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REPORT

TO

GOVERNMENT ARCHITECTS OFFICE

ON

GEOTECHNICAL ASSESSMENT AND DESIGN ADVICE

FOR

PROPOSED FORESHORE WORKS

AT

SYDNEY FISH MARKETS, BLACKWATTLE BAY, PYRMONT, NSW

31 August 2010

Ref: 24125SPrpt

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1 INTRODUCTION

This report presents the results of a geotechnical assessment for the proposed foreshore development, which forms part of the redevelopment programme of the Sydney Fish Markets at Blackwattle Bay, Pyrmont, NSW. The assessment was commissioned by the Governments Architect's Office, part of the NSW Department of Services, Technology and Administration, on the basis of our fee proposal Ref: P32395S, dated 6 May 2010.

A number of conceptual architectural drawings have been provided to us with details of the proposed foreshore works with minor changes on each of the drawings. The most recent drawing that we have been supplied with (No reference or date), was emailed to us on the 18 August 2010 by Judith Fritsche, of the Government Architects Office and is attached to this report as Figure 3. We also have been provided with a copy of a brief issued by TLB Engineers dated 12 July 2010 which outlines the proposed scope of works.

Based on the above information we understand that the foreshore development area extends from Pyrmont Bridge Road in the south to the boundary with the adjacent property to the north, and up to 45m east of the mean high water mark. The location of the foreshore development area is shown on the attached Figures 1 and 3. We understand that the foreshore development will comprise the following:

- Alterations and additions to the existing board walk and embankment as well as an improved entrance off Pyrmont Bridge Road.
- A new over-water walkway north of the existing concrete wharf and west of the existing seawall.
- Reconstruction and modification of the existing seawall between the concrete wharf and the existing timber wharf.
- A new timber deck area just to the south and north of the existing timber wharf.

- A new foreshore revetment north of the existing timber wharf.
- New on-shore retaining walls
- Two new landscaped garden areas
- New pavement areas
- A new pedestrian ramp and associated retaining walls along the entire northern boundary of the site.

We understand that the proposed development works will be at or close to existing site levels. The proposed new foot-path along the northern boundary of the site will be at and slightly above existing ground levels.

The proposed overwater walk-way will generally be at slightly lower levels than the existing shore levels to the east.

Excavation will be required for some locations for alterations to the existing embankment to the west of the main building, new retaining walls, new fill embankments, new pavement areas as well as for any new service trenches. Proposed foundation loads for the new seawall and suspended board walk have not been indicated but are anticipated to be in the light to moderate range.

This assessment has been carried out using information from previous investigations completed by Jeffery and Katauskas which cover the proposed foreshore development area, in particular reports Ref: 6416K, dated 27 January 1989, Ref:11168SJ/a, dated 29 June 1995, Ref:16325Srpt, dated 19 December 2001 and Ref:23982S, dated 16 June 2010. We have also included the boreholes drilled as part of the current environmental investigation of the foreshore area Ref: E24125K.

It should also be noted that Jeffery and Katauskas have carried out a number of other geotechnical investigations within the Fish Markets dating back to 1989.

The purpose of this assessment was to review results of the geotechnical investigations as a basis for comments and recommendations on excavation, footings, retaining walls, sea wall design, pavements and any other geotechnical issues.

2 ASSESSMENT PROCEDURE

The information from 24 boreholes (BH1 to BH4, BH206 to BH212, BH402, BH403, BH514 and BH601 to BH610), which are closest to the proposed foreshore area, have been used to interpret the subsurface conditions.

- Boreholes BH1 and 2 were drilled on the 19 December 1988, using an Edson rig.
- BH3 and 4 were drilled on the 4 January 1989, from a barge using a Pioneer Mole rig.
- BH201 to 205 were drilled on the 22 May 1995, using a truck mounted GCH rig.
- BH206 to 212 were drilled between 30 May and 9 June 1995 using a portable rotary hydraulic (Melvelle) rig, both on-shore and from a scaffold platform.
- BH401 and 402 were drilled on the 4 December 2001, using a truck mounted JK450 drilling rig.
- BH514 was drilled on the 11 May 2010, using a track mounted JK250 rig and similar auger equipment and BH 601 to 610 were drilled on the 21 and 22 July 2010, using a track mounted JK250 rig.

We have also included the results of boreholes BH201 to BH205, which cover the area near the proposed pedestrian access path along the northern boundary of the site.

Drilling through the soils was carried out using both spiral augers and wash boring equipment.

The strengths of the subsurface soils were assessed from Standard Penetration Tests (SPT's) which were carried out at regular intervals in most of the boreholes, and in the case of the over water boreholes, by Dynamic Cone Penetration (DCP) test. The strength of the underlying bedrock in augered boreholes was assessed by examination of auger cuttings and from monitoring the resistance to penetration of the augers. It should be noted that rock strengths assessed in this way are only a guide to rock strength and variations of one strength order should not be unexpected. In some cases the rock was cored using NMLC triple tube core barrels and rock strengths were assessed by inspection of the cores and with reference to point load strength index tests, the results of which area plotted on the log sheets.

Copies of the borehole logs used as the basis of this assessment are provided with this report, together with explanatory notes which provide a glossary of terms and symbols used and further details of the investigation procedures.

The borehole locations have been plotted onto a "Google" image, which forms the basis of Figure 1. It should be noted that the borehole locations are only approximate as they have been interpolated from previous investigation location plans. Unless otherwise stated the reduced levels shown on the logs were interpolated from survey plans provided at the time of the investigations, and which seem to be similar to the spot heights and ground levels shown on the supplied survey plan (Drawing No. 40269, Issue, Dated 14/04/10), prepared by Hill & Blume. The survey datum unless otherwise stated is the Australian Height Datum (AHD). We consider it unlikely that there has been any major change in surface levels over the site over recent time, with the possible exception of the Fish Market Entry Ramp in the north-east corner of the site which is slightly higher than previous site levels in the far north-east.).

Boreholes BH201 to 205 have been displayed separately on the attached Figure 2.

In the case of the 200 series boreholes (BH206 to 212), the boreholes were related to an assumed datum of 0.0m (RL 1.56m AHD) adjacent to the fire hose on the existing timber jetty which runs into Blackwattle Bay between BH211 and BH212.

Groundwater levels shown on the logs were observed during drilling and for a short time afterwards. On completion of drilling, PVC standpipes were installed in BH605, 606 and 608 to monitor ground water levels and to allow environmental water sampling to be carried out. No long term groundwater monitoring has been carried out in any of the other boreholes.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The Sydney Fish Markets are situated on the eastern foreshore of Blackwattle Bay. The foreshore development area under consideration comprises the corridor directly adjacent to the Bay and ranges from about 12m to 45m in width. As mentioned previously the foreshore development area extends from Pyrmont Bridge Road in the south to the boundary with the adjacent property to the north. The area is shown on the attached Figures 1 and 3.

Behind the seawalls the foreshore area is generally flat, with a gentle slope towards the bay at about 1° to 2°. Ground levels range from about RL 1.5m in the north-west to about RL 3.2m in the south-east, adjacent to the main auction building. A number of different types of sea wall and revetment are present. These are discussed further below.

At the time of the investigation much of the area was paved with asphaltic concrete and used mostly for car parking, storage for the fishermen and storage of a number of metal containers. There was a timber jetty (shown as Feature A on the attached Figure 1) at the north-western end of the site. At the south-eastern corner of the asphalt paved area was a one and two storey building, occupied by a seafood wholesaler 'Claudios'. Directly to the south of this building, ground levels were between 0m and 0.7m lower, and the building platform was supported by concrete jersey kerbs directly adjacent to the building. Beyond the building to the south was a concrete paved area used for deliveries.

All of the concrete and AC surfaced areas were generally in fair condition. There were some areas of cracking and a number of repairs had been made to some areas of the AC.

In the southern portion of the foreshore, to the west of the main auction building, ground levels stepped over two levels. The higher level (concrete walk-way) was at the same level as the ground floor of the main building, and the lower level (existing boardwalk) was about 1.5m lower. This step down in level is supported by a 0.5m high concrete wall, below which was a 3m wide batter slope that dips towards the west at between 1° and 5° and is covered by faux grass surfacing. This slope was in turn supported by a 0.5m high block wall. Both walls appeared in fair condition, as did the board walk. We understand that a separate assessment has been carried out on the existing seawalls, revetments and timber boardwalk.

At the north-western end of the existing boardwalk was a concrete jetty, this is shown on the attached Figure 1 as Feature B. Along the northern boundary of the site was the concrete access ramp into the fish markets as shown on the attached Figures 1 and 2.

Existing Sea Walls and Revetments

Just to the south of the timber deck area, and east of the concrete walk-way was a fill embankment that runs into the bay, approximately 2m in height with slopes ranging from approximately 30° to 60°. Part of this embankment was supported by large boulders (rip-rap), although the southern end was almost vertical, with no boulders or support. This area is shown as Feature C on Figure 1.

Directly below the existing board-walk was an embankment protected with rip-rap with seemingly moderate batter slopes, although we were not able to gain direct access to this area and could make only a visual examination from the concrete jetty.

Just to the north of the concrete jetty was an embankment with rip-rap extending about 6m to the north of the jetty and sloping towards the bay at about 30°. Directly to the north of the embankment was a sandstone block seawall between 1.2m and 1.8m in height, extending just to the south of the timber jetty, although the top of the southern end of the wall was still below the water level. This wall was in poor condition in the area directly west of the 'Claudios' building shown as Feature D on Figure 1, although it was not possible to get close to the wall due to access restrictions. The remaining parts of the sandstone block wall were in fair condition and appeared to have a slight back slope of about 5°. Just to the south and north of the timber jetty the sea wall comprised timber piles and timber lagging, with the section just to the north of the jetty in a poor state of repair, which is shown as Feature E on Figure 1.

North of the timber sea wall, running to the northern boundary was a fill embankment with a batter slope of about 10°, but steeper towards the crest.

Towards the crest of this embankment was an old block wall about 0.4m in height that had completely collapsed. This is shown as Feature F on Figure 1.

3.2 Subsurface Conditions

As the previous investigations have comprised both on-shore (to the east of the existing seawall/revetments), over-water boreholes (to the west of the existing seawall/revetments), as well as boreholes for a new access ramp (as shown on Figure 2), we have discussed these three areas separately.

3.2.1 Pedestrian Access Ramp Boreholes

The previously drilled boreholes were drilled just to the south of the proposed new pedestrian access ramp, but we believe they give a good indication of the existing ground conditions. It should be noted that these boreholes were drilled prior to construction of the concrete vehicle access ramp that currently runs along the northern boundary.

Concrete now covers the surface at each of these locations and earth works may have been carried out in the construction of the ramp.

Fill

Below any pavements, fill extended to depths of up to 1.9m, but possibly deeper as BH204 and BH205 both terminated within the fill at a depth of 1.5m. The fill comprised silty sand, sandy gravel and silty gravely clay. The fill contained inclusions such as igneous and sandstone gravel. Where assessed the fill was generally moderately or moderately to well compacted.

Borehole BH202A terminated on obstructions within the fill at a depth of 0.25m.

Estuarine Soils

These natural soils were encountered beneath the fill in boreholes BH201 and 202B only, to a depth of 2.3m. The soils generally comprised a silty sand which was assessed as being very loose and either moist or wet.

Sandstone Bedrock

Sandstone bedrock was encountered directly below the fill in BH203 and beneath the natural soils in BH201 and 202B, at depths between 0.7m (BH203) and 2.3m (BH201 and 202B). On first contact the sandstone ranged from extremely low to very low strength and extremely to distinctly weathered. In BH202B and 203 the sandstone increased to low to medium strength at between 1.2m and 3m.

Groundwater

BH201, 202B, 203, 204, and 205 were dry immediately after completion. In BH202B, water seepage was encountered during drilling in the sandy soils at a depth of 2m. Water levels of 1.5m and 1.9m were recorded within BH201 and 202B respectively, about 3 hours after completion of drilling.

3.2.2 Onshore Boreholes

In summary, the boreholes all encountered fill which in most places overlies a sandy soil layer, which in turn is underlain by sandstone bedrock. It is clear to see from the borehole logs that the depth of fill and depth to bedrock increase towards the south-east of the site. Further comments on the subsurface conditions encountered are provided below. Reference should be made to the borehole logs for detailed descriptions of the subsurface conditions.

Pavements

Concrete and asphalt pavements (AC), where present, were between 20mm and 230mm thick. In BH402, 605 and 606 concrete was present directly below the AC, being between 150mm and 320mm thick.

Fill

Fill was encountered below the pavements or from ground level in all boreholes to depths ranging from 1.1m (BH609) to 6m (BH1). The fill mainly comprised silty sand, sandy gravel and silty gravely clay. The fill contained inclusions such as igneous and sandstone gravel as well as fragments of ash and wood. Where assessed the fill varied from poorly to moderately or well compacted. In some areas such as in BH1, BH2, BH401 and BH609 the fill contained larger sized particles up to cobble size of sandstone, concrete and brick rubble. It should be noted that there is likely to be other areas of similar fill between the areas of the completed boreholes.

Boreholes BH602 and BH603 terminated on obstructions within the fill at depths of 3.5m and 2.5m respectively.

Estuarine Soils

These natural soils were encountered beneath the fill in the majority of the boreholes to depths of between 2.2m (BH513) and 12.8m (BH2). Where rock was deeper the soils ranged up to a maximum of about 6.8m (BH2) in thickness. The soils generally comprised silty and clayey sands with occasional clay and silt bands, although BH1, 2, 601 and 605, contained sandy clays as well. The sandy soils were assessed as being very loose or loose and either moist or wet. The sandy clay soils varied from firm, stiff and up to very stiff in strength. In BH1 a zone of peaty clay 1.3m thick, just below the fill was encountered to a depth of approximately 5.6m depth.

Boreholes BH601, 604, 605, 607 and 610 were terminated with the natural, generally sandy soils at depths from 3.45m to 6m.

Sandstone Bedrock

Sandstone bedrock was encountered directly below the fill in BH402, 606, 608 and 609 and beneath the sandy soils in BH1, 2, 207, 208, 209 and 401 at depths from 1.1m (BH609) to 12.8m (BH2). On first contact the sandstone ranged from

extremely low to very low strength and was extremely to distinctly weathered. In the lower parts of the augered boreholes the sandstone was generally distinctly weathered, low to medium and medium in strength.

The three cored boreholes (BH207 to 209) encountered sandstone bedrock of medium strength or better from between 2.8 and 6.3m in depth.

Groundwater

Groundwater was encountered in BH1, 207, 208, 209, 401, 514, 604, 605 and 606 during drilling at depths from 1.6m to 3.4m depth in BH207 and BH2, respectively.

BH602, 603, 604, 609 and 402 were dry on completion of augering. Standing water levels of between 2m and 4.2m were observed on completion of drilling and shortly after in boreholes BH514 and BH601, respectively.

The table below shown the standing water levels recorded in the three PVC standpipes installed in BH605, 606 and 608.

Monitoring Well	SWL (m) on 22.7.10	SWL (m) on 27.7.10
BH605	2.1	2.04
BH606	2.19	2.18
BH608	1.71	1.56

3.2.3 Over-Water Boreholes

The borehole logs have shown zero depth as being the bay floor deposit level for simplicity. In reality these boreholes were drilled off scaffolding and then through air space and water prior to intersecting the sea-bed deposits.

In summary, the boreholes encountered natural sandy soils, underlain by sandstone bedrock, although in BH206 fill was also encountered. It is clear to see from the borehole logs that the depth of the natural sandy soils and depth to bedrock increase towards the south-east of the site. Further comments on the subsurface conditions encountered are provided below. Reference should be made to the borehole logs for detailed descriptions of the subsurface conditions.

Fill

Fill was only encountered in BH206 where it extended to a depth of 2.4m. The fill comprised silty sand which was assessed as poorly compacted.

Estuarine Soils

Estuarine soils were encountered beneath the fill in BH206 and from the bay floor in the remaining boreholes to depths of between 2.26m (BH211) and 11.1m (BH4). The soils generally comprised silty sand, although BH3 and BH4 also contained clay, sandy clay, peaty clay and clayey sand. The sandy soils were assessed as being very loose or loose and either moist or wet. The sandy clay soils varied from very soft, firm, stiff and up to very stiff in strength. In BH3 and BH4 zones of peaty clay 1.7m and 1m thick respectively, were encountered.

Sandstone Bedrock

The sandstone bedrock in the six over-water boreholes was quite variable in quality. With the exception of BH211, on first contact the sandstone ranged from extremely low to very low strength and extremely to distinctly weathered. In BH3 and BH4 low to medium strength sandstone was encountered a short distance into the sandstone, although these two boreholes were not cored so the exact extent of the weathering and strength is not well defined. In BH211 on first contact the sandstone was distinctly weathered to slightly weathered and medium to high in strength for the full depth of the borehole, with BH206 having similar strength sandstone from about 6.7m, although this borehole was terminated at 6.8m depth.

Over the full depth of the profile in BH210 and BH212, the sandstone was extremely weathered to distinctly weathered and extremely low strength to low strength, with a number of core loss zones up to 0.96m thick present. In BH206 a core loss zone of 0.17m thick was recorded.

It is expected that the core loss zones are due to drilling water erosion of the very weak sandstone bands and possible clay seams. It is most unlikely that core losses represent any form of void.

4 COMMENTS AND RECOMMENDATIONS

The recommendations provided below should form a sound basis for the design of the proposed foreshore works. However, it is likely that there will be elements or issues that may arise of which we are currently unaware. It is also possible that alternate techniques may be proposed which vary slightly from the recommendations in this report. These may require additional geotechnical input during the design phase of the project.

4.1 Summary of Principal Geotechnical Design Issues

A. Construction of the new timber boardwalk will require installation of piles from a barge. This piling will be very similar to that previously installed for the deck in front of the main market building. Piles at the southern end of the boardwalk will be driven through substantial depths of soil of very low bearing capacity and may need to be driven to rock. Piles further to the north near Jetty A will encounter rock at depths of 2m, perhaps even less and will have to be socketed into the rock for lateral stability.

B. The soils which occur between Jetties A and B will form a very poor foundation for any new sea walls. The soils comprise 2m to 3m of poorly compacted

sandy fill containing sandstone fragments of gravel to boulder size as well as some building rubble. If vertically faced sandstone block walls are required then piled foundations will be necessary or large unpredictable settlements will occur. Alternatively an armoured revetment such as those present elsewhere should be considered – as the boardwalk will obscure the wall it will not have any aesthetic value. Existing walls of marginal stability can be stabilised with a rock fill berm placed after the boardwalk piles are driven.

C. Landscaping of the foreshore area behind and between Jetties A and B with pavements, grassed areas and other planting will encounter a subgrade which generally comprises 2m to 3m of fill of predominantly sandy composition, though with some clayey zones, and containing sandstone and other rubble. The fact that the existing car park pavements have performed tolerably well suggests that the proposed landscaping should not encounter major problems in site preparation or forming footings for outside seating where bearing pressures are low.

D. The proposed pedestrian ramp along the northern boundary will more or less follow the existing vehicle ramp, involving only straightforward earthworks and pavement construction. Parts of the ramp will be up to 1.5m above existing levels, which we understand will be supported by low height retaining walls.

4.2 Site Preparation and Earthworks

For any new pavement areas and for preparation of shallow footing bases, the comments and recommendations provided below should be used as a guideline. Details should be reviewed by a geotechnical engineer when the design is more advanced. Earthworks recommendations in this report should be read in conjunction with AS3798-2007: *'Guidelines on Earthworks for Commercial and Residential Developments'*.

Prior to the commencement of any earthworks on this site, reference should be made to the Environmental Investigation Services report (Ref: E24125Krpt dated August 2010) for details of any contamination and waste classification for the disposal of any soils.

Site Drainage

Good drainage should be provided both during construction and for the long term maintenance of the site. The principle aim of the drainage should be to promote run off but avoid erosion. The earthworks should be carefully planned and scheduled to maintain cross-falls during construction, avoiding breaks for holidays etc.

Subgrade Preparation

The following subgrade preparation is recommended under any new pavement areas if not suspended, for high level footing base preparation, and prior to the placement of engineered fill:

- Strip the subgrade of all hard surfacing and/or vegetation, root affected soils or soils containing other deleterious materials. The sandy fill may be separated, screened for deleterious materials and reused as engineered fill.
- Following stripping, proof roll the subgrade using at least 8 passes of a smooth drum roller in static mode with a static weight of no less than 6 tonnes. All proof rolling should be completed in the presence of an experienced geotechnical engineer or geotechnician. As there is the potential for transmitted vibrations to damage nearby structures, proof rolling should be completed under static loads only.
- In the case of shallow footings where it is not possible to use a 6 tonne roller, a 'whacker packer' should be used.
- The purpose of proof rolling is to improve the near surface density of the soils and identify any soft or unstable areas. Any soft or unstable areas identified

should be excavated down to a sound base and reinstated with engineered fill as described below.

General Excavation Comments

Excavation (if any) is expected to be generally of a localised nature for new services trenches and footings and is anticipated to extend to a maximum depth of around 1m.

After removal of the existing pavements, excavation of the fill, and sandy soils should be readily achievable using conventional means such as the buckets of hydraulic excavators. Some difficulties with sandstone and building rubble in the fill could arise.

As excavations should not be greater than about 1m in depth, no shoring would be required, although some localised slumping of the soils should be expected. Care should be taken not to undermine any adjacent buildings or structures.

Engineered Fill

Some of the existing fill and natural sandy soils on site are considered re-usable for engineered fill, provided that they are prepared as detailed below. All fill should be compacted in layers no greater than 150mm loose thickness. Granular materials should be compacted to at least 98% Standard Maximum Dry Density (SMDD) or 75% Density Index. Compaction without vibration in proximity to existing buildings or structures will be difficult and the use of engineered fill is best avoided.
It may be necessary to get further advice for specific areas close to existing structures when further details are known, and possible solutions may include:

- Compaction of engineered fill in very thin layers, with non-vibratory techniques;

- Use of coarse granular fill tamped into place where the stiffness and strength of the fill is not so dependent upon compaction;
- Use a cemented material such as cement stabilised sand which does not rely on compaction for strength/stiffness.

We anticipate that service trench backfill will be compacted using a vibrating plate attached to an excavator, a trench roller, or similar. Where this is not the case and compaction is undertaken using a hand operated whacker packers we recommend that layer thicknesses be reduced to 100mm to help achieve the desired level of compaction.

Compaction Control

Compaction control should consist of density tests completed at a minimum frequency of 1 test/layer/300m^2 or 3 test/layer, whichever is the greater. Level 2 is the lowest category of compaction control that may be completed. For localised backfill areas such as service trenches, excavated soft spots etc, the frequency of testing should be 1 test/2 layers/50m^2. These recommendations should be read in conjunction with AS3798-2007.

4.3 On Shore Retaining Walls & Permanent Batters

Some minor walls may be required such as for the pedestrian ramp. Free-standing and low height cantilevered retaining walls, say to about 2m height should be designed using a coefficient of active earth pressure, K_a of 0.35 for a near level backfill surface and a bulk unit weight of 20kN/m^3. This earth pressure coefficient assumes that some minor movements of the wall will be acceptable; otherwise the design should be based upon an at-rest earth pressure coefficient of 0.55.

Permanent batters should be no steeper than 1V in 2H and protected from erosion using a quickly establishing grass cover or by structural means.

Should footings be constructed near the back of the retaining walls or batters, the surcharge loads should be considered in the design of construction. The design of retaining walls should incorporate appropriate surcharge loads and hydrostatic pressures; alternatively the design should incorporate behind wall drainage to fully and permanently dissipate the pore water pressures.

4.4 Sea Wall Design

As noted above, any sort of vertical structural retaining walls along the waterfront would have to be piled to rock as the near-surface soils comprise 2m to 3m of loose tipped fill. Piles may be designed using the recommendations given in Section 4.5 below.

A cheaper alternative would be to form a battered revetment protected with rip-rap as settlement would not be a critical issue (though settlement of any surcharge fill would of course occur). It would be logical to drive the boardwalk piles first and then form the batter slope behind the outer row of piles using coarse granular fill such as crushed concrete. The less durable the fill the greater the long term settlement of the revetment would be and we would not recommend use of materials such as brick, shale or sandstone (unless the latter were of high quality). A batter face of 2H: 1V should be protected with rip-rap of appropriate type and size.

If vertical walls are required between Jetty A and B, a soldier pile wall will probably be the easiest to construct. Piles could be placed directly in front of the existing walls. The piles could be steel, in which case the panels could be formed by sliding in planks of pre-cast concrete or hardwood. If concrete piles are preferred it will be more difficult to secure the lagging panels, though a range of options are possible. For the design of a soldier pile wall:

- The pile walls should be founded in very low strength sandstone or better. Allowable bearing pressure recommendations are provided in Section 4.5.

- Where movement is of little concern (i.e. where only grassed areas are to be retained), a cantilever retaining wall may be used and designed for a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient, K_a, of at least 0.35, assuming a near horizontal backfill surface.
- If the retaining walls are to be laterally restrained (eg. By anchors), then a trapezoidal lateral earth pressure distribution should be assumed. The pressure may be calculated as 6H kPa where H is the depth in front of the wall in meters, assuming a horizontal backfill surface. The pressure should be taken as a uniform distribution over the central 70% of the trapezoid tapering to zero at the crest and bed level. If there are any structures in the zone of influence of the shoring the assumed earth pressures should be increased to 8H kPa to reduce deflections of the shoring.
- The drilling of conventional strand anchors would be very challenging. We would recommend the use of dead man anchors or plates, which may be designed for a friction angle of 28° or a passive earth pressure coefficient, K_p of 2.8.
- A bulk unit weight of 20kN/m^3 should be adopted for the soils.
- Any surcharge (including nearby footings, ground slopes, compaction stresses etc) affecting the walls should be allowed in the design. If inclined (uphill) ground surfaces are proposed, then they should be treated as a surcharge.
- Any retaining walls should be designed as drained and provision made for permanent and effective drainage of the ground behind the walls. Subsurface drains should incorporate a non-woven geotextile fabric to act as a filter against subsoil erosion.
- Lateral toe restraint may be calculated using a triangular earth pressure distribution with a 'passive' earth pressure coefficient, K_p, of 2.8 for the fill, silty sand or sand. A Factor of Safety of at least 2 should be adopted to limit

deformations, assuming horizontal ground in front of the wall. The passive pressure due to the upper 0.3m below the bay floor level should be ignored in the analysis to consider excavation tolerances. Note that the K_p value should be appropriately reduced if the ground falls away from the wall toe or if excavation is carried out within an envelope radiating up from the wall toe at 1V in 2H.

- Where piles are socketed into the rock for lateral restraint the contribution of the soils above should be ignored.
- Sockets in excess of 0.3m formed in sandstone of low strength or above may be assumed to have 1/3 of the allowable bearing pressures for that quality of rock.
- The design of these walls must take potential deflections of the wall into account, and so we recommend the use of programs such as 'Wallap' or 'Plaxis' for the design.

For the design of cantilever walls (such as new sandstone block sea walls) they should be designed for a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient, K_a, of 0.35, assuming a near horizontal backfill surface behind the wall.

4.5 Footings

The boreholes from this assessment have shown the depth to bedrock to be quite variable over the site. There is a clear trend that depth to rock is greater towards the south. The rock is generally overlain by fill and very loose and loose sandy soils which could not support moderate loads without the probability of significant differential settlements. Consequently we recommend that new structures be

founded on the underlying sandstone bedrock, with the exception of on-land light weight structures.

Any deep footing solutions which bear on the sandstone bedrock will more than likely be below the water table and will penetrate fill and natural silty sand which will not be self supporting. Consequently, conventional bored piers are not a feasible solution. We recommend that driven piles be used for the construction of piles installed over water, which may have to be installed from a barge depending on the reach of the machine.

Driven, CFA piles or bored piers with steel casing could be used for the construction of piles on land. In the latter case prior to pier boring, steel casing would be driven through fill and natural sandy soils, and keyed into underlying sandstone bedrock. The material within the steel casing is bored out, and the concrete tremmied from the base of the hole immediately after completion of boring and cleaning. This process can be very difficult to carry out to good standards and only experienced contractors with a proven track record should attempt it. For any new boardwalk piles it may be possible to cantilever a support system for the walkway on-land without having to drill off a barge.

Whichever combination of techniques is chosen, the presence of concrete rubble over the site in the fill is significant as it would severely impact pile construction and it may be necessary either to dig out the upper layers of the fill to remove obstructions prior to piling or to use powerful boring rigs which could penetrate the layer.

For boardwalk piles that are subject to lateral loads and where rock is shallower then either the pile may need to be pre-bored or perhaps steel piles could be driven into the rock.

High level footings in the sandstone may be possible for some locations along the line of the pedestrian access ramp area only, where the depth to rock may be as little as 0.7m below existing ground.

Piles or shallow footings (less than 1m depth) founded in sandstone may be designed for an allowable bearing pressure of 600kPa. This would increase to 1000kPa if the footings are taken down to sandstone of at least low strength.

A higher allowable bearing pressure of 2500kPa may be adopted for sockets 0.5m into sandstone of at least low to medium in strength, although currently this quality of sandstone has only been proven in a small area of the site between BH206 and BH211. In the other areas of the site the quality of the cored portions of the boreholes is distinctly poorer and includes a number of clayey seams, core loss and extremely weathered zones, and as such this higher bearing pressure is not feasible in these other locations unless piles are founded deeper in the profile at depths proven appropriate by further cored borehole drilling.

Piles should have a nominal socket of 0.5m into the bearing layer. The length of socket greater than 0.5m may be designed for an allowable shaft adhesion value of 10% of the appropriate allowable bearing pressure for that material.

No cored boreholes have been carried out to the south of BH206. Based on the results of the augured borehole logs to the south of BH206, it is likely that higher bearing pressures are feasible, though additional cored boreholes would be required in this area to confirm this.

Both CFA and bored piers generate spoil. The amount of spoil requiring off site disposal should be considered when selecting the piling system, as the soils may be acid sulphate soils that may require treatment or even contaminated.

For the design of small on-land light weight structures the use of shallow (less than 1m in depth) pad or strip footings would be feasible. An allowable bearing pressure of 50kPa should be adopted for shallow footings for light weight structures in the fill or natural sandy soils provided that the footing bases are properly prepared and inspected as detailed below.

Following the detailed excavation for the footing, the foundation should be lightly watered and compacted using a 'whacker packer'. Approximately one day following the compaction, the prepared footing should be inspected by a geotechnical engineer (who would undertake DCP tests) to confirm that the required bearing capacity is achieved. It is likely to be beneficial to over excavate by about 100mm and place a thin layer of material such as roadbase or 'quarter minus' and compact it at the base of the footing to provide a suitable base for forming any shallow footing.

We recommend that at least the initial stages of footing and pile construction be inspected by a geotechnical engineer to confirm that appropriate bearing has been achieved. The need for additional inspections can be determined at that time based on the variability and strength of the strata.

4.6 Pavements

Prior to the placement of any pavements we recommend that the comments and recommendations provided above in Section 4.2 are followed.

Given that the existing pavements over the site area performing moderately well we expect there should be no major problems with long term consolidation and settlement although some slight movement (probably less than 20mm) could occur.

The exposed subgrade should be inspected and any clay soil removed to a depth of at least 400mm and replaced with good quality granular engineered fill

A subbase layer of minimum 100mm thickness of DGB20, compacted to at least 98% of Modified Maximum Dry Density (MMDD), should be used beneath any concrete on-grade floor slabs and pavements. This will provide more uniform slab support and will reduce the pumping of fines at joints. Concrete pavements should be designed with an effective shear transmission of all joints by way of either doweled or keyed joints. Concrete pavements should be constructed with relatively closely spaced joints, say 3m to 4m, to reduce the risk of cracking from the differential movements within the subgrade.

For flexible pavements, all subbase and base layers should be similarly compacted to at least 98% MMDD. The pavements at the site should be provisionally designed for a soaked CBR of 5%, subject to confirmation by soaked CBR testing at the time of the works. A soaked CBR of 5% correlates with a modulus of subgrade reaction of 35KPa/mm (for a 300mm diameter plate) or a small strain elastic modulus of about 50MPa.

Subsoil drains should be installed around the perimeter of the pavements, with inverts not less than 0.2m below the subgrade level. Drainage trenches should be excavated with a significant longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding within the drains. The pavement subgrade should also be graded toward the subsoil drains to promote runoff and minimise ponding on the subgrade. The pavement surface should also have adequate falls to shed surface water.

It should be recognised that where the subgrade comprises uncontrolled fill of variable depth, there is a slight risk of long term settlements affecting the pavements and cross-falls to drainage points should be higher than the usual minimum values.

4.7 Additional Investigation

The investigation data available has provided a reasonable overview of the geotechnical conditions. If detailed design shows a sensitivity to factors such as the depth to rock or the rock quality (bearing capacity), then additional boreholes may be required.

4.8 Further Geotechnical Input

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

- Involvement providing additional advice during the detailed design phase.
- Drilling of additional boreholes if required.
- Inspections of proof rolling and density testing.
- Inspection of the initial stages of footing construction.

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 could be 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.

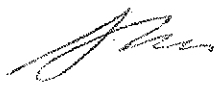
This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented 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.

If there is any change in the proposed development described in this report then all recommendations should be reviewed.

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. 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.



A Ivor
Geotechnical Engineer

Reviewed by:

P Wright
Senior Associate

For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 1 1/2

BOREHOLE LOG

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 19·12·88
Method: SPIRAL AUGER / WASH BORE EDSON RIG
R.L. Surface: + 2.16
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			0			FILL: ripped and crushed sandstone with gravel, clay and sandy zones mottled brown	D to M			APPEARS POORLY/ MODERATELY COMPACTED
	D.S.	N = 30 10, 15, 15	1			——— as above, also with brick fragments				HIGH SPT DUE TO SANDSTONE COBBLES.
						FILL: ripped and crushed sandstone light grey.	M			
	D.S.	N = 8 5, 4, 4	2							
▼ ON RODS AFTER SPT 3m							W			
	D.S.	N = 5 3, 2, 3	3			FILL: ripped and crushed sandstone with gravel cobble, sand and trace of clay, mottled brown.				APPEARS POORLY COMPACTED
			4							
	D.S.	N = 3 11, 2, 1			SC	PEATY CLAYEY SAND: fine to medium grained, black.	W	ML		STRONG ORGANIC ODOUR
			5		PT/ CH	PEATY CLAY: high plasticity with numerous root fibres, black.	MC>PL	S		
	D.S.					Grading to				
	D.S.	SUNN 0·1m HAMMER WEIGHT N = 1 1, 1/300mm	6		SC	CLAYEY SAND: fine to medium grained with shells, grey.	W	VL		
										WASH BORE TRICONE BIT.
	D.S.	N = 3 1, 2, 1	7							

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 1 1/2

BOREHOLE LOG

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 19·12·88
Method: SPIRAL AUGER / WASH BORE EDSON RIG
R.L. Surface: + 2.16
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			0			FILL: ripped and crushed sandstone with gravel, clay and sandy zones mottled brown	D to M			APPEARS POORLY/ MODERATELY COMPACTED
	D.S.	N = 30 10, 15, 15	1			——— as above, also with brick fragments				HIGH SPT DUE TO SANDSTONE COBBLES.
						FILL: ripped and crushed sandstone light grey.	M			
	D.S.	N = 8 5, 4, 4	2							
▼ ON RODS AFTER SPT 3m							W			
	D.S.	N = 5 3, 2, 3	3			FILL: ripped and crushed sandstone with gravel cobble, sand and trace of clay, mottled brown.				APPEARS POORLY COMPACTED
			4							
	D.S.	N = 3 1, 2, 1			SC	PEATY CLAYEY SAND: fine to medium grained, black.	W	ML		STRONG ORGANIC ODOUR
					PT/ CH	PEATY CLAY: high plasticity with numerous root fibres, black.	MC>PL	S		
	D.S.		5			Grading to				
	D.S.	SLIDE 0·1m HAMMER WEIGHT N = 1 1, 1/300mm			SC	CLAYEY SAND: fine to medium grained with shells, grey.	W	VL		
			6							WASH BORE TRICONE BIT
	D.S.	N = 3 1, 2, 1								
			7							

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 1 2/2

BOREHOLE LOG

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K. Method: SPIRAL AUGER / WASH BORE R.L. Surface: + 2·16
Date: 19·12·88 EDSON RIG Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			7		SC	CLAYEY SAND: fine to medium grained with shells, grey	W	VL		WASH BORE
						Grading to				
	D.S.	N=4 2,1,3			SC/CL	SANDY CLAY / CLAYEY SAND: medium plasticity, fine to medium grained, light grey	MC>PL	F to St VL to L	100 150 150 120	
			8			Grading to				
	U50				CL	SANDY CLAY: medium plasticity, light grey	MC>PL	V.St to H	450 >600 330	
						red and yellow brown				
			9							
						SANDSTONE: medium strong to strong? red brown and yellow brown.				HIGH ROLLER BIT RESISTANCE
			10			as above with interbedded "weaker" zones (possibly clay)				BANDED HIGH AND LOW
						Becoming light grey.				
			11							
						END OF BOREHOLE AT 11·1m				
			12							

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 2. 1/2

BOREHOLE LOG

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 19·12·88
Method: SPIRAL AUGER / WASH BORE EDSON RIG
R.L. Surface: + 2.35
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			0			FILL: crushed and ripped sandstone with sand and clay, brick and concrete rubble mottled brown.	D to M			APPEARS POORLY TO MODERATELY COMPACTED
	D.S.	N > 15 15,15/150mm	1							HIGH SPT BLOW COUNT DUE TO SANDSTONE GRAVEL AND COBBLES.
	D.S.	N = 10 8, 6, 4	2			as above, but predominantly crushed and ripped sandstone, brown and light grey				
	D.S.	N = 9 3, 5, 4	3							
ON RODS AFTER SPT AT 4.4m							W			
	D.S.	N = 13 6, 6, 7	4			as above, also with black peaty clay zones and gravelly and cobbly zones brown and black.				
			5							WASH BORE AND CASE. SPT ATTEMPTED @ 5.5m BUT TOO MUCH RUBBLE
	D.S.	SUNK 0.6m UNDER HAMMER WEIGHT	6		SC	CLAYEY SAND: fine to medium grained with shells and root fibres	W	VL		
	U50				CH	Grading to CLAY: high plasticity, with root fibres, light grey	MC>PL	F	50 50 70 100	

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 2 2/2

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 19·12·88
Method: SPIRAL AUGER / WASH BORE EDSON RIG
R.L. Surface: + 2.35
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	U50		7		CH	CLAY: high plasticity, with some sand no root fibres evident, light grey	MC>PL	F to St	150 100 100 80	BASE OF U50
						Grading to				
			8		CL/SC	SANDY CLAY/CLAYEY SAND: medium plasticity fine to medium grained, light grey				
						Grading to				
					SC	CLAYEY SAND: fine to medium grained with interbedded bands of clay, light grey.				
	D.S.	N=4 1, 2, 2	9					L	100 150 125	ON CLAY ZONES
			10							
	D.S.	N=4 3, 2, 2							100 120	ON CLAY ZONES
			11							
			12					VL	100 100	ON CLAY ZONES
	D.S.	N=3 1, 1, 2								
			13			SANDSTONE: medium strong, light grey, brown and red brown.				MODERATE TRICONE RESISTANCE
						END OF BOREHOLE AT 13.7m				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 3.

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 4·1·89
Method: WASH BORE BARGE/ PIONEER MOLE
R.L. Surface: — 1·09
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
					SM	SILTY SAND: fine to medium grained with packets of clay, also with leaves, root fibres gravel and pieces of "alfoil" black.	W	VL		CONTAMINATED WITH WASH FROM NEARBY STORM WATER OUTLET.
	D.S.	N < 1 0/300, 1	1			as above also with shells but no "alfoil" evident.				SPT ATTEMPTED AT 1·5m BUT DRILL RODS SINKING UNDER SELF WEIGHT.
						Grading to				
	D.S.	SUNK 0·5m UNDER ROD WEIGHT SUNK 0·45m UNDER HAMMER WEIGHT	2		CH	CLAY: high plasticity, with interbedded sand zones and some decomposed organics, dark grey	MC>>PL	VS		
		VS	3							
						Grading to				
	D.S.	SUNK 450mm UNDER HAMMER WEIGHT	4		SP	SAND: fine to medium grained with some gravel	W	VL		
						Grading to				
					CH/PT	PEATY CLAY: high plasticity with interbedded sand, gravel and shells, dark grey	MC>>PL	VS		
		VS	5							
			6			SANDSTONE: fine to medium grained, highly weathered, weak, light grey red and yellow brown				MODERATE ROLLER BIT RESISTANCE
	D.S.	N > 20 20/90mm HAMMER BOUNCING				as above, but weak to medium strong				MODERATE TO HIGH ROLLER BIT RESISTANCE

END OF BOREHOLE AT 7·0m

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No. 4. 1/2

BOREHOLE LOG

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 4·1·89
Method: WASH BORE / BARGE / PIONEER MOLE
R.L. Surface: – 3.67
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
					SM	SILTY SAND: fine to medium grained with gravel leaves, pieces of plastic, paper and root fibres, some clay, black.	W	VL		CASING SUNK TO 1·0m UNDER SELF WEIGHT
						Grading to				
	D.S.	SUNK 0·45m UNDER HAMMER WEIGHT	1		CH/Pt	PEATY CLAY: high plasticity with sand and shells, black.	MC>>PL	VS	10 20 20 10 20	
	D.S.	VS								
						Grading to				
	U50		2		CH	CLAY: high plasticity, with some fine root fibres also fine sand and gravel, dark grey and grey	MC>>PL		50 50 60	U 50 SUNK UNDER SELF WEIGHT OF RODS
	D.S.	VS								
			3							
						Becoming				
	D.S.	VS				light grey with some fine to medium grained sand no root fibres or gravel evident	MC>PL	St.		
	U50		4						150 150 160	
						Grading to				
					SC/CL	SANDY CLAY / CLAYEY SAND: (INTERBEDDED) fine to medium grained, medium plasticity, light grey.	(MC>PL W)	(F to St) (L)		
	D.S.	N=4 3,2,2	5						100 100 100 100	
						Grading to				
	D.S.	SUNK 0·7m UNDER SELF WEIGHT OF RODS ONLY	6		SC	CLAYEY SAND: fine to medium grained, light grey	W	VL		

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 4 2/2

Client: FISH MARKETING AUTHORITY
Project: PROPOSED BROADWALK PROJECT
Location: FISH MARKETS BLACKWATTLE BAY PYRMONT N.S.W.

Job No. 6416 K
Date: 4·1·89
Method: WASH BORE BARGE / PIONEER MOLE
R.L. Surface: − 3·67
Datum: AHD

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer kPa.	Remarks
			7		SC	CLAYEY SAND: fine to medium grained, light grey	W	VL		
	D.S.	N = 13 9, 8, 5				as above, but light grey and yellow brown.		MD		
			8			Grading to	MC>PL	St	150, 130 120	
					CL	SANDY CLAY: medium plasticity, red brown and light grey				HIGH ROLLER BIT RESISTANCE
					CH	SANDSTONE ?? + HARD IRONSTONE GRAVEL BAND ??? — YELLOW BROWN	MC>PL	V.St		
	D.S.	N = 14 3, 6, 8	9			SILTY CLAY: high plasticity with fine ironstone gravel inclusions light grey and yellow brown			200 250 200 250	
			10							
	D.S.	N = 18 3, 7, 11				as above, also with brown			250 250 300 200 300	
			11			SANDSTONE: fine to medium grained weak to medium strong, brown.				MODERATE TO HIGH ROLLER BIT RESISTANCE
			12			END OF BOREHOLE AT 12·2m				
			13							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 201 1/1

BOREHOLE LOG

Client: McMILLAN BRITTON & KELL PTY LTD
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S **Method:** SPIRAL AUGER GCH RIG **R.L. Surface:** –
Date: 22–5–95 **Datum:** –
Logged/Checked by: D.J.

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0		–	ASPHALTIC CONCRETE: 30mm.t.	MC>PL	–	–	
	DS					FILL: Silty gravely clay, medium plasticity, dark grey with fine igneous gravel.				APPEARS MODERATELY TO WELL COMPACTED
	DS	N > 31 10,15, 16/ 100mm				FILL: Gravelly sand, fine to medium grained, grey with fine igneous gravel.	M			
			1			FILL: Sandy gravel, fine to coarse sandstone gravel.				
▼ AFTER 3 HRS	DS									
					SM	SILTY SAND: fine grained, brown, with many fine grained root fibres.	M	VL	–	–
	DS	N < 1 1/280mm	2							
		BOUNCING			–	SANDSTONE: medium to coarse grained, pale grey, highly weathered, weak with clay bands.	–	–	–	LOW TO MODERATE 'TC' BIT RESISTANCE
	DS		3			END OF BOREHOLE AT 3.0m				
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 202A 1/1

BOREHOLE LOG

Client: McMILLAN BRITTON & KELL PTY LTD
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 22-5-95
Method: SPIRAL AUGER, GCH RIG
R.L. Surface: –
Datum: –
Logged/Checked by: D.J./

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			ASPHALTIC CONCRETE: 20mm.t. over 230mm roadbase.				
						END OF BOREHOLE AT 0.25m				'TC' BIT REFUSAL ON CONCRETE
			1							
			2							
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

BOREHOLE LOG

Borehole No. 202B 1/1

Client: McMILLAN BRITTON & KELL PTY LTD
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 22-5-95
Method: SPIRAL AUGER, GCH RIG
R.L. Surface: –
Datum: –
Logged/Checked by: D.J./

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0		–	ASPHALTIC CONCRETE: 20mm.t.	M	–	–	
						FILL: Sandy gravel, fine to coarse gravel, dark grey.				APPEARS MODERATELY COMPACTED
						FILL: Sand, fine to medium grained, orange brown, with some clay and fine to medium sandstone gravel.				
	DS	N = 27 6,10,17	1							
▼ AFTER 2.25 HRS ▶	DS									
			2		SM	SILTY SAND: fine to medium grained, brown.	W	–	–	–
					–	SANDSTONE: medium to coarse grained, pale grey with yellow mottling, highly weathered, very weak to weak.	–	–	–	LOW 'TC' BIT RESISTANCE
	DS		3			as above, but extremely weathered, extremely weak.				VERY LOW RESISTANCE
						as above, but highly to moderately weathered, weak to medium strong.				LOW TO MODERATE RESISTANCE
	DS		4							
						END OF BOREHOLE AT 4.0m				
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 203 1/1

BOREHOLE LOG

Client: McMILLAN BRITTON & KELL PTY LTD
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 22-5-95
Method: SPIRAL AUGER GCH RIG
R.L. Surface: –
Datum: –
Logged/Checked by: D.J./

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION & AFTER 1.75 HRS			0		–	ASPHALTIC CONCRETE: 30mm.t. over 70mm fine crushed rock.	–	–	–	–
	DS				–	CONCRETE: 120mm.t.	M	–	–	APPEARS MODERATELY COMPACTED
	DS	N > 10 10/ 130mm BOUNCING				FILL: Sand, fine to medium grained, yellow brown with fine to medium sandstone gravel.				
			1		–	SANDSTONE: medium to coarse grained, pale grey with red and yellow mottling, moderately weathered, weak to medium strong.	–	–	–	MODERATE 'TC' BIT RESISTANCE
	DS					as above, but moderately to slightly weathered, medium strong to strong.				HIGH RESISTANCE
	DS		2			END OF BOREHOLE AT 2.0m				
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 204 1/1

BOREHOLE LOG

Client: McMILLAN BRITTON & KELL PTY LTD
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 22-5-95
Method: SPIRAL AUGER GCH RIG
R.L. Surface: –
Datum: –
Logged/Checked by: D.J./

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION & AFTER 30 MINS			0			ASPHALTIC CONCRETE: 40mm.t. over concrete 150mm.t.				
	DS	N = 12 2,6,6			–	FILL: Silty sand, fine to medium grained, brown with fine to medium sandstone gravel.	M	–	–	APPEARS MODERATELY COMPACTED
	DB		1			FILL: Clayey sand, fine to medium grained, pale grey and brown with some fine to medium sandstone gravel.				
						END OF BOREHOLE AT 1.5m				
			2							
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 205 1/1

BOREHOLE LOG

Client: McMILLAN BRITTON & KELL PTY LTD
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 22-5-95
Method: SPIRAL AUGER GCH RIG
R.L. Surface: –
Datum: –
Logged/Checked by: D.J./

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION & AFTER 10 MINS	DS	N = 28 13,9,19	0			ASPHALTIC CONCRETE: 30mm.t. over 150mm concrete.				10mm REINFORCEMENT
	DB		1			FILL: Clayey sand, fine to medium grained, pale grey and brown with red mottling, with some fine to medium sandstone gravel.	M			APPEARS MODERATELY TO WELL COMPACTED
						END OF BOREHOLE AT 1.5m				
			2							
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

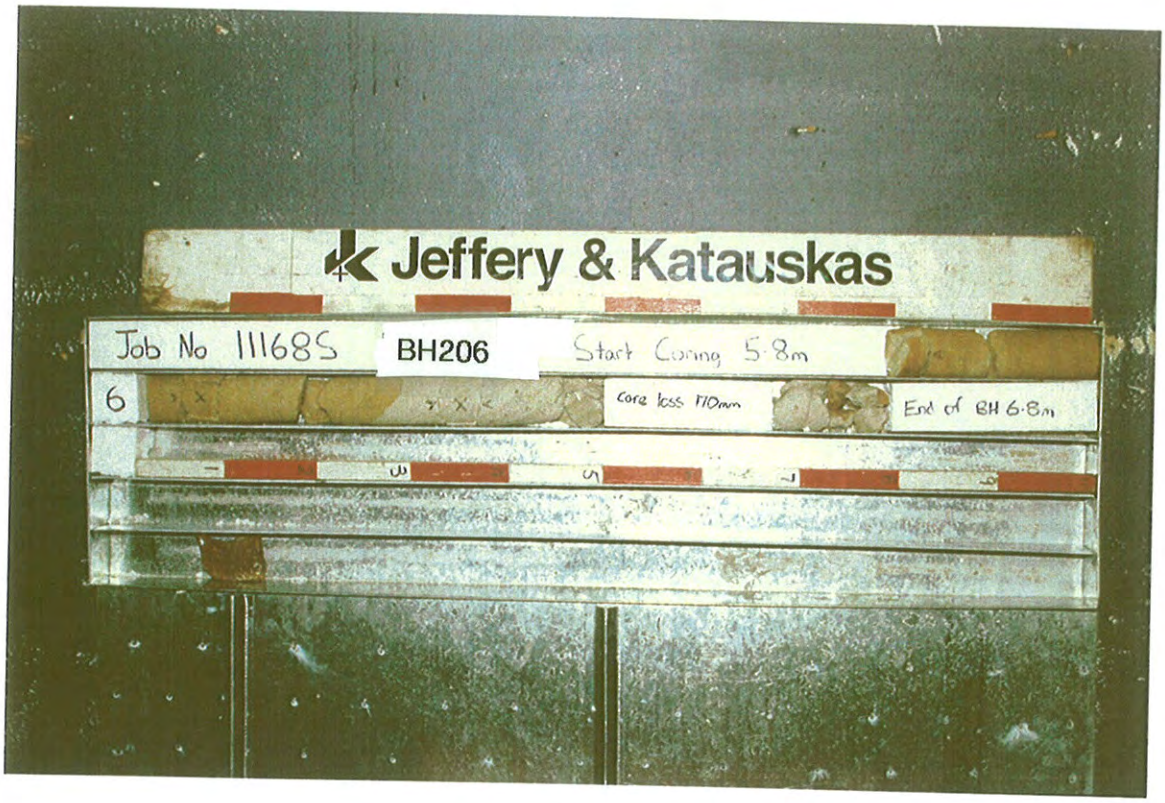
Borehole No. 206 1/2

BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S **Method:** WASH BORING ** **R.L. Surface:** −2.29m
Date: 30−5−95 **Datum:** WOODEN JETTY
Logged/Checked by: K.B.

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0		–	FILL: Silty sand, fine to medium grained, grey.	W			WASHBORING APPEARS POORLY COMPACTED METAL PIPE CASING REFUSAL WOOD
			2		SM	SILTY SAND: fine to medium grained, grey.	W	(L) (MD)	–	– BOREHOLE COLLAPSED AFTER CORING
			6			REFER TO CORED BOREHOLE LOG ** NOTE: BH's 6, 10, 11 & 12 ALL ADOPT ZERO DEPTH AS BAY FLOOR LEVEL				


Jeffery & Katauskas
Job No 111685
BH206
Start Coring 5·8m
6
Core loss 110mm
End of BH 6·8m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 206 2/2

CORED BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** −2.29m
Date: 30−5−95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY
Drill Type: MELVELLE **Bearing:** − **Logged/Checked by:** K.B./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EW VW W MS S VS ES	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		5		START CORING AT 5.8m					
		6		SANDSTONE: fine to medium grained, pale white grey with orange brown staining.	HW−MW	W−MS	× × ×		
				CORE LOSS 0.17m					BOREHOLE COLLAPSED
				SANDSTONE: as above.	MW	MS			
				END OF BOREHOLE AT 6.8m					
		7							
		8							
		9							
		10							
		11							
		12							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

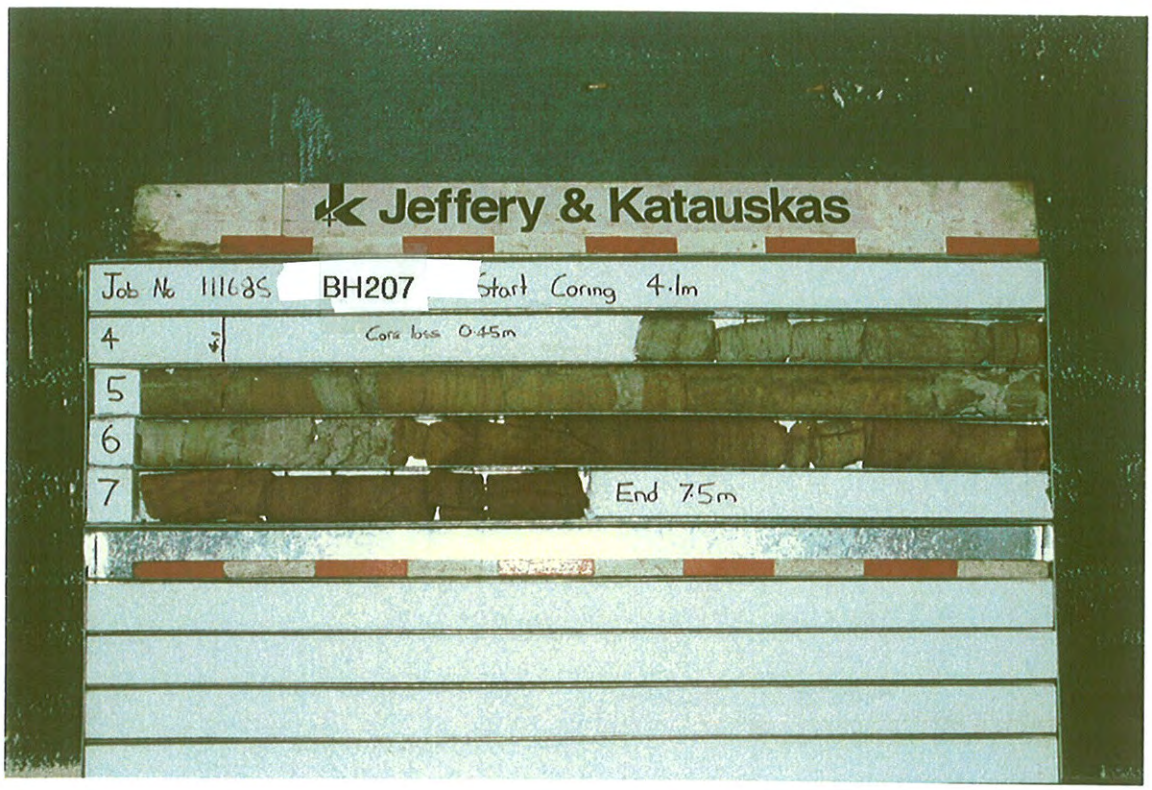
Borehole No. 207 1/2

BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 29-5-95
Method: SPIRAL AUGER BCD 450
Logged/Checked by: K.B.
R.L. Surface: +0.49m
Datum: WOODEN JETTY

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			ASPHALTIC CONCRETE: 45mm.t. over roadbase; silty sand, fine grained, grey with crushed igneous rock up to 10mm diameter.				
					–	FILL: Sand, fine to medium grained, yellow brown and grey with ripped sandstone.	M	–	–	–
	DS	N = 2 2/450mm	1							
▶						FILL: Silty clay, medium plasticity, pale grey and brown with some ripped sandstone gravel.	MC>PL			
	DS	N = 6 6,3,3	2							STRONG HYDROCARBON ODOUR
	DS		3		SM	SILTY SAND: fine to medium grained, grey with a trace of sea shells.	W	–		–
	DS									
	DS	SUNK 0.2m								
		N > 15 13,15/ 100m	4							
		BOUNCING				REFER TO CORED BOREHOLE LOG				
			5							
			6							
			7							


Jeffery & Katauskas
Job No 11168S
BH207
Start Coring 4.1m
4
Core loss 0.45m
5
6
7
End 7.5m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 207 2/2

CORED BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** +0.49m
Date: 29-5-95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY
Drill Type: BCD 450 **Bearing:** – **Logged/Checked by:** K.B./

Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 600 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		4		START CORING AT 4.1m					
1/2 RET-URN		5		SANDSTONE: fine to medium grained, pale grey, subhorizontally bedded 0-20°.	HW	W	×		
				as above, but with some yellow brown staining.			×		- EW, EW SEAM, 0°, 20mm.t.
		6			EW	EW	×		
				as above, but mottled yellow brown and purple brown.	HW	MS			- JOINT, 80°, PLANAR, ROUGH
		7					×		- JOINT, 75°, PLANAR, ROUGH - JOINT, 90°, PLANAR, INTACT
				END OF BOREHOLE AT 7.5m					
		8							
		9							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 208 1/2

BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 29-5-95
Method: SPIRAL AUGER BCD450
Logged/Checked by: K.B.
R.L. Surface: +0.88m
Datum: WOODEN JETTY

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			FILL: Clayey sand, fine to medium grained, mottled grey and pale brown with a trace of ripped concrete and sandstone gravel.	M			APPEARS POORLY COMPACTED
	DS		1							
▶	DS	N = 1 1/450mm								
			2							
	DS				SM	SILTY SAND: fine grained, pale grey.	W	(L)		–
					–	SANDSTONE: medium grained, yellow brown, highly weathered, weak.	–	–	–	LOW TO MODERATE 'TC' BIT RESISTANCE
						REFER TO CORED BOREHOLE LOG				
			3							
			4							
			5							
			6							
			7							


Jeffery & Katauskas
Job No. 111685 BH208 Start Coring 28m
3
4
5
Core Loss 0%
End of BH 5.6m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 208 2/2

CORED BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** +0.88m
Date: 29-5-95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY
Drill Type: BCD 450 **Bearing:** – **Logged/Checked by:** K.B./

Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EW VW W MS S VS ES	DEFECT SPACING (mm) 600 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		1							
		2		START CORING AT 2.8m					
RET-URN		3		SANDSTONE: fine to medium grained, mottled pale grey, red brown and orange, subhorizontally bedded 0-10°.	HW-MW	MS	×		NOTE: DEFECTS NOT DESCRIBED ARE BEDDING PARTINGS, 0-10°, PLANAR, ROUGH.
		4					× × ×		
				CORE LOSS 0.14m					· EW,EW SEAM, 0°,30mm.
		5		SANDSTONE: as above.	HW-MW	MS-S	× × ×		
				END OF BOREHOLE AT 5.6m					
		6							
		7							
		8							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

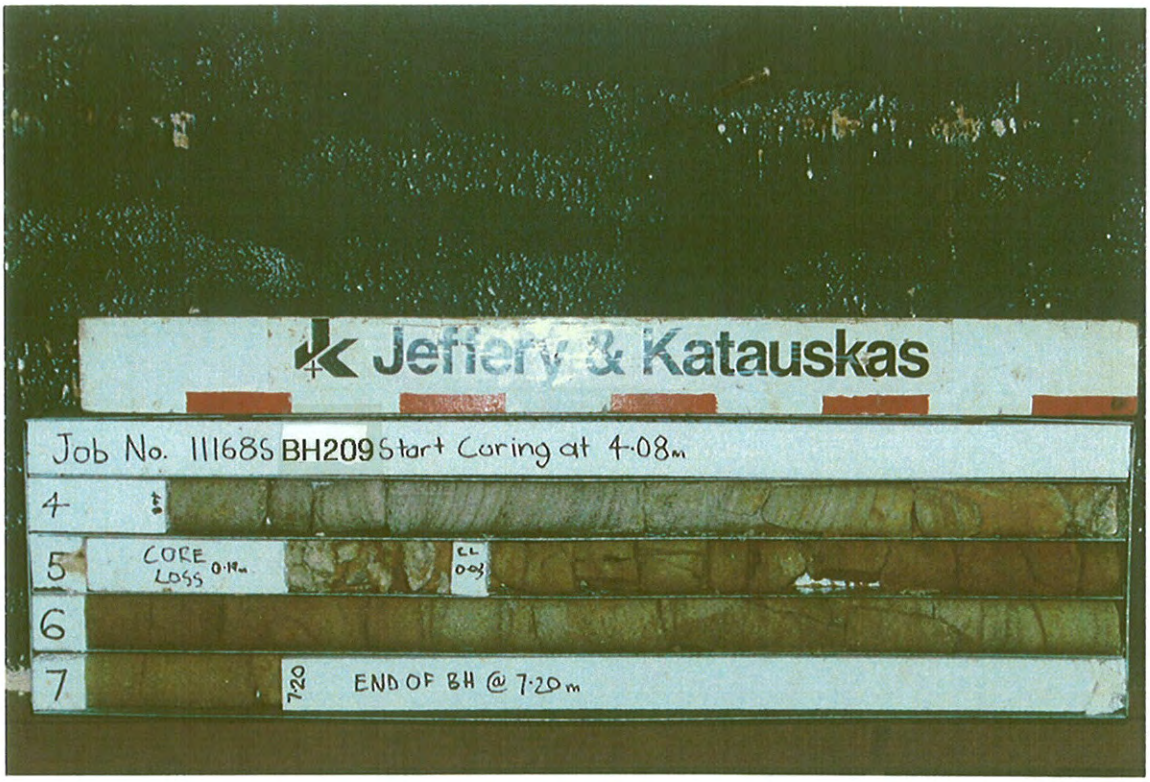
BOREHOLE LOG

Borehole No. 209 1/2

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S
Date: 25-5-95
Method: SPIRAL AUGER BCD 450
Logged/Checked by: T.S./
R.L. Surface: +0.21m
Datum: WOODEN JETTY

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			ASPHALTIC CONCRETE: 70mm.t.				
					–	over Roadbase gravel and sand.	M			
	DS					FILL: Sand, fine to medium grained, yellow/orange with some crushed sabdstone and igneous gravel.				APPEARS POORLY TO MODERATELY COMPACTED TOO FRIABLE FOR H.P.
	DS	N = 17 2,9,8	1			FILL: Sandy silt, fine grained, black, with some fine igneous gravel.				STRONG ORGANIC ODOUR
▶										
	DS	N = 2 1,1, 1/500mm	2			FILL: Sand, medium to coarse grained, grey mottled orange with some crushed sandstone gravel.	W			50mm SAMPLE RECOVERED
						grading to FILL: Clayey sand, medium grained, grey brown.				
	DS		3							
										SOME SMALL SHELLS
	DS				SP	SAND: medium to coarse grained, grey mottled orange.	W	–	–	–
	DS	N > 10 27,10/ 50mm	4			as above, but grading to grey.				
		BOUNCING			–	SANDSTONE: medium to coarse grained, pale grey.	–	–	–	LOW TO MODERATE 'TC' BIT RESISTANCE
						REFER TO CORED BOREHOLE LOG				
			5							
			6							
			7							


Jeffery & Katauskas
Job No. 11168S BH209 Start Coring at 4.08m
4
5
CORE LOSS 0.19m
CL 0.03
6
7
7.20
END OF BH @ 7.20m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. 209 2/2

Client:

Project: FORESHORE DEVELOPMENT

Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** +0.21m

Date: 25-5-95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY

Drill Type: BCD 450 **Bearing:** — **Logged/Checked by:** T.S.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EW VW W MS S VS ES	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		4		START CORING AT 4.08m					
FULL RETURN		5		SANDSTONE: medium to coarse grained, subangular, pale grey.	MW	W			- BEDDING PARTING, 0mm, 2°. - CLAY SEAM, 20mm.t, SANDY CLAY - CLAY SEAM, 60mm.t. - JOINT, 1mm.t, 80°, PLANAR, ROUGH - CLAY SEAM
				CORE LOSS 0.19m					
		6		SANDY CLAY: fine to medium grained, pale grey with some ironstone bands.	MW	W-MS			
				SANDSTONE: fine to medium grained, yellow mottled red brown.					
		7		as above, but pale yellow grey.					- JOINT, 0mm.t, 4°, PLANAR, ROUGH - BEDDING PARTING, 1mm.t, ROUGH - BEDDING PARTING, 1mm.t, ROUGH - JOINT, 75°, PLANAR, ROUGH
				END OF BOREHOLE AT 7.2m					
		8							
		9							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 210 1/2

BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S **Method:** WASH BORING **R.L. Surface:** -1.52m
Date: 2-6-95 **Datum:** WOODEN JETTY
Logged/Checked by: K.B./

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO SCALA SHEET	0		SM	SILTY SAND: fine to medium grained, grey with some seashells.	W	VL	1	WASHBORING
			3			REFER TO CORED BOREHOLE LOG				


Jeffery & Katauskas
Job No 11168S
BH210
Start Coring 3.0m
3
Core Loss 0.73m
4
Core Loss 0.88m
5
Core Loss 0.96m
6
End 6.83m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. 210 2/2

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** −1.52m
Date: 2−6−95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY
Drill Type: MELVELLE **Bearing:** − **Logged/Checked by:** K.B.

Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ (EW VW W MS S VS ES)	DEFECT DETAILS: DEFECT SPACING (mm) (600 300 100 50 30 10)	DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating. Specific / General
		2		START CORING AT 3.0m					
		3		SANDSTONE: fine to meidum grained, mottled pale grey yellow brown and red.	HW	VW	×		
				CORE LOSS 0.73m					
		4		SANDSTONE: medium grained, pale grey, yellow brown and red.	EW	EW−VW			
				CORE LOSS 0.88m					
		5		SANDSTONE: as above.	HW	VW	×		JOINT, 90°, PLANAR, ROUGH SANDY CLAY SEAM, 15°, 30mm.t.
				CORE LOSS 0.96m					
		6		SANDSTONE: medium to coarse grained, yellow brown with red staining.	HW	W	×		JOINT, 85°, PLANAR, IRONINDURATED
		7		END OF BOREHOLE AT 6.88m					
		8							
		9							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 211 1/2

BOREHOLE LOG

Client:

Project: FORESHORE DEVELOPMENT

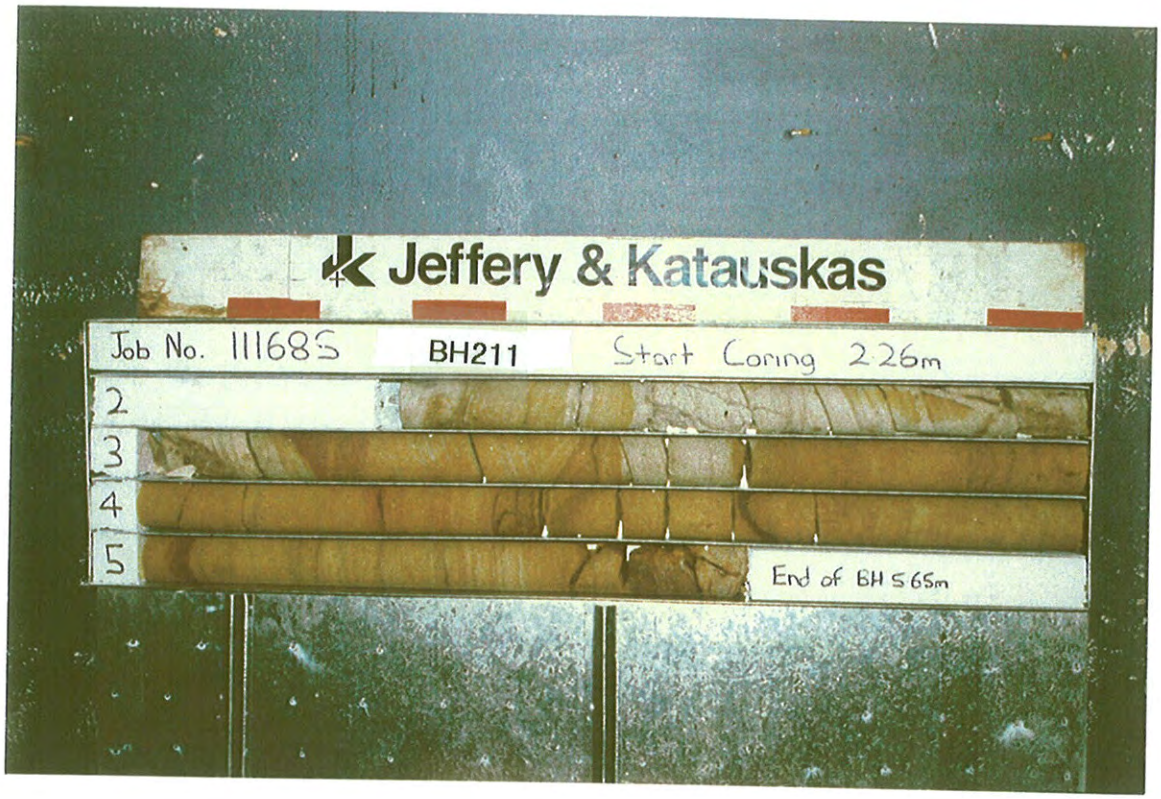
Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S **Method:** WASHBORING **R.L. Surface:** −1.59m

Date: 6−6−95 **Datum:** WOODEN JETTY

Logged/Checked by: K.B.

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO SCALA SHEET	0		SM	SILTY SAND: fine to medium grained, grey and pale brown with some sea shells.	W	VL		BRICKS AND RUBBLE SURFACE COVER
			1							
			2							
						REFER TO CORED BOREHOLE LOG				
			3							
			4							
			5							
			6							
			7							


Jeffery & Katauskas
Job No. 111685
BH211
Start Coring 2.26m
2
3
4
5
End of BH 5.65m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 211 2/2

CORED BOREHOLE LOG

Client:
Project: FORESHORE DEVELOPMENT
Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** −1.59m
Date: 6−6−95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY
Drill Type: MELVELLE **Bearing:** − **Logged/Checked by:** K.B.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ (EW VW W MS S VS ES)	DEFECT DETAILS: DEFECT SPACING (mm) (500 300 100 50 30 10)	DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating. Specific / General
		1							DEFECTS NOT DESCRIBED ARE BEDDING PARTINGS, 0-20°, PLANAR, ROUGH
		2		START CORING AT 2.26m					
		3		SANDSTONE: fine to medium grained, pale white grey with yellow brown staining subhorizontally bedded 0−20°.	HW−MW	MS−S	×		- 2 JOINTS, 80-85°, PLANAR, ROUGH - JOINT, 70°, PLANAR, ROUGH - JOINT, 60°, PLANAR, ROUGH
		4		as above, but yellow brown with a trace of red staining.			×		- SANDY CLAY SEAM, 0°, 1mm.t.
		5					×		- JOINT, 30°, PLANAR, IRONSTAINED - CLAY NODULE - JOINT, 60°, PLANAR, ROUGH
		6		END OF BOREHOLE AT 5.65m					
		7							
		8							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 212 1/2

BOREHOLE LOG

Client:

Project: FORESHORE DEVELOPMENT

Location: SYDNEY FISH MARKETS. NSW.

Job No. 11168S **Method:** WASHBORING **R.L. Surface:** −2.14m

Date: 9−6−95 **Datum:** WOODEN JETTY

Logged/Checked by: K.B.

Groundwater Record	Samples	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO SCALA SHEET	0		SM	SILTY SAND: fine to medium grained, grey with some seashells.	W	VL		WASHBORING
			1							
			2							
			3			REFER TO CORED BOREHOLE LOG				
			4							
			5							
			6							
			7							


Jeffery & Katauskas
Job No 111685
BH212
Start Coring 2.86
3
4
5
6
Core Loss 0.56m
Core Loss 0.37m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL ENGINEERS

Borehole No. 212 2/2

CORED BOREHOLE LOG

Client:

Project: FORESHORE DEVELOPMENT

Location: SYDNEY FISHMARKETS, PYRMONT. NSW.

Job No. 11168S **Core Size:** NMLC **R.L. Surface:** −2.14m

Date: 9−6−95 **Inclination:** VERTICAL **Datum:** WOODEN JETTY

Drill Type: MELVELLE **Bearing:** − **Logged/Checked by:** K.B.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EW VH H MS S VS ES	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		1							
		2		START CORING AT 2.86m					
		3		SANDSTONE: fine to medium grained, pale white grey subhorizontally bedded 0−10°.	EW	EW EW−VW	×		
		4					×		- JOINT, 85°, INTACT, PLANAR
		5		CORE LOSS 0.56m					
				SANDSTONE: as above.	EW	EW VW	×		
				CORE LOSS 0.37m					
		6		SANDSTONE: as above, but with some orange brown staining.	EW	EW VW	×		
		7							- CLAY SAND SEAM, 0°, 35mm t.
				END OF BOREHOLE AT 7.0m					
		8							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 401 1/1

Client: SYDNEY HARBOUR FORESHORE AUTHORITY
Project: PROPOSED UPGRADE
Location: SYDNEY FISH MARKETS, PYRMONT. NSW

Job No. 16325S **Method:** SPIRAL AUGER JK 450 **R.L. Surface:** ≅ 2.7m
Date: 4-12-01 **Datum:** AHD
Logged/Checked by: P.R./

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			ASPHALTIC CONCRETE: 100mm.t				
								-	FILL: Silty sand, fine to medium grained, grey brown, with sub angular igneous gravels, fine to medium grained.	D	-	-	- CONCRETE AND SANDSTONE BOULDERS ≅1.1m.t
▼ ON COMPLETION DURING DRILLING					N = 4 2,2,2	2			FILL: Clayey sand, fine to medium grained, grey and brown, with bands of sub rounded slag gravels, fine to medium grained.	M-W			STRONG PETROLEUM ODOUR APPEARS POORLY COMPACTED
					N < 1 1/450mm	3		SP	SILTY SAND: fine to medium grained, grey, with a trace of small pieces of decomposed wood.	W	VL	-	SLIGHT PETROLEUM ODOUR TO 3.5m DEPTH
						4		SC	CLAYEY SAND: fine to medium grained, grey.	M-W	(VL)		
					SPT 1/150mm REFUSAL	5		-	SANDSTONE: fine to medium grained, grey with brown mottling and with a trace of clay bands.	DW	L-M	-	LOW 'TC' BIT RESISTANCE WITH MEDIUM BANDS
											M		MODERATE RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

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Borehole No. 402 1/1

BOREHOLE LOG

Client: SYDNEY HARBOUR FORESHORE AUTHORITY
Project: PROPOSED UPGRADE
Location: SYDNEY FISH MARKETS, PYRMONT. NSW

Job No. 16325S **Method:** SPIRAL AUGER JK 450 **R.L. Surface:** ≅ 2.0m
Date: 4-12-01 **Datum:** AHD
Logged/Checked by: P.R./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
DRY ON COMPLETION						0			ASPHLATIC CONCRETE: 80mm.t over CONCRETE: 320mm.t				
					N = 13 10,8,5	1		-	FILL: Silty sand, fine to medium grained, dark grey, with sub rounded sandstone gravels and with a trace of clay fines and ash bands.	M	-	-	APPEARS WELL COMPACTED
						2		-	SANDSTONE: fine to medium grained, yellow brown and grey banded and with a trace of clay bands.	XW-DW	VL	-	VERY LOW TO LOW 'TC' BIT RESISTANCE
▼ AFTER 3 HRS										DW	L-M		LOW RESISTANCE
						3			END OF BOREHOLE AT 3.0m				
						4							
						5							
						6							
						7							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 514 1/1

BOREHOLE LOG

Client: SYDNEY FISH MARKET PTY LTD

Project: SYDNEY FISH MARKET REDEVELOPMENT

Location: SYDNEY FISH MARKETS, PYRMONT, NSW

Job No. 23982S **Method:** SPIRAL AUGER JK250 **R.L. Surface:** ≈ 2.1m

Date: 11-5-10 **Datum:** AHD

Logged/Checked by: A.M./

Groundwater Record	SAMPLES ES	SAMPLES ASB	SAMPLES ASS	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 230mm.t				
								-	ASPHALTIC CONCRETE: 150mm.t	-	-	-	
								-	FILL: Clayey gravelly sand, fine to medium grained, orange brown and grey, fine to coarse grained sub angular to sub rounded igneous and sandstone gravel.	M	-	-	SLIGHT HYDROCARBON ODOUR
					N = 10 5,7,3	1			FILL: Silty sand, fine to medium grained, light grey ad and yellow brown, with fine to coarse grained sub rounded sandstone gravel.				APPEARS MODERATELY COMPACTED
					N = 7 3,3,4			SM	SILTY SAND: fine to medium grained, grey and yellow brown.	M	L	-	
▼ DURING DRILL -ING & ON COMPLET -ION						2			as above, but grey, with shell fragments.	W	L		ALLUVIAL
					N = 2 0,1,1	3					VL		
						4		-	SANDSTONE: fine to medium grained, yellow brown, with clay bands.	DW	VL-L	-	LOW 'TC' BIT RESISTANCE
						5			SANDSTONE: fine to medium grained, light brown.		L-M		LOW TO MODERATE RESISTANCE
						6			END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 601 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER **R.L. Surface:** N/A

Date: 21-7-10 JK250 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 200mm.t				15mm DIA. REINFORCEMENT, 150mm TOP COVER
								-	FILL: Silty sand, brown.	M	-	-	
					N = 15 3,3,12				FILL: Silty sandy clay, medium plasticity, grey brown, with igneous gravel and a trace of slag and ash.	MC≈PL			
						1			FILL: Silty clayey sand, fine to medium grained, brown, with a trace of sandstone gravel, ash and slag.	M			APPEARS WELL COMPACTED
					N = 23 8,10,13				as above, but also with a trace of organic material.				ORGANIC MATERIAL INCLUDED GRASS/ STRAW
						2							
									FILL: Silty sand, fine to medium grained, light brown, with sandstone gravel.	M			
					N = 12 ?,4,8	3							SPT SANK 150mm UNDER SELF WEIGHT
ON COMPLET -ION									as above, but dark grey brown, with sandstone gravel and cobbles.	W			
					N = 19 4,9,10	4							
						5							
								CL	SILTY CLAY/CLAYEY SILT: low to medium plasticity, dark grey, with organic material and shell fragments.	MC>PL	-	-	
						6			END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 602 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			CONCRETE: 220mm.t				15mm DIA. REINFORCEMENT, 150mm TOP COVER
					N = 4 1,2,2			-	FILL: Silty sandy clay, medium plasticity, light brown, with sandstone gravel and a trace of ash.	MC≈PL	-	-	APPEARS MODERATELY COMPACTED
					N > 50 12,25, 25/130mm REFUSAL	1			FILL: Silty sand, fine to medium grained, brown, with brick and sandstone gravel, and a trace of ash and slag.	M			APPEARS WELL COMPACTED
						2			as above, but light brown, with clay fines, brick, slag and ash absent.				
					N > 28 6,28/ 100mm REFUSAL	3							
									END OF BOREHOLE AT 3.5m				'TC' BIT REFUSAL ON OBSTRUCTION IN FILL
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 603 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			CONCRETE: 230mm.t				10mm DIA. REINFORCEMENT, 95mm TOP COVER
					N = 13 3,7,6			-	FILL: Sandy gravel, fine to medium grained sub angular, grey, igneous gravel, fine to medium grained sand.	M	-	-	APPEARS WELL COMPACTED
						1			FILL: Silty sand, fine to medium grained, light brown.	D-M			
					N = 3 1,1,1				as above, but grey, with a trace of igneous gravel.				APPEARS POORLY COMPACTED
						2							
									END OF BOREHOLE AT 2.5m				'TC' BIT REFUSAL ON OBSTRUCTION IN FILL (POSSIBLY CONCRETE)
						3							
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 604 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 21-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			CONCRETE: 170mm.t				6mm DIA. REINFORCEMENT, 100mm TOP COVER
								-	FILL: Sandy gravel, fine to coarse grained sub angular igneous gravel, grey, fine to medium grained sand.	M	-	-	
						1			FILL: Silty clayey sand, fine to medium grained, brown, with a trace of igneous and sandstone gravel.				APPEARS POORLY COMPACTED
					N = 4 4,1,3								
						2							SLIGHT HYDROCARBON ODOUR
					N = 2 1,1,1	3		ML SM	CLAYEY SILT: medium plasticity, dark grey, with a trace of shell fragments and organic material	MC > PL W	-	-	
									SILTY SAND: fine to medium grained, dark grey brown, with a trace of shell fragments.				
						4			END OF BOREHOLE AT 3.45m				
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 605 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 90mm.t CONCRETE: 200mm.t				
					N = 7 9,4,3			-	FILL: Silty sand, fine to medium grained, dark brown, with sandstone gravel.	M	-	-	APPEARS MODERATELY COMPACTED
						1			FILL: Silty gravel, fine to coarse grained sub angular igneous gravel, grey, fine to medium grained sand.	W			HYDROCARBON ODOUR
					N = 3 1,2,1				FILL: Silty sand, fine to medium grained, dark brown, with sandstone gravel.	M			APPEARS POORLY COMPACTED
▼ ON COMPLET -ION						2		SM	SILTY SAND: fine to medium grained, dark grey brown, with a trace of shell fragments.	W	-	-	HYDROCARBON ODOUR
					SPT 0	3							SPT SUNK 450mm UNDER SELF WEIGHT
						4							MONITORING WELL INSTALLED TO 6m, CLASS 18 50mm DIA. PVC FROM 6m TO 3m, CASING FROM 3m TO SURFACE, 2mm SAND FILTER PACK TO 1m, BENTONITE SEAL FROM 1m TO 0.5m, BACKFILLED WITH CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP
						5							
						6		CL	SILTY CLAY: medium plasticity, orange brown, with sand.	MC > PL	-	-	
									END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **606** 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0		-	ASPHALTIC CONCRETE: 40mm.t	-	-	-	9mm DIAMETER REINFORCEMENT, 60mm TOP COVER
									CONCRETE: 150mm.t	M	-	-	
					N = 9 7,5,4				FILL: Silty clayey sand, fine to medium grained, brown, with sandstone gravel and a trace of ash and slag.				APPEARS MODERATELY COMPACTED
						1			as above, but grey and brown, ash and slag absent.				HYDROCARBON ODOUR
					N = 6 7,3,3								
						2			as above, but dark grey.	W			VERY STRONG HYDROCARBON ODOUR
								-	SANDSTONE: fine to medium grained, light grey.	DW	L	-	LOW TO MODERATE 'TC' BIT RESISTANCE
▼ ON COMPLET -ION						3							SLIGHT HYDROCARBON ODOUR
						4			END OF BOREHOLE AT 4.0m				MONITORING WELL INSTALLED TO 4m, CLASS 18 50mm DIA. PVC FROM 4m TO 1m, CASING FROM 1m TO SURFACE, 2mm SAND FILTER PACK TO 4m, BENTONITE SEAL FROM 0.7m TO 0.3m, BACKFILLED WITH CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 607 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0		-	ASPHALTIC CONCRETE: 60mm.t	D	-	-	
									FILL: Gravelly silty sand, fine to medium grained, red brown, fine to medium grained sub angular igneous gravel, with a trace of slag.	MC < PL			
						1			FILL: Sandy clay, medium plasticity, brown, fine to medium grained sand, with a trace of sandstone gravel.				
					N = 4 3,3,1				as above, but orange brown, red brown and light brown.	MC≈PL			
ON COMPLET -ION						2		SC	SILTY CLAYEY SAND: fine to medium plasticity, dark grey, with a trace of shell fragments and organic material.	W	VL	-	SLIGHT HYDROCARBON ODOUR AND ORGANIC ODOUR
					N = 1 1/450mm	3							SPT SANK 450mm AFTER 1 BLOW
									END OF BOREHOLE AT 3.45m				
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. 608 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK250 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 150mm.t				
								-	FILL: Silty sand, fine to medium grained, light brown, with sandstone gravel.	D-M	-	-	APPEARS WELL COMPACTED
					N = 25 7,13,12				as above, but with a trace of slag.	M-W			SLIGHT HYDROCARBON ODOUR
						1							
								-	SANDSTONE: fine to medium grained, orange brown.	XW-DW	VL-L	-	LOW 'TC' BIT RESISTANCE
						2			as above, but light brown.	DW	L-M		MODERATE RESISTANCE
									SANDSTONE: fine to coarse grained, orange brown.				
						3							
											M		MODERATE TO HIGH RESISTANCE
						4							
													MONITORING WELL INSTALLED TO 6m, CLASS 1B 50mm DIA. PVC FROM 6m TO 3m, CASING FROM 3m TO SURFACE, 2mm SAND FILTER PACK FROM 6m TO 2m, BENTONITE SEAL FROM 2m TO 1.6m, BACKFILLED WITH CUTTINGS TO SURFACE AND COMPLETED WITH A STEEL GATIC COVER AND LOCKABLE CAP
						5							
▼ ON COMPLET -ION						6			END OF BOREHOLE AT 6.0m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 609 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER JK300 **R.L. Surface:** N/A

Date: 20-7-10 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			ASPHALTIC CONCRETE: 150mm.t				
								-	FILL: Gravelly sand, light brown, fine to coarse grained sub angular igneous and concrete gravel.	D	-	-	
						1			FILL: Bricks	-			
								-	SANDSTONE: fine to medium grained, brown.	DW	L	-	LOW TO MODERATE 'TC' BIT RESISTANCE
									END OF BOREHOLE AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 610 1/1

Environmental logs are not to be used for geotechnical purposes

Client: STATE PROPERTY AUTHORITY C/- GOVERNMENT ARCHITECTS OFFICE

Project: PROPOSED REDEVELOPMENT - WATERFRONT

Location: SYDNEY FISH MARKETS, 56-60 PYRMONT BRIDGE ROAD, PYRMONT, NSW

Job No. E24125K **Method:** SPIRAL AUGER **R.L. Surface:** N/A

Date: 20-7-10 JK300 **Datum:**

Logged/Checked by: B.P./

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			ASPHALTIC CONCRETE: 150mm.t				
					N = 11 4,5,6			-	FILL: Gravelly sand, fine to medium grained, dark grey and brown, fine to coarse grained sub angular igneous gravel.	D-M	-	-	APPEARS MODERATELY COMPACTED
						1			FILL: Silty clayey sand, fine to medium grained, dark brown, with a trace of sandstone gravel and ash.	M			
					N = 2 1,1,1				FILL: Silty clay, medium to high plasticity, grey and brown, with a trace of sandtone gravel.	MC > PL			APPEARS POORLY COMPACTED
▼ ON COMPLET -ION						2		SM	SILTY SAND: fine to medium grained, dark grey.	W	VL	-	
					SANK 450mm	3							SPT SANK 450mm UNDER SELF WEIGHT
									END OF BOREHOLE AT 3.45m				
						4							
						5							
						6							
						7							

Image sourced from Google Earth Pro

LEGEND:

BOREHOLE LOCATION

MONITORING WELL LOCATION

A **REFERENCED FEATURE POINTS A TO F**

APPROXIMATE SITE BOUNDARY

Approximate Scale (m)

0 10 20 30 40 50

Note: Reference should be made to the text for a full understanding of this plan.

INVESTIGATION LOCATION PLAN

Sydney Fish Markets
56-60 Pyrmont Bridge Road, Pyrmont, NSW

Job No: 24125S
Figure: 1

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

ABN 17 003 550 801

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 subsurface 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 or where only a limited investigation has been completed or 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.

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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

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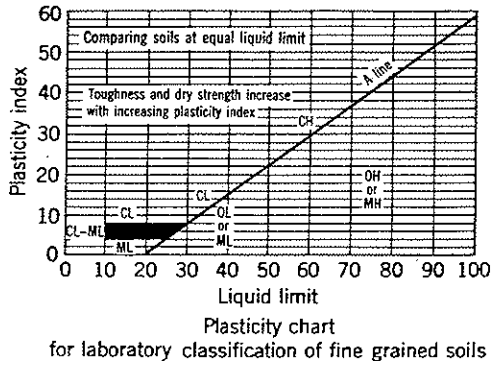
UNIFIED SOIL CLASSIFICATION TABLE

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*)	
			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		



Plasticity chart
for laboratory classification of fine grained 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.

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LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
		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 (Id) 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.

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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.

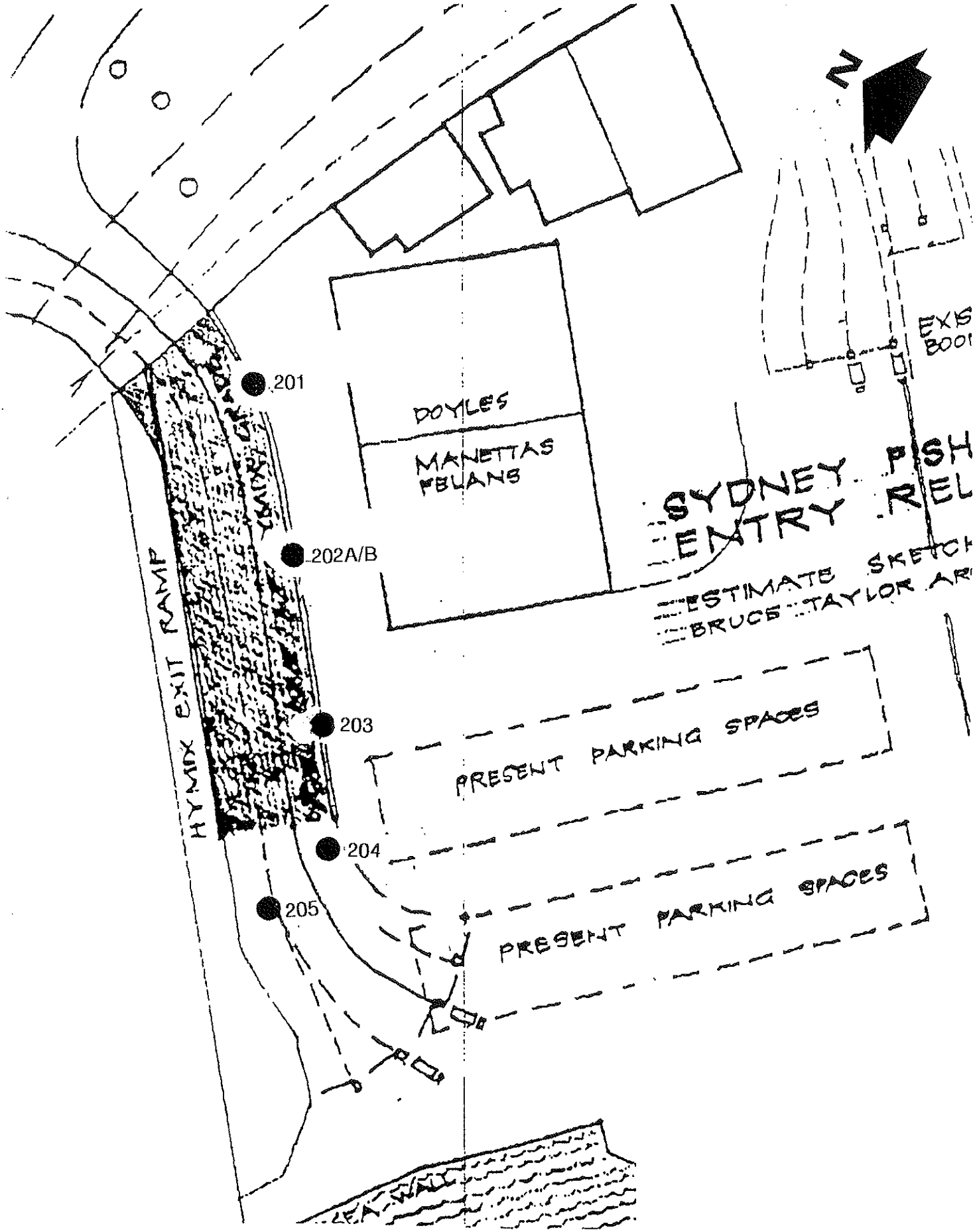
ROCK STRENGTH

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	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	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.
Medium Strength:	M	1	A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	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.
Very High:	VH	10	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.
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	



BOREHOLE LOCATION PLAN

SCALE 0 10m

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Report No. 24125S Figure No. 2

EXTENT OF BATTERED RIP-RAP REVETMENT

NEW TIMBER DECK

NEW TIMBER DECK OVER DRY LAND WITH FILL BEHIND SEAWALL

NEW TIMBER BOARDWALK

PROPOSED FORESHORE DEVELOPMENT PLAN

SCALE (m)

0 50

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Report No. 24125S **Figure No. 3**