance. Given that dispersive soils are present, all permanently exposed fill batters should be protected from erosion by quickly establishing a grass cover, or by structural means (eg. shotcrete, stone pitching, etc). For batters greater than 1.5m vertical height, stormwater drains should be provided at the toe and the crest to collect surface runoff and direct it to the stormwater system.

4.1.3 Density Testing

Density testing of placed fill should be carried out at a frequency of at least one test per fill layer per 1,000m^2, or three tests per layer per visit, whichever requires the most tests. At least Level 2 testing of earthworks should be carried out in accordance with AS3798. However, if the proposed warehouse building will be founded directly in the fill, then we recommend Level 1 testing be carried out. Preferably the Geotechnical Testing Authority should be engaged directly on behalf of the client and not as part of the earthworks contract.

4.1.4 Site Drainage

The clay subgrade may soften with an increase in moisture content, as evidenced by the relatively low four day soaked CBR values. Dispersive soils are also present. Therefore, good and effective site drainage should be provided both during construction and for long term site maintenance. Earthworks platforms should be graded to maintain crossfalls during construction. The principle aim of drainage is to promote runoff and reduce ponding. A poorly drained subgrade may become untrafficable when wet. We recommend that if soil softening occurs, the subgrade be over-excavated to below the depth of moisture softening, and that the excavated material be replaced with engineered fill as specified above. The earthworks should be carefully planned and scheduled to avoid breaks for holidays during construction, etc.

4.2 Excavation Conditions

Excavations to achieve the design subgrade level of the development will be required to maximum depths of approximately 4m over the western portion of the site. Such excavations will encounter the soil profile and extend locally into the underlying weathered shale bedrock.

The soil cover should be readily excavatable using conventional earthworks equipment (such as hydraulic excavators, dozers, etc). Some of the underlying weathered shale of extremely and very low strength may also be excavated by a large bucket excavator, possibly with some ripping. However, we expect excavation of medium and higher strength shale would be most effectively excavated using a Caterpillar D8 dozer. A ripping hook on a 40 tonne excavator would also be an effective method for at least some of the work.

We would expect some groundwater seepage flows will occur from the base of the fill, at the soil-rock interface and through joints and bedding planes within the completed cut faces, particularly after periods of heavy rain. Seepage, if any, during excavation is expected to be satisfactorily controlled by conventional sump pumping or gravity drainage systems.

We recommend that groundwater seepage into the excavation be monitored by site personnel, and the results (source, location, quantity, etc) be provided to the hydraulic and geotechnical engineers, so that any unexpected conditions can be timeously addressed.

4.3 Excavation Batters

Where space permits, excavations in the soil and extremely weathered shale profiles may be temporarily battered to a side slope no steeper than 1V in 1H. For depths deeper than approximately 3m, the batter should be flattened to 1V in 1.5H. Possible seepage from the batters may cause localised instability, and allowance should be made for sand bagging.

We expect that good quality shale bedrock of low to medium and higher strength may be cut vertically. However, localised stabilisation measures may be necessary if adverse defects (such as inclined joints or bedding) are found. Treatment for zones requiring stabilisation may include rock bolting, shotcreting, underpinning, etc. We therefore recommend that the rock face be progressively inspected by a geotechnical engineer as excavation proceeds, to identify adverse defects and proposed appropriate stabilisation measures.

Retaining walls may be constructed at the toe of the batters and subsequently backfilled.

4.4 Retaining Walls

The major consideration in the selection of earth pressures for the design of retaining walls is the need to limit deformations occurring outside the excavations. The following characteristic earth pressure coefficients and subsoil parameters may be adopted for the design of temporary or permanent retention systems:

- Conventional free-standing cantilever walls which support areas where movement is of little concern (ie. where gardens or open areas are being retained), should be designed using a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient, K_a, of 0.3, for the soil profile and extremely weathered shale bedrock, assuming a horizontal retained surface.

- Cantilever walls, the tops of which will be restrained by the permanent structure or which support movement sensitive elements, should be designed using a triangular lateral earth pressure distribution and an 'at rest' earth pressure coefficient, K_o, of 0.55, for the soil profile and extremely weathered shale bedrock, assuming a horizontal backfill surface.
- A bulk unit weight of 20kN/m^3 should be adopted for the soil profile and extremely weathered shale bedrock.
- Any surcharge affecting the walls (eg. traffic loading, construction loads, nearby high level footings, etc) should be taken into account in the wall design using the appropriate earth pressure coefficient from above.
- The retaining walls should be designed as drained and measures taken to provide complete and permanent drainage of the ground behind the walls. Subsurface drains should incorporate a non-woven geotextile fabric (eg. Bidim A34) to act as a filter against subsoil erosion.
- Lateral toe restraint may be achieved by keying the wall footing into shale bedrock below bulk excavation level. An allowable lateral stress of 150kPa may be adopted for key design, subject to inspection by a geotechnical engineer. Alternatively, lateral restraint may be provided by the ground in front of the wall. A triangular lateral earth pressure distribution should be used with a 'passive' earth pressure coefficient, K_p, of 3, assuming horizontal ground in front of the walls. We note that significant movement is required in order to mobilise the full passive resistance of the soil, and we therefore recommend that factor of safety of 2 be adopted in order to reduce such deflections. The upper 0.3m below bulk excavation level should be ignored in the above analyses to take excavation tolerances into account. Any excavations in front

of the walls (such as for footings, buried services, etc) should also be taken into account in the wall design.

4.5 Footings

4.5.1 Site Classification

Due to the depth of existing fill across the site, a Class 'P' is applicable in accordance with AS2870. As indicated in Section 4.1.1 above, the fill as placed cannot be confirmed as being 'controlled' fill and this reclassification is not possible.

4.5.2 Warehouse

The proposed warehouse structure may be supported by high level footings founded in the existing and proposed fill, provided the movements associated with settlement and shrink-swell, can be safely accommodated. Footings founded in the existing or proposed fill (which is compacted under Level 1 testing), may be designed using an allowable bearing pressure of 150kPa. We estimate that a 1.2m wide footing founded in the silty clay fill as above, will undergo approximately 5mm of settlement. However, should the founding material become wet due, for example, to excessive surface water infiltration or a leaking pipe, then the above settlement could double in magnitude. This latter settlement is likely to be localised.

We further note that the silty clays, both fill and residual, have a moderate and high shrink-swell reactivity. Typical surface shrink-swell movements associated with the residual clays and existing fill which has been placed more than five years ago, would be of the order of 40mm, whilst those associated with recently placed engineered fill may be as high as 60mm. The proposed warehouse structure must therefore be designed to accommodate the above movements, if founded using high level footings. The effects of differential movements associated with the reactive underlying silty clays, would be minimised if the paving extends around the entire perimeter of the warehouse. In any event, planters or garden areas adjacent to the building must be avoided.

4.5.3 Office Building

We recommend that the proposed office building be supported using pile footings which are founded in the underlying shale bedrock. Given the subsoil conditions encountered, suitable pile types include conventional bored piles. Such piles founded at least 0.3m into the underlying shale bedrock, may be designed for an allowable end bearing pressure of 700kPa. In addition, an allowable shaft adhesion of 70kPa (in compression) may be applied to that length of rock socket in excess of 0.3m into the underlying shale bedrock. The above side adhesion value should be halved in the case where tension or uplift is being resisted.

In the area of the office building, shale bedrock was encountered at depths between about 9m and 11m below existing ground level (ie. between about RL28m and RL33m).

We recommend that high level footing excavations and the initial pile drilling be witnessed by a geotechnical engineer to confirm that adequate founding has been achieved and to reduce unnecessary drilling depths into the underlying shale bedrock.

4.5.4 Footing Construction

We recommend that high level footings be excavated, cleaned, inspected and poured with minimal delay to avoid deterioration. If delays in pouring concrete are anticipated, we recommend that the base of the footings be protected with a blinding layer of concrete.

Water should be prevented from ponding in the base of footings as this will tend to soften the foundation material, resulting in further excavation and cleaning being required.

Some groundwater inflow would be expected into bored pile excavations, and we expect that this inflow would be controllable by conventional pumping methods. The bored piles should be drilled, cleaned, inspected and poured with minimal delay (ie. on the same day).

4.6 On-Grade Floor Slab

Slab-on-grade construction is feasible for the proposed warehouse, provided the subgrade has been prepared in accordance with recommendations described in Section 4.1 above. The on-grade floor slab should be designed using a CBR value of 3.5%, or a long term Young's Modulus of 15MPa. We note that we have recommended a CBR value that is lower than most of the laboratory test results, as it is probable that the testing was affected by scale factors presented by the gravels which are present in the fill.

The on-grade floor slab should be isolated from the wall footings to allow for shrink-swell movements in the underlying clays. Joints in the concrete on-grade floor slab should be designed to accommodate shear forces but not bending moments by using dowelled or keyed joints.

The detailing of the ground floor slab within the office building, as a slab-on-grade which can accommodate the shrink-swell movements of the underlying clays, as well as the relative movements associated with a piled structure, is extremely difficult. We therefore recommend that the ground floor slab to the office be designed as suspended and poured over a void former at least 50mm thick.

4.7 Pavements

The design of hardstand, driveways and parking areas will depend on subgrade preparation, subgrade drainage, and the nature and composition of new fill imported to the site, as well as vehicular loadings and use. Based on the soaked CBR test results and provided subgrade preparation is carried out as described in Section 4.1 above, we recommend that the design of pavements be based on a CBR value of 3.5%, or a short term Young's Modulus of 23MPa.

Improvement of the subgrade CBR design value and consequent reduction of the crushed rock pavement thickness, may be achieved by stabilising the clay subgrade with lime to a minimum depth of 400mm. To determine the optimum lime addition rate to achieve the beneficial effect desired, laboratory tests should be carried out. However, in indicative proportion to achieve a CBR of 6% would probably be the addition of 4% of quick lime by dry weight of the clay. The lime must be thoroughly mixed with a clay using specialist blending machines and then compacted to not less than 98% SMDD and within 2% of SMOC.

Concrete pavements should be supported on a subbase layer of RTA 3051 Specification unbound or equivalent good quality crushed rock, compacted to a density of at least 100% SMDD. The subbase material would provide more uniform slab support and would reduce 'pumping' or subgrade 'fines' at joints. Concrete pavements should be provided with effective shear connection at joints by using dowels or keys.

Subsoil drains should be provided along the perimeter of pavements with inverts not less than 0.2m below clay subgrade level. The drainage trench should be excavated with a longitudinal fall to appropriate discharge points, so as to reduce the risk of water ponding. The pavement subgrade should be graded to promote water flow or infiltration towards the subsoil drains.

4.8 Infiltration Trenches

Based on the borehole infiltration tests, a relatively low coefficient of permeability of 4×10^{-7}m/sec has been determined for the clays, as would be expected. An infiltration rate of 5H litres/hour/m^2 should be assumed, where 'H' is the water head in metres within the system, assuming that groundwater flows vertically from the base of the trench only.

4.9 Soil Aggression

The soil pH, sulphate and chloride test results indicate a non aggressive exposure classification for concrete and steel in soil, in accordance with AS2159.

4.10 Further Geotechnical Input

The following summarises the further geotechnical input which is required and which has been previously detailed in the preceding sections of this report:

- Topsoil investigation/inspection, if appropriate.
- Direction of proof-rolling.
- Compaction testing of engineered fill.
- Monitoring of groundwater seepage into excavations.
- Geotechnical footing inspections.
- Geotechnical inspection of cut rock faces.

- Density testing of pavement subbase.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Jeffery and Katauskas Pty Ltd accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. If the natural soil has been stockpiled, classification of this soil as Excavated Natural Material (ENM) can also be undertaken, if requested. However, the criteria for ENM are more stringent and the cost associated with attempting to meet these criteria may be significant. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

For and on behalf of
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SOIL TEST SERVICES
ABN 43 002 145 173

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TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
2	4.50-4.80	15.4				
3	4.50-4.95	18.7	47	18	29	14.0
3	8.50-9.00	8.1				
6	1.50-1.95	16.6	41	16	25	13.0
6	4.50-4.55	8.9				
6	5.50-6.00	4.0				
9	10.00-10.50	10.1				
10	1.50-1.95	15.2	45	16	29	14.5
13	10.00-10.50	2.2				
15	1.50-1.95	16.0	47	17	30	15.0
15	11.50-12.00	7.1				
17	4.50-4.95	27.8	59	22	37	17.0

Notes:

- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions

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TABLE B
SUMMARY OF FOUR DAY SOAKED C.B.R.TEST RESULTS

BOREHOLE NUMBER	4	5	9	21
DEPTH (m)	0.30 - 1.00	0.40 - 1.00	0.20 - 1.00	0.30 - 1.00
Surcharge (kg)	9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)	1.762 STD	1.617 STD	1.780 STD	1.813 STD
Optimum Moisture Content (%)	15.1	21.9	13.4	14.1
Moulded Dry Density (t/m^3)	1.73	1.59	1.75	1.78
Sample Density Ratio (%)	98	98	98	98
Sample Moisture Ratio (%)	102	99	99	101
Moisture Contents				
Insitu (%)	13.0	20.3	8.3	12.3
Moulded (%)	15.3	21.7	13.2	14.3
After soaking and After Test, Top 30mm(%)	17.2	28.0	16.8	15.2
Remaining Depth (%)	15.3	23.3	15.2	14.5
Material Retained on 19mm Sieve (%)	0	0	0	0
Swell (%)	1.0	1.5	1.5	0.5
C.[illegible] value: @5.0mm penetration	5	2.5	4.5	6

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1

Approved Signatory
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Date: 10/12/10

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TABLE C
SUMMARY OF EMERSON CLASS NUMBER TEST RESULTS

BOREHOLE NUMBER	DEPTH (m)	Air dried soil crumbs in water	Remoulded soil samples in water	Calcite or Gypsum present/ absent	1: 5 Soil/Water Suspension	Emerson Class Number
17	0.50-0.95	Slaking (Complete Dispersion)	na	na	na	1
17	1.50-1.95	Slaking (No Dispersion)	no dispersion	absent	flocculation	6

NOTES:

- The lowest Emerson Class Number refers to the highest dispersion potential(Range: Class 1 to Class 8)
- Test Method: AS 1289 3.8.1-1997
- All contact water was distilled water, water temperature was between 22 & 23°C
- Vigorous Shaking causes Dispersion/Flocculation
- Refer to appropriate Borehole logs for soil descriptions
- na denotes not applicable

NATA
NATA Accredited Laboratory
Number:1327

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Approved Signatory
(A Tatikonda)

Date: 10/2/10

Miscellaneous Inorg - soil			
Our Reference:	UNITS	37601-1	37601-2
Your Reference	-------------	BH15	BH21
Depth	------------	0.5-0.95	0.3-3.45
Date Sampled		22/01/2010	22/01/2010
Type of sample		Soil	Soil
Date prepared	-	9/02/2010	9/02/2010
Date analysed	-	9/02/2010	9/02/2010
pH 1:5 soil:water	pH Units	7.7	6.3
Chloride, Cl 1:5 soil:water	mg/kg	95	250
Sulphate, SO4 1:5 soil:water	mg/kg	160	160

TABLE D

Envirolab Reference: 37601

NATA
ACCREDITED FOR
TECHNICAL
COMPETENCE

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1
1/1

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 17-2-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: J.M.K./
R.L. Surface: ≈ 41.3m
Datum: AHD

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION						0	▩		FILL: Silty clay, medium plasticity, dark brown, with fine to coarse grained ironstone and igneous gravel, and fine to medium grained sandstone gravel.	MC≈PL			APPEARS WELL COMPACTED
				■	N = 21 7,9,12		▩						
						1	▩						
				■	N = 15 5,8,7		▩		FILL: Silty clay, medium to high plasticity, dark brown, brown, grey and orange brown, with fine to medium grained ironstone gravel, and a trace of slag.				
						2	▨	CL	SILTY CLAY: medium plasticity, light grey and brown, with XW shale bands and a trace of root fibres.	MC>PL	(VSt)	-	
				■	N = 27 10,13,14	3	▨			MC<PL	H	440 430 530	
							▤	-	SHALE: grey brown, with iron indurated bands.	DW	L-M	-	LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS
				■		4	▤						
						5	▤						
				■			▤						
						6			END OF BOREHOLE AT 6.0m				
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
2
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 39.8m
Datum: AHD

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION				■	N = 16 7,9,7	0	▨		FILL: Silty clay, medium plasticity, brown, with root fibres and a trace of fine to coarse grained angular and sub angular igneous and ironstone gravel and ash.	MC≤PL			GRASS COVER
				■	N = 11 4,5,6	1 2	▨		FILL: Silty clay, high plasticity, brown grey, light brown and orange brown, with a trace of fine to coarse grained angular and sub angular igneous, shale and ironstone gravel, ash and slag.	MC>PL			APPEARS WELL COMPACTED
				■	N = 13 3,5,8	3	▧	CL-CH	SILTY CLAY: medium to high plasticity, light grey mottled red brown, with a trace of fine to medium grained angular and sub angular ironstone gravel.	MC>PL	H	- 450 500 520	
				■	N > 16 7,16/150mm REFUSAL	4	▧		SILTY CLAY: medium to high plasticity, light grey, with fine to coarse grained angular and sub angular ironstone gravel bands.		VSt-H	250 450 550	
				■		5 6 7	☰	-	SHALE: grey and brown, with iron indurated and clay bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE

BOREHOLE LOG

Borehole No.
2
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 39.8m
Datum: AHD

undwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■			▤		SHALE: grey and brown, with iron indurated and clay bands.	XW-DW	EL-VL		LOW RESISTANCE
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
3
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 38.2m
Datum: AHD

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■	N = 21 6,10,11	0	▨		FILL: Silty clay, low plasticity, brown, with root fibres and fine to coarse grained angular and sub angular igneous, shale and ironstone gravel, and a trace of ash, slag and fine to medium grained sand.	MC<PL			GRASS COVER
				■	SPT 12/100mm REFUSAL	1 2	▨		as above, but medium plasticity.	MC≈PL			
				■	N = 11 4,4,7	3	▨		FILL: Silty clay, high plasticity, brown grey and light brown, with a trace of slag, ash, fine to medium grained angular and sub angular igneous, ironstone, shale and sandstone gravel.	MC>PL		210 190 250	APPEARS WELL COMPACTED
						4	▨		as above, but with a trace of timber fragments and china fragments.				
				■	N = 15 5,6,9	5	▨		FILL: Silty clay, medium plasticity, grey, brown and light brown, with a trace of ash, slag, fine to medium grained sand and fine to medium grained angular and sub angular igneous, shale and ironstone gravel.			300 310 290	
				■	N = 10 4,5,5	6 7	▨		FILL: Silty clay, high plasticity, grey and yellow brown, with a trace of ash, fine to medium grained angular to sub angular igneous, ironstone and shale gravel.			160 200 190	

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
3
2/2

BOREHOLE LOG

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
R.L. Surface: ≈ 38.2m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
									FILL: Silty clay, high plasticity, grey and yellow brown, with a trace of ash, fine to medium grained angular to sub angular igneous, ironstone and shale gravel.	MC>PL			
ON COMPLETION					SPT 10/100mm REFUSAL	8		-	SHALE: grey brown, with iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
										DW	L		LOW RESISTANCE
						9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

BOREHOLE LOG

Borehole No.
4
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 36.6m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	ES	U50	DB	DS	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0		FILL: Silty clay, low plasticity, brown, with fine to coarse grained angular and sub angular igneous gravel, root fibres and a trace of brick and concrete fragments.	MC<PL			GRASS COVER
			■		SPT 12/50mm REFUSAL				MC≥PL			APPEARS WELL COMPACTED
						1		FILL: Silty clay, medium plasticity, brown, with a trace of fine to medium grained angular to sub angular igneous, shale and ironstone gravel, fine to medium grained sand, ash and slag.				
					SPT 9/50mm REFUSAL	2		FILL: Silty clay, medium to high plasticity, grey and brown, with a trace of fine to medium grained angular and sub angular igneous, shale and ironstone gravel, woodchips, ash and slag.	MC>PL			
				■	N = 19 7,8,9	3					290 340 390	
				■	SPT 10/100mm REFUSAL	4	-	SHALE: brown and grey, with iron indurated bands.	XW-DW	EL-VL	-	VERY LOW 'TC' BIT RESISTANCE
				■		5			DW	L		LOW TO MODERATE RESISTANCE
						6		SHALE: dark grey.	SW	L-M		
						7						

BOREHOLE LOG

Borehole No.
4
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 36.6m
Datum: AHD

undwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
				■			▤		SHALE: dark grey.	SW	L-M		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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Borehole No.
5
1/1

BOREHOLE LOG

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 25-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 42.4m
Datum: AHD

oundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low plasticity, brown, with root fibres and a trace of fine to coarse grained angular and sub angular igneous gravel.	MC<PL			GRASS COVER
			■		N = 10 4,6,4	1		CH	SILTY CLAY: high plasticity, light grey, red brown and orange brown, with a trace of fine to medium grained angular and sub angular ironstone gravel.	MC>PL	VSt	240 290 300 260	
				■	N = 21 4,9,12	2		CL	SANDY CLAY: low to medium plasticity, light grey, with fine to medium grained angular and sub angular ironstone gravel bands.	MC<PL	H	>600 >600	
				■		3		-	SHALE: brown.	XW-DW	EL-VL	-	VERY LOW 'TC' BIT RESISTANCE
				■		4				DW	L		LOW RESISTANCE
						5 6 7			END OF BOREHOLE AT 4.5m				50mm DIA. PVC STANDPIPE INSTALLED TO 4.5m DEPTH, SLOTTED BOTTON 3m

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BOREHOLE LOG

Borehole No.
6
1/1

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 20-1-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 42.5m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, low to medium plasticity, light brown, with root fibres and fine to coarse grained angular and sub angular igneous, sandstone and ironstone gravel and occasional cobble sized.	MC≤PL			GRASS COVER
						1			FILL: Silty clay, medium plasticity, brown, with a trace of fine to medium grained angular and sub angular shale, ironstone and igneous gravel, glass and slag fragments.	MC≥PL			APPEARS MODERATELY TO WELL COMPACTED
				■	N = 10 5,5,5							380 480 360	
						2		CL	SANDY CLAY: low plasticity, light grey and orange brown, with ironstone gravel bands and XW sandstone seams.	MC≤PL	(St)	-	
				■	N > 10 15,10/ 50mm REFUSAL	3							
								-	SHALE: grey.	XW-DW	EL-VL	-	VERY LOW 'TC' BIT RESISTANCE
				■	SPT 20/50mm REFUSAL	4							
				■		5			SHALE: grey, with iron indurated bands.	DW	L-M		LOW RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
7
1/1

BOREHOLE LOG

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 17-2-10
Method: SPIRAL AUGER
JK500
R.L. Surface: ≈ 41.0m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION & AFTER 1 HR						0			FILL: Silty clay, medium plasticity, dark brown, with fine to coarse grained ironstone and shale gravel, and fine to medium grained sandstone gravel.	MC<PL			APPEARS WELL COMPACTED
				■	SPT 15/130mm REFUSAL								
						1							
				■	N = 17 6,7,10				as above, but dark brown, brown and dark grey, with a trace of root fibres.				
						2							
				■	N = 21 7,10,11	3							
								CH	SILTY CLAY: high plasticity, red brown, light brown and grey, with a trace of fine to grained ironstone gravel and root fibres.	MC>PL	VSt-H	420 350 520	
						4							
				■				-	SHALE: dark grey and brown, with iron indurated bands.	DW	L-M		LOW TO MODERATE 'TC' BIT RESISTANCE
						5							
				■							M		MODERATE RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
8
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 17-2-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 40.0m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION & AFTER 2 HRS 15 MINS						0			FILL: Silty clay, medium plasticity, brown, grey and light brown, with fine to medium grained ironstone and shale gravel, with a trace of root fibres.	MC<PL			APPEARS WELL COMPACTED
				■	N = 31 11,13,18								
						1							
				■	N = 35 10,15,20				FILL: Silty clay, medium to high plasticity, brown, light brown, grey and orange brown, with fine to medium grained ironstone gravel.	MC≈PL			
						2							
				■	N = 30 8,12,18	3			as above, but with a trace of root fibres.				
						4		CH	SILTY CLAY: high plasticity, light grey mottled red brown, with a trace of root fibres.	MC>PL	VSt	-	
				■	N = 13 4,5,8							280 240 340	
						5							
				■				-	SHALE: brown, with iron indurated bands.	DW	VL-L		
						6			SHALE: light grey and grey brown, with iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
8
2/2

BOREHOLE LOG

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 17-2-10
Method: SPIRAL AUGER
JK500
R.L. Surface: ≈ 40.0m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■			▤		SHALE: grey and orange brown, with iron indurated bands.	XW	EL		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

BOREHOLE LOG

Borehole No.
9
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 25-1-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 38.6m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			■			0			FILL: Silty clay, low plasticity, brown, with root fibres and a trace of fine to coarse grained angular to sub angular igneous gravel and fine to medium grained sand, brick and concrete fragments.	MC<PL			GRASS COVER APPEARS WELL COMPACTED
						1							
									FILL: Silty clay, medium to high plasticity, brown, with a trace of fine to medium grained angular and sub angular igneous gravel, ash and slag.	MC≥PL			
						2							
				■	SPT 10/100mm REFUSAL	3						400 360	
						4							
				■	N = 15 5,7,8							400 380 420	
						5							
								CL-CH	SILTY CLAY: medium to high plasticity, light grey mottled red brown and orange brown, with a trace of fine to medium grained angular and sub angular ironstone gravel.	MC>PL	(St)	-	
								CH					
				■	N = 13 4,5,8	6			SILTY CLAY: high plasticity, light grey, with a trace of fine to medium grained angular and sub angular ironstone gravel.			250 280 300	
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
9
2/2

BOREHOLE LOG

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 25-1-10
Method: SPIRAL AUGER JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 38.6m
Datum: AHD

undwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
▼ ON COMPLETION							▨	CH	SILTY CLAY: high plasticity, light grey, with a trace of fine to medium grained angular and sub angular ironstone gravel.	MC > PL	(St)		
						8 9	▨	CL-CH	SILTY CLAY: medium to high plasticity, grey mottled red brown, with a trace of fine to medium grained angular and sub angular ironstone gravel.				
				■		10	▤	-	SHALE: dark grey, with XW bands.	DW	L	-	LOW 'TC' BIT RESISTANCE
						11 12 13 14			END OF BOREHOLE AT 10.5m				

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
10
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 27-1-10
Method: SPIRAL AUGER JK500
Logged/Checked by: D.S./
R.L. Surface: ≈ 37.0m
Datum: AHD

ndwater ecord	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION						0			FILL: Silty clay, medium plasticity, dark brown, with a trace of fine to coarse grained igneous, shale sandstone and asphaltic concrete gravel, with a trace of root fibres.	MC<PL			GRASS COVER TO 50mm DEPTH
				■	N = 32 8,14,18								
						1							
				■	N = 15 5,6,9								APPEARS WELL COMPACTED
						2							
				■	N = 20 7,10,10	3							
									as above, but with L-M strength sandstone seams.				
						4							
				■	SPT 4,3/0mm REFUSAL								
						5		CL-CH	SILTY CLAY: medium to high plasticity, light brown, with a trace of fine to coarse grained ironstone gravel.	MC>PL	VSt	-	
				■	N = 17 5,6,11	6						250 220 200	
									SILTY CLAY: medium to high plasticity, light grey mottled orange brown, with a trace of root fibres.				
						7							

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BOREHOLE LOG

Borehole No.
10
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 27-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: D.S./
R.L. Surface: ≈ 37.0m
Datum: AHD

undwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
								CL-CH	SILTY CLAY: medium to high plasticity, orange brown, with fine to medium grained ironstone gravel.	MC>PL	VSt		
				■	N = 16 6,9,7				SILTY CLAY: medium to high plasticity, grey mottled orange brown and brown.			300 320 350	RESIDUAL
				■		8							
				■	N > 25 5,10, 15/100mm REFUSAL	9						300 300 320	
						10							
				■	N = 29 8,12,17				as above, but with L strength ironstone seams.				
						11							
								-	SHALE: dark grey, with iron indurated bands.	DW	VL-L	-	LOW 'TC' BIT RESISTANCE
						12							
						13							MODERATE RESISTANCE
													MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 13.5m				
						14							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
11
1/1

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 27-1-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 41.2m
Datum: AHD
Logged/Checked by: D.S./

undwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0	▨		FILL: Silty clay, medium to high plasticity, brown, with a trace of fine to coarse grained ironstone, shale and sandstone gravel, with a trace of asphaltic concrete and igneous gravel.	MC<PL			GRASS COVER TO 50mm DEPTH
				■	N = 28 6,11,17		▨						APPEARS WELL COMPACTED
						1	▨						
				■	N = 20 8,11,9		▨						
						2	▨						
				■	N = 30 10,12,18	3		CL	SANDY SILTY CLAY: medium plasticity, orange brown and light grey, with ironstone seams.	MC<PL	H	>600 >600 >600	
								-	SHALE: dark grey.	DW	L	-	LOW 'TC' BIT RESISTANCE
				■		4							MODERATE RESISTANCE
									END OF BOREHOLE AT 4.5m				
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
12
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 39.9m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Gravelly silty clay, low to medium plasticity, brown, fine to coarse grained angular and sub angular igneous, ironstone and shale gravel, with a trace of root fibres and fine to medium grained sand.	MC<PL			GRASS COVER
				■	N > 15 10,15/ 150mm REFUSAL								
						1							
				■	N = 23 5,11,12								APPEARS WELL COMPACTED
						2			FILL: Silty clay, high plasticity, light brown grey and brown, with a trace of fine to medium grained angular and sub angular igneous, ironstone and shale gravel and ash.				
				■	N = 17 5,6,11	3							
						4			as above, but with fine to coarse grained igneous, shale and ironstone gravel and fine to medium grained sand.				
				■	N > 10 6,10/ 100mm REFUSAL								
						5							
								CH	SILTY CLAY: high plasticity, light brown mottled red brown.	MC>PL	(St)	-	
				■	SPT 15/150mm REFUSAL	6		-	SHALE: grey.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						7							

BOREHOLE LOG

Borehole No.
12
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 39.9m
Datum: AHD

undwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
				■					SHALE: grey.	XW	EL		
				■		8			SHALE: grey and brown, with iron indurated and XW bands.	DW	L		LOW RESISTANCE
						9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No.
13
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 20-1-10
Method: SPIRAL AUGER JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 39.4m
Datum: AHD

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0	▩		FILL: Silty clay, low to medium plasticity, brown, with a trace of fine to medium grained angular and sub angular igneous, shale and ironstone gravel and occasional cobble sized.	MC<PL			GRASS COVER
						1	▩		FILL: Silty clay, medium to high plasticity, brown, with a trace of fine to medium grained angular and sub angular igneous, shale and ironstone gravel, and ash and slag.	MC>PL			
				■	N = 10 2,5,5		▩					380 >600 >600	APPEARS MODERATELY TO WELL COMPACTED
						2	▩		as above, but brown, light brown and grey.				
				■	N = 13 3,5,8	3	▩					350 400 350	
						4	▩						
				■	N = 13 4,6,7		▩					400 500 550	
						5	▩						
							▨	CH	SILTY CLAY: high plasticity, light grey mottled orange brown, fine to medium grained angular and sub angular ironstone gravel.	MC>PL	St	-	RESIDUAL
				■	N = 18 4,9,9	6	▨					150 180 160	
						7	▨						

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BOREHOLE LOG

Borehole No.
13
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 20-1-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 39.4m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								CH	SILTY CLAY: high plasticity, light grey mottled orange brown, fine to medium grained angular and sub angular ironstone gravel.	MC>PL	St		
								CL-CH			H		POSSIBLY XW SHALE
				■	N = 13 4,6,7				SILTY CLAY: medium to high plasticity, light grey, with orange brown ironstone gravel bands.			550 500 >600	
▼ AFTER 1.5 HRS						8							
				■	N > 19 11,19/ 50mm REFUSAL	9		-	SHALE: grey, with iron indurated bands.	XW	EL		
▼ ON COMPLETION										DW	L-M		LOW 'TC' BIT RESISTANCE
				■		10							
									END OF BOREHOLE AT 10.5m				
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. 14
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 16-2-10
Method: SPIRAL AUGER JK500
Logged/Checked by: J.M.K./
R.L. Surface: ≈ 38.8m
Datum: AHD

Groundwater Record	ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0	▨		FILL: Silty clay, medium plasticity, dark brown, with fine to coarse grained igneous, ironstone, concrete and sandstone gravel.	MC<PL			APPEARS WELL COMPACTED
				■	N = 41 11,20,21		▨						
						1	▨						
				■	N = 32 13,16,16		▨						
						2	▨						
				■	N > 20 9,10, 10/100mm REFUSAL	3	▨		FILL: Silty clay, medium to high plasticity, light grey, brown, light brown and orange brown, with fine to coarse grained ironstone and sandstone gravel and charcoal fragments and with a trace of root fibres.	MC≈PL			
						4	▨						
				■	N = 16 6,7,9		▨						
						5	▨						
							▧	CH	SILTY CLAY: high plasticity, brown, orange brown and light grey, with a trace of fine grained ironstone gravel.	MC>PL	St- VSt	-	
				■	N = 14 5,5,9	6	▧					300 240 190	
						7	▧						

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BOREHOLE LOG

Borehole No.
14
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 16-2-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 38.8m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
▼ AFTER 2 HRS 15 MINS							▨	CH	SILTY CLAY: high plasticity, brown, orange brown and light grey, with a trace of fine to medium grained ironstone gravel.	MC>PL	VSt		
				■	N = 20 5,7,13		▨				H	420 400 440	
						8	▨						
				■	N = 16 5,7,9	9	▨		SILTY CLAY: high plasticity, dark grey and orange brown, with a trace of ironstone gravel.		VSt	290 350 300	
▼						10	▨						
						11	▤	-	SHALE: grey, with iron indurated bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
						12			END OF BOREHOLE AT 12.0m				
						13							
						14							

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Borehole No.
15
1/2

BOREHOLE LOG

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 37.9m
Datum: AHD

undwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION						0			FILL: Silty clay, medium plasticity, brown, with fine to medium grained angular and sub angular igneous, ironstone and shale gravel, with a trace of root fibres, ash, slag and fine to medium grained sand.	MC≈PL			GRASS COVER
				■	N = 21 12,10,11							500 520 >600	
						1			as above, but with a trace of glass fragments.	MC< PL			
				■	N = 12 5,4,8							200 180 220	APPEARS WELL COMPACTED
						2							
									FILL: Silty clay, medium to high plasticity, grey, brown and light brown, with fine to medium grained angular and sub angular igneous, shale and ironstone gravel, with a trace of ash, fine to medium grained sand, and fine to medium grained angular and sub angular sandstone gravel.				
				■	N = 21 5,10,11	3						600 300 510	
						4			FILL: Silty clay, high plasticity, brown and grey, with a trace of fine to medium grained sand, fine to medium grained angular and sub angular igneous, shale and ironstone gravel, ash and slag.				
				■	N = 13 5,7,6							250 310 200	
						5							
								CL-CH	SILTY CLAY: medium to high plasticity, light grey mottled orange brown, with fine to medium grained angular to sub angular ironstone gravel.	MC>PL	VSt	-	
				■	SPT 14/150mm REFUSAL	6						380	
								CH	SILTY CLAY: high plasticity, light grey, with a trace of fine to medium grained angular and sub angular				
						7							

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BOREHOLE LOG

Borehole No.
15
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 22-1-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 37.9m
Datum: AHD

undwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							▨	CH	ironstone gravel.	MC>PL	VSt		
							▨		SILTY CLAY: high plasticity, light grey, with a trace of fine to medium grained angular and sub angular ironstone gravel.				
				■	N > 12 7,12/ 100mm REFUSAL		▨					240 250	
						8	▨						
							▨		SILTY CLAY: high plasticity, light grey mottled orange brown.		H		
				■	N > 13 6,13/ 150mm REFUSAL	9	▨					>600 >600 >600	
						10	▨						
				■			▤	-	SHALE: grey.	XW-DW	EL-VL		VERY LOW 'TC' BIT RESISTANCE
						11	▤						
				■			▤						
						12			END OF BOREHOLE AT 12.0m				
						13							
						14							

BOREHOLE LOG

Borehole No.
16
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 16-2-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 37.7m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION				■	N > 8 8,8/90mm REFUSAL	0 1	▩		FILL: Silty clay, medium plasticity, dark brown, brown and orange brown, with fine to coarse grained ironstone, shale, sandstone and igneous gravel.	MC<PL			APPEARS WELL COMPACTED
				■	N = 18 8,8,10	2	▩		FILL: Silty clay, medium plasticity, dark grey and dark brown, with fine to coarse grained ironstone and shale gravel, with a trace of charcoal.	MC≈PL			
				■	N = 22 6,10,12	3 4	▩		as above, but with a trace of fine to medium grained concrete gravel and root fibres.				
				■	N = 18 3,8,10	5	▩		FILL: Silty clay, medium plasticity, dark brown and dark grey, with fine to medium grained sandstone and ironstone gravel, and with a trace of charcoal.	MC>PL			
				■	N = 20 9,9,11	6 7	▨	CH	SILTY CLAY: high plasticity, brown, orange brown and light grey, with ironstone gravel.	MC>PL	VSt	280 300 320	

BOREHOLE LOG

Borehole No.
16
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 16-2-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 37.7m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							▨	CH	SILTY CLAY: high plasticity, brown, orange brown and light grey, with fine to coarse grained ironstone gravel.	MC>PL	VSt		
				■	N = 13 5,6,7		▨		SILTY CLAY: high plasticity, grey, orange brown, with a trace of root fibres and fine to medium grained ironstone gravel.			270 220 320	
						8	▨						
				■	N = 27 6,10,17	9	▨		as above, but with fine to medium grained ironstone gravel.		St	160 180 150	
						10	▨						
				■	SPT 11,3/ 10mm REFUSAL		▨				VSt	300	
							☰	-	SHALE: grey and brown.	XW	EL	360 340	
				■		11	☰			DW	L		LOW 'TC' BIT RESISTANCE
						12			END OF BOREHOLE AT 12.0m				
						13							
						14							

BOREHOLE LOG

Borehole No.
17
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 20-1-10
Method: SPIRAL AUGER JK300
Logged/Checked by: G.F./
R.L. Surface: ≈ 37.1m
Datum: AHD

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION & AFTER 3.5 HRS						0			FILL: Silty clay, medium to high plasticity, light brown, light grey and orange brown, with a trace of fine to medium grained angular and sub angular igneous and ironstone gravel.	MC>PL			GRASS COVER
				■	N = 15 6,7,8							>600 550 >600	
						1							
									FILL: Silty clay, medium plasticity, dark grey and dark brown, with a trace of ash, fine to medium grained sand and fine to medium grained angular and sub angular igneous and ironstone gravel.				
				■	N = 16 5,8,8							500 >600 550	APPEARS WELL COMPACTED
						2							
				■	N = 17 7,7,10	3						500 550 >600	
						4							
				■	N = 9 5,4,5			CH	SILTY CLAY: high plasticity, light brown mottled red brown, with a trace of fine to medium grained angular and sub angular ironstone gravel.	MC>PL	VSt	200 250 260	RESIDUAL
						5							
									SILTY CLAY: high plasticity, light grey mottled red brown, with a trace of root fibres and fine to medium grained angular and sub angular ironstone gravel.		VSt -H		
				■	N = 15 4,6,9	6						310 450 450	
											VSt		
						7							

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BOREHOLE LOG

Borehole No.
17
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 20-1-10
Method: SPIRAL AUGER
JK300
Logged/Checked by: G.F./
R.L. Surface: ≈ 37.1m
Datum: AHD

undwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES	U50	DB	DS									
								CL	SILTY CLAY: medium plasticity, light grey, with a trace of root fibres.	MC>PL	VSt		
				■	N = 13 4,6,7							250 280 300	
						8							
								CH	SILTY CLAY: high plasticity, grey.				
						9							
						10			SILTY CLAY: high plasticity, grey mottled light brown.		VSt- H		
				■	N = 17 3,7,10							350 500 550	
						11							
				■	SPT 10/50mm REFUSAL	12		-	SHALE: grey.	XW	EL	-	
									END OF BOREHOLE AT 12.05m				
						13							
						14							

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BOREHOLE LOG

Borehole No.
18
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 17-2-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 37.5m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium plasticity, dark brown and brown, with fine to coarse grained igneous, ironstone and sandstone gravel.	MC<PL			GRASS COVER APPEARS WELL COMPACTED
				■	N > 6 7,6/60mm REFUSAL								
						1							
				■	N = 26 13,13,13				as above, but grey, with shale gravel.				
						2							
				■	N = 21 10,9,12	3			FILL: Silty clay, medium plasticity, brown grey, with fine to medium grained ironstone and shale gravel, with a trace of timber fragments.	MC≈PL			
						4							
				■	N = 14 9,6,8								
						5		CH	SILTY CLAY: high plasticity, light grey, with a trace of fine grained ironstone gravel.	MC>PL	St	140 140 150	
▼ AFTER 3 HRS 15 MINS				■	N = 11 2,2,9	6		CL-CH	SILTY CLAY: medium to high plasticity, light grey and orange brown, with fine to medium grained ironstone gravel and a trace of XW shale gravel.		F	60 60 90	
						7							

BOREHOLE LOG

Borehole No.
18
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 17-2-10
Method: SPIRAL AUGER JK500
R.L. Surface: ≈ 37.5m
Datum: AHD
Logged/Checked by: J.M.K./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							▨	CL-CH	SILTY CLAY: medium to high plasticity, light grey and orange brown, with fine to medium grained ironstone gravel, and with a trace of XW shale gravel.	MC>PL	F		
				■			▤	-	SHALE: dark grey and dark brown, with iron indurated bands.	DW	L-M	-	LOW 'TC' BIT RESISTANCE WITH MODERATE BANDS
						8	▤						
▼							▤						
				■			▤						
						9			END OF BOREHOLE AT 9.0m				
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No.
19
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 16-2-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: J.M.K./
R.L. Surface: ≈ 38.3m
Datum: AHD

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium to high plasticity, dark brown and brown, with fine grained sandstone and igneous gravel, fine to coarse grained ironstone and concrete gravel and cobbles, with a trace of shale gravel.	MC≈PL			GRASS COVER APPEARS WELL COMPACTED
				■	N > 15 6,11, 4/20mm REFUSAL								
						1							
				■	N = 27 4,9,18				as above, but with charcoal fragments.				
						2							
				■	N = 22 5,8,14	3							
						4							
				■	N = 28 13,14,14								
						5			FILL: Silty clay, medium to high plasticity, light grey, red brown, brown and dark brown, with fine to coarse grained ironstone gravel.				
▼ AFTER 5 HRS 15 MINS				■	N = 19 4,8,11	6							
								CH	SILTY CLAY: high plasticity, light grey, light orange red brown, with fine to coarse grained ironstone	MC>PL	(St-VSt)	-	
						7							

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BOREHOLE LOG

Borehole No.
19
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 16-2-10
Method: SPIRAL AUGER
JK500
Logged/Checked by: J.M.K./
R.L. Surface: ≈ 38.3m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
								CH	gravel.	MC>PL	(St-VSt)		
									SILTY CLAY: high plasticity, light grey and light orange, with fine to coarse grained ironstone gravel.				
				■	SPT 6/70mm REFUSAL						VSt	200 280 250	
						8			as above, but brown and red brown.				
				■	N = 24 4,11,13	9			SILTY CLAY: high plasticity, orange brown, brown, light grey and grey, with fine to coarse grained ironstone gravel.			200 320 400	
						10							
▼				■	SPT 12/140mm REFUSAL			-	SHALE: grey.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
						11				DW	M		LOW TO MODERATE RESISTANCE
				■									
						12			END OF BOREHOLE AT 12.0m				
						13							
						14							

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BOREHOLE LOG

Borehole No.
21
1/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 25-1-10
Method: SPIRAL AUGER
JK500
R.L. Surface: ≈ 37.1m
Datum: AHD
Logged/Checked by: G.F./

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0	▨		FILL: Silty clay, low to medium plasticity, brown, with fine to coarse grained angular and sub angular igneous gravel and a trace of fine to medium grained sand, brick and concrete fragments.	MC<PL MC≈PL			
			■		SPT 10/100mm REFUSAL		▨						
						1	▨		FILL: Silty clay, medium plasticity, brown, with a trace of fine to coarse grained angular and sub angular igneous gravel, ash, slag and concrete fragments.				
					SPT 9/50mm REFUSAL		▨						
						2	▨		FILL: Silty clay, medium to medium plasticity, brown and grey, with a trace of ash, slag and fine to medium grained angular and sub angular shale and ironstone gravel.	MC>PL			
				■	N = 9 3,4,5	3	▨					150 200 130	APPEARS MODERATELY TO WELL COMPACTED
						4	▨						
▼ ON COMPLETION				■	N = 10 5,5,5		▨					200 100 110	
						5	▨						
				■	N = 16 3,9,7	6	▧	CL	SILTY CLAY: medium plasticity, light grey, with fine to medium grained angular and sub angular ironstone gravel.	MC>PL	St	110 100 100	
						7							

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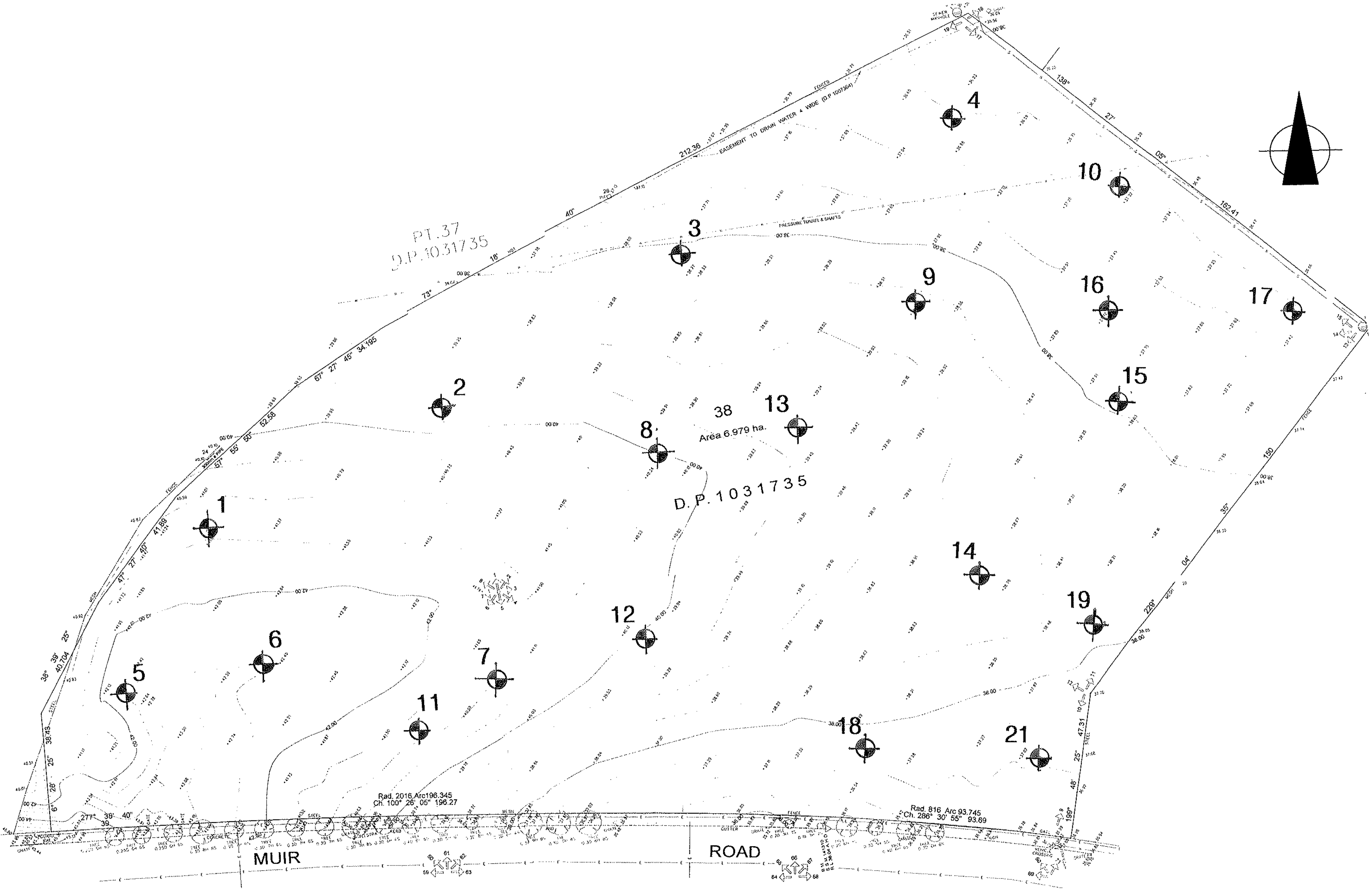
BOREHOLE LOG

Borehole No.
21
2/2

Client: COMMERCIAL & INDUSTRIAL PROPERTY PTY LTD
Project: PROPOSED INDUSTRIAL DEVELOPMENT
Location: 24 MUIR ROAD, CHULLORA, NSW

Job No. 23692Z
Date: 25-1-10
Method: SPIRAL AUGER JK500
Logged/Checked by: G.F./
R.L. Surface: ≈ 37.1m
Datum: AHD

undwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
							▨	CL	SILTY CLAY: medium plasticity, light grey, with fine to medium grained angular and sub angular ironstone gravel.	MC>PL	H		
				■	N > 10 7,10/ 150mm REFUSAL		▨					400 550 >600	
						8	▨						
				■	N = 21 7,10,11	9	▨				VSt- H	360 390 440	
								-	SHALE: grey, with clay bands.	XW	EL	-	VERY LOW 'TC' BIT RESISTANCE
				■		10			SHALE: grey, with XW and clay bands.	DW	L		MODERATE RESISTANCE WITH VERY LOW BANDS
									END OF BOREHOLE AT 10.5m				50mm DIA. PVC STANDPIPE INSTALLED TO 10.5m DEPTH. BOTTOM 4m SLOTTED
						11							
						12							
						13							
						14							



SCALE (m)

0 50

LEGEND

⊕ BOREHOLE

NOTE THERE IS NO BH20

BOREHOLE LOCATION PLAN

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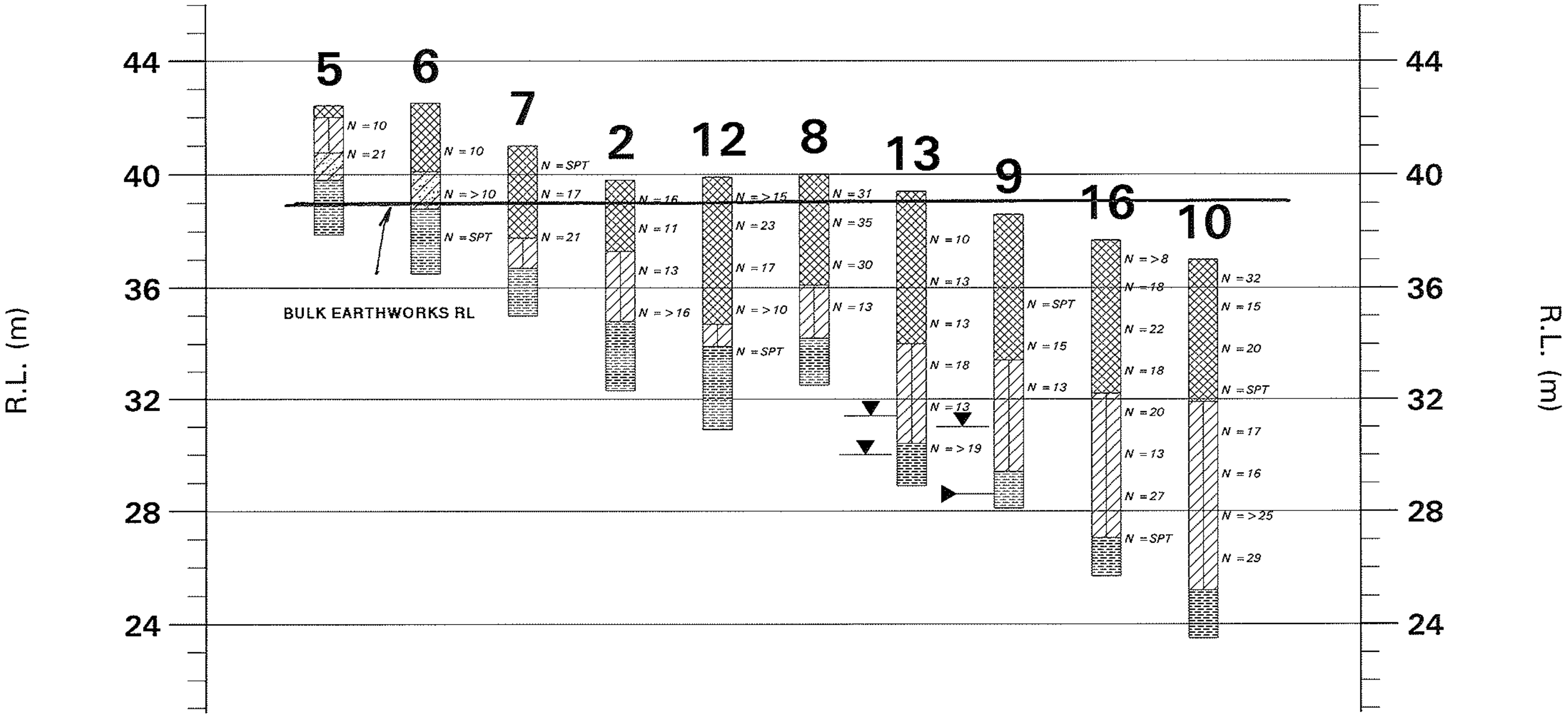
Report No.23692Z Figure No. 1

GRAPHICAL BOREHOLE SUMMARY



▩	Fill	▤	Shale	N	SPT "N" VALUE
▨	Silty Clay	▼	Observed water level	Nc	SOLID CONE BLOW COUNTS PER 150mm
▨	Sandy Clay	▶	Groundwater seepage level		

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 200 (vert) ; NTS (horiz)

Jeffery and Katauskas Pty Ltd

Job No.: 23692Z

Figure No.: 2

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties - soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained 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.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water 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 "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength 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 F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N_c" on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The 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.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed <u>or</u> where only a limited investigation has been completed <u>or</u> where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

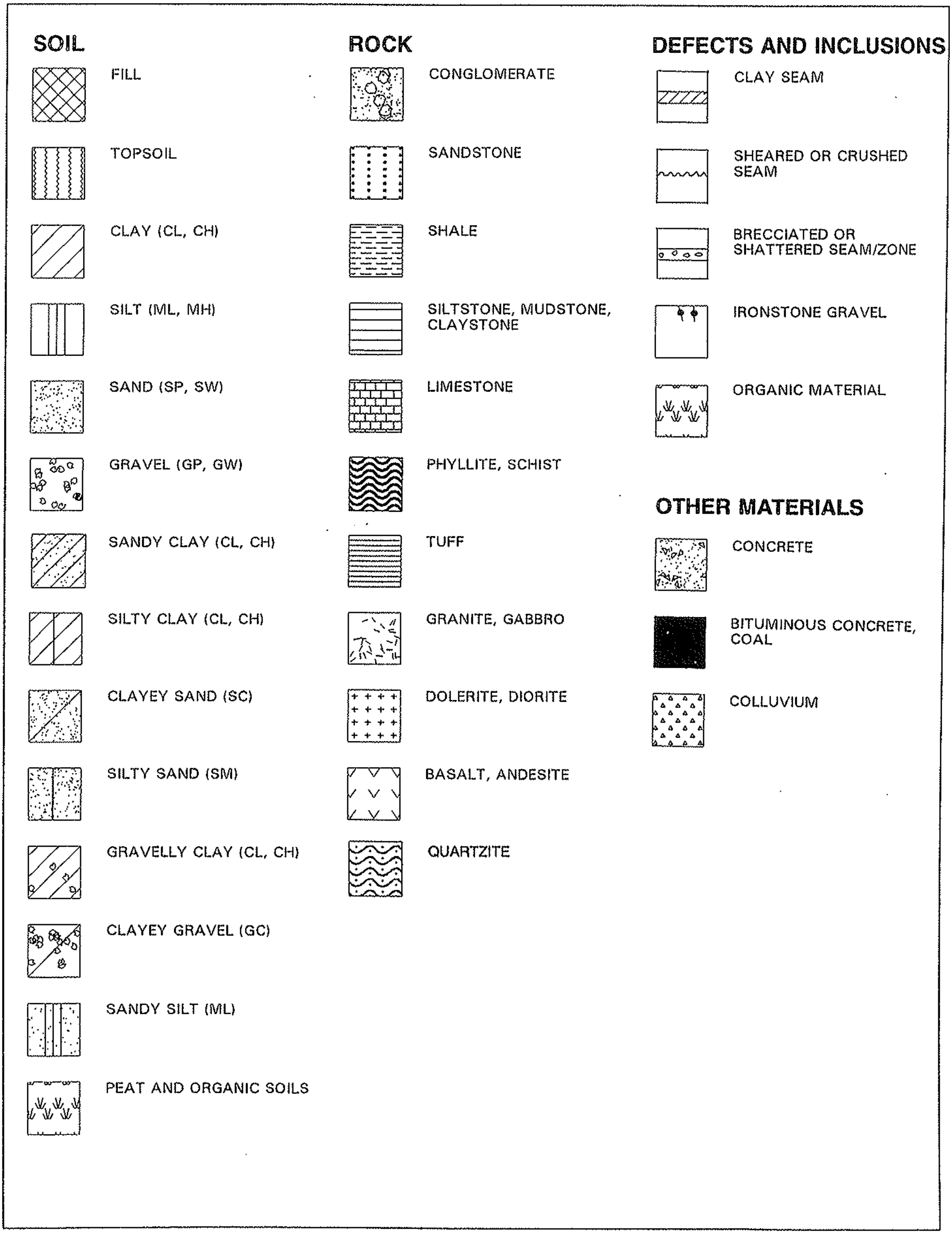
i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS



SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

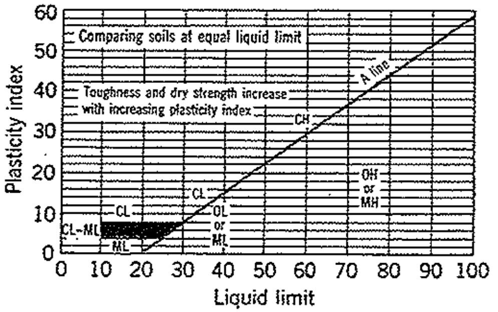
DEFECTS AND INCLUSIONS

- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 µm and basing fractions on estimated weights)							Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria			
Coarse-grained soils More than half of material is *larger* than 75 µm sieve size[b]	(The 75 µm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification	Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 µm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
				Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines				Not meeting all gradation requirements for *GW*	
			Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures				Atterberg limits below "A" line, or *PI* less than 4	Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
				Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures				Atterberg limits above "A" line, with *PI* greater than 7	
		Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines				$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
				Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines				Not meeting all gradation requirements for *SW*	
			Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures				Atterberg limits below "A" line or *PI* less than 5	Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
				Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures				Atterberg limits below "A" line with *PI* greater than 7	
Fine-grained soils More than half of material is *smaller* than 75 µm sieve size		Identification Procedures on Fraction Smaller than 380 µm Sieve Size											
				Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)							
		Silts and clays liquid limit less than 50		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)		 Plasticity chart for laboratory classification of fine grained soils		
				Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays					
				Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity					
		Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts					
				High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays					
				Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity					
Highly Organic Soils				Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils					

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	—⊤—	Standing water level. Time delay following completion of drilling may be shown.
	—C—	Extent of borehole collapse shortly after drilling.
	▶—	Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose <15 0-4
	L	Loose 15-35 4-10
	MD	Medium Dense 35-65 10-30
	D	Dense 65-85 30-50
	VD	Very Dense >85 >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

Ref: Standard Sheets/Log Symbols

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LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
		0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
		1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
		3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
		10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

Ref: Standard Sheets/Log Symbols
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