Hornsby Shire Council
Report on Proposed Filling
Old Man's Valley
Hornsby

Report S8463/2-AC    July, 1989
S8463/2-AC  CPT: BS
10th July 1989

The Shire Clerk,
Hornsby Shire Council,
296 Pacific Highway,
HORNSBY. N.S.W. 2077

ATTENTION MR. WARREN LATHAM

Dear Sir,

RE: Report on Proposed Filling, Old Man's Valley, Hornsby

Please find enclosed our report on the geotechnical investigations for the proposed filling at Old Man's Valley, Hornsby.

Our estimates of costs and fees for further geotechnical work in the area of proposed fill and for undertaking a rock mechanics study of the eastern quarry face as outlined in the report are included in Appendices D and E respectively.

We also recommend that consultations continue during the pre-construction and construction phases. It is understood that the Council will be responsible for detail designs and for supervising and directing the works, and that the Council will advise when consultations are required. We have not made an estimate of costs and fees for such consultations as these are dependent upon the progress of work. However, these consultations would be undertaken in accordance with standard Terms of Agreement for Professional Services (rev 89/3), a copy of which is attached in Appendix D.

Should you have any queries regarding this report please do not hesitate to contact Mr. Tony Scott or the undersigned.

Yours faithfully,
COFFEY & PARTNERS PTY. LTD.

C.P. THORNE
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1.0 INTRODUCTION

This report follows our earlier reports S8463/1 dated 11th October 1988 and S8463/2-AB dated 1st March 1989 undertaken at the request of Hornsby Shire Council, who plan to construct a substantial fill over the headwaters of a series of creeks above the Hornsby breccia quarry (see Figure 1). The first report discussed the proposed additional fill at Old Man's Valley and recommended further work. The second report described the results of additional work with respect to the southern end of the proposed fill.

Subsequent to the issue of this second report and during work related to the northern end of the site, it became evident that the survey information which had been provided as part of the Brief was not correct. The shape of the slope below the existing fill was found to steepen down towards the creek rather than to flatten as the earlier survey showed. In addition, initial stability analyses of the northern end were not favourable. Following a meeting with the Council, further survey and investigation was requested as per our facsimile dated 26th April 1989.

The findings of the new survey at the southern end plus information provided concerning toe construction indicated that a complete revision of Report S8463/2-AB was necessary and that report must be considered as completely superseded.

Because of wet conditions and difficult access, the survey results were not received until late May and access for test pits and boreholes was not available until the first week of June.

This present report describes the additional field work and analyses relating to the southern end and the results of work at the northern end.

Information provided by the Council consisted of:


* Golder Associates "Geotechnical Investigation Proposed Alternations to the Northern Bund Wall and Associated Filling Program, Hornsby Quarry" (prepared for the Readymix Farley Group), November 1982;

* Golder Associates "Supplementary Report on Slope Stability Study Eastern Face, Hornsby Quarry" (prepared for Readymix Group), August 1982;

* Contour survey by Rygate & West, Surveyors, 13-4-1970 (on drawing by GH&D, 21st July 1970);

* Later contour survey on Council plan 428.14;

* Plans and sections showing approximate present and proposed surface levels (plan 428.21, 8 sheets);
* Drawing showing current position of drainage gullies and piping;
* Recent survey of Hornsby quarry;
* Surveyed sections at Ch 170, 190, 215, 230, 270, 310, 350, 390 and 403.4m and a contour plan No. 428.24 of the area near the new drainage outlet pipes to the quarry.

The survey and other factual data supplied, including factual data in Golder Associates' report, has not been checked and this report relies on that data.

2.0 RESULTS OF FIELD WORK

2.1 Northern End

The field work for this report consisted of the drilling of one additional hole (BH6) near the toe of the highest section of the proposed fill, mapping of the quarry face below this section, excavation of pits (TP1 to TP7) and mapping of exposed features in the creek. Nine 50mm undisturbed tube samples were taken in the borehole and test pits.

The locations of the bore and test pits are shown in Figure 1 and logs are given in Appendix A. Results of laboratory testing are presented in Appendix B.

Attempts were also made to map areas of seepage and to measure flows during wet weather.

2.2 Southern End

Two additional boreholes (BH7 and BH8) were drilled at approximately Ch 215m and Ch 230m and a standpipe was installed in each borehole. A test pit was also excavated at about Ch 240m. The logs of earlier holes BH1 to BH5, together with BH7 and BH8, are given in Appendix A and locations are shown in Figure 1.

3.0 DISCUSSION OF SUBSURFACE CONDITIONS AT THE PROPOSED FILL SITE

3.1 General

As described in previous reports, the proposed fill is immediately above the Hornsby breccia quarry. The original landform comprised a steep sandstone slope at the rear of the site feeding a creek which ran through the centre of the site leaving two ridges (see Figure 2 which shows conditions in 1970).

Both ridges are breccia and the approximate sandstone/breccia interface is given in Figure 3. The southern breccia ridge is now almost fully covered with fill to form the present playing field area (Figure 3).
3.2 Surface and Subsurface Drainage

The surface runoff from the slope uphill of the site on the eastern side is intended to be intercepted by surface drains along the base of the slope which lead into a pipe which runs from about the centre of the site northwards to discharge into the valley to the north of the proposed fill area (Figure 4). It was observed during a very wet period that almost all the flow from the centre and southern slope disappeared south of the drain into the fill. Dye placed in this water did not show discharge on the downhill side of the fill. However, this cannot be considered as a definite indication that the two are not linked.

Seepage was noted from halfway along the access road which runs down to the quarry. This road forms a berm in the northern batter of the existing playing field and is cut into natural soil on the uphill side over part of its length (Figure 3 and Photographs 1a, 1b and 1c). A substantial localised seepage flow emerges from this batter in the centre of a feature which could be a shallow slip in the batter. Elsewhere, general seepage was evident along the toe. This seepage is presently collected in an unlined drain and led to the creek which runs from south to north along the west boundary.

Seepage was also noted at the toe of the filled slope of the existing fill near BH7 (Photographs 2a and 2b). As described below, a toe "key" was constructed along the toe and BH7 was drilled just uphill from the key and a standpipe was installed to check if water was ponding behind the key (Figures 1 and 5). This standpipe showed a water level at about the natural ground surface. A second standpipe was installed at BH8 just downhill from the toe. This standpipe showed a much lower water level. It is possible that there is a time lag in the response but it is also possible that the water level in BH7 is ponded in the residual/extremely weathered breccia behind the "key", while the water level in BH8 represents that in the underlying highly to moderately weathered breccia. More standpipes would be required to decide this issue.

The top of the fill bench below the access road is also cut into natural soil and further seepage is evident from this slope. This seepage is led partially to the west to the boundary creek and partly north to the existing depression.

The original set of drainage depressions has been filled over at the top and further fill has been placed over the main east-west drainage depression, moving it north to its present location.

Despite wet conditions, little seepage was evident near the upper depressions in the fill. However, very substantial seepage emerged from the fill batter approximately on the line of the old depression (Photograph 3). This flow was the main contributor to the flow of this depression, which was measured at 5 l/sec where it entered the main west boundary creek about midday, roughly 6 hours after rain stopped. The flow was measured at 2.5 l/sec approximately 12 hours later.
Photograph 1a – Natural drainage gully developed at (Approx. Ch.260m) boundary between northern toe of playing fields and access road. Note residual red-brown clay exposed in gully. Water in gully is almost entirely derived from seepage from toe of fill embankment.

Photograph 1b – View looking west along drainage gully. Note wet soil and seepage to left of drainage gully. (Approx. Ch 260m)
Photograph 1c - View of seepage emerging at toe of north western corner of existing playing fields. The seepage emerges near to the boundary between the fill and residual breccia soil.

(Approx. Ch 260m)
Photograph 2a - Seepage emerging at western toe of existing playing fields at approximately Ch.220m.

Photograph 2b - View of boreholes BH7 and BH8 (white pipes). Note water siting on surface in foreground. This area was dry 12 hrs prior to photograph being taken. The water is seepage from fill toe. (Approx Ch 215m to 230m).
Photograph 3 - View of creek at Ch 350m at toe of filled area. Extremely weathered and highly weathered Breccia is exposed in eroded channel with fill overlying in upper right of photograph. Water flows of up to 5L/sec were emerging near boundary of fill and natural material (See green mossy area), on 6-6-89.
In the quarry side, seepage was evident emerging from the toe of the natural slope on the eastern side of the road.

Groundwater levels were recorded in a number of standpipes in bores and standing water levels in pits were also recorded. These are summarised in Table 1.

<table>
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<tr>
<th>Bore</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>95.89</td>
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<tr>
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<td>blocked</td>
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<td>--------</td>
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<td>116.2</td>
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During late May and early June an excavation for a new drainage pipe was made (Figures 3 and 4). This pipe is to collect drainage from all the main creeks east of the quarry so as to divert the water. It is understood that this pipe is to be placed with its invert at RL 90.5m, which is substantially lower than the previous pipe. The creek bed has rapidly eroded downwards as the result of this deeper outlet, exposing weathered breccia in its bed (Photograph 4).

Golder Associates, in their report dated August 1982 noted that there was no evidence of groundwater in the rock slope. It appears therefore that the fresh to slightly weathered breccia is drained by the quarry and that the water levels observed in the site above are the result of groundwater perched on the relatively impermeable residual soils and extremely weathered rock. The actual groundwater pressures at various depths in the weathered breccia profile are therefore uncertain.

3.3 Subsurface Conditions at Site

The site can be considered as having four zones with the boundaries running east west.

The first zone is the sandstone country and lies south of about CH 120m. This zone consists of breccia overburden fill over shallow residual sandy clays over sandstone, as evidenced by BH1 and BH2. The proposed fill extends to the south of the existing fill onto the steep sandstone hillside (see Figure 1).
Approximate level of creek before lowering of culvert invert level.

Boundary between alluvium, brown (top) and residual clay/breccia yellow-brown (bottom).

Photograph 4 – View showing scouring and erosion in creek after culvert invert level was lowered by approximately 1.5m about 3 weeks before photograph. Chainage 380m.
The second zone runs from Ch 120m up to near the access roadway at about Ch 230 to 270m. In this zone, breccia underlies all but the easternmost part of the fill. The sections at Ch 170, 190 and 215m (Figure 5) show the conditions, which consist of breccia overburden fill overlying the natural breccia land surface under the present playing field. It is understood that a "key" was constructed at the toe of the batter by excavating a trench 1.5m deep at the toe and 4.5m wide and filling with compacted fill. Downslope the weathering is deep and the creek has incised deeply into the weathered profile, giving very steep sides to the creek, with a flat floor covered with sandy alluvium. Over most of this length the fill batter and creek bank continue to give a more or less continuous slope from the top of the fill to the creek bed. Because the breccia is weathered deeply, the lower slope comprises extremely to highly weathered breccia, in the form of a sandy or gravelly clay with corestones of moderately to highly weathered breccia, and has essentially soil properties.

The third zone extends from the access road to the east west drainage depression. Here the boundary creek is less deeply incised and the ground beyond the creek slopes up more gently to the east. Breccia overburden fill has been placed at the back (east) side of this zone, covering the original drainage course, and it is understood that the drainage course was cleaned "to rock" prior to fill placement, although it has not been possible to confirm this. It is further understood that no attempt was made to place any subsurface drainage provisions in the depression.

To the west of the fill the natural surface consists of deeply weathered breccia at the southern end and alluvium to the north west (see Figure 3 and sections at 270, 310 and 350m on Figures 6 and 7). The depth of weathering, as evidenced by excavator refusal on slightly weathered grey breccia, decreases to the north. Intermediate between the alluvium, residual soil/ extremely weathered breccia is a clay layer of high plasticity and a cemented sand layer - both are thin. The alluvium consists of silty and clayey loose sand.

The fourth zone comprises the area north of the east-west drainage depression. The northern breccia ridge is deeply weathered breccia to at least 4m just at the change of slope above the creek and deeper towards the top. The test pits show a similar profile to that in the southern breccia ridge, with a thin layer of red residual clay of high plasticity over extremely and highly weathered breccia. There is a clear boundary where the steep breccia slope ends and the alluvium begins (see Figure 7). The alluvial area is extensive (Figure 3) and the creek has eroded through the alluvium into the underlying weathered rock in places. As in the southern ridge, it appears that the creek has downcut through the weathered breccia and in this zone there is a thin ridge of weathered breccia left between the creek and the access road which runs round the top of the quarry. The slightly weathered to fresh breccia occurs at about RL 90m in the quarry just opposite the new outlet pipe.
3.4 Results of Shear Strength Testing of Weathered Breccia

One triaxial and four direct shear strength tests have been undertaken on samples from the site. These results are summarised in Figure 8 as shear strength versus normal effective stress, and to allow plotting of the triaxial results the shear and normal stress on the failure surface have been used to give the plotted points.

There is a wide scatter of points, partially due to the influence of gravel size rock fragments which "reinforced" the shearing surface in some instances. In the scale of the real slope, such reinforcement would not occur. In assessing individual $C'$ and $\varphi'$ values the unusually high points have been ignored.

It is normal practice to adopt, for design, values approximating the lower quartile, and to require a factor of safety of at least 1.5 using these. Figure 8 shows the average values and computed lower quartile results for all tests and for tests on extremely weathered breccia only. For the extremely weathered breccia, values of $C' = 40$ kPa and $\varphi' = 20^\circ$ are obtained, while for all results the values are $C' = 11$ kPa and $\varphi' = 23^\circ$. The lower bound is $C' = 5$ kPa and $\varphi' = 25^\circ$.

There are areas around the pit with substantial slopes up to about $50^\circ$ and 20 to 30m high and these slopes appear to be free of seepage. A friction angle of $20^\circ$ and cohesion of 40 kPa would allow a slope to be about 25m high for a factor of safety of 1.0. For the overall lower quartile values of $C' = 11$ kPa, $\varphi' = 23^\circ$ the corresponding height is about 9m, and for the lower-bound value of $C' = 5$ kPa, $\varphi' = 25^\circ$ it is about 4m.

The existence of the steep, highly weathered breccia slopes does not, therefore, necessarily indicate higher parameters than those given above as the extremely weathered breccia lower quartile, especially given that unsaturated conditions could exist in the slopes. The mass strength must, however, be higher than the lower bound for these slopes to exist.

The approach has therefore been adopted of using $C' = 40$ kPa and $\varphi' = 20^\circ$ for weathered breccia and $C' = 5$ kPa, $\varphi' = 25^\circ$ for residual soils. Because the cohesion intercept is uncertain a check has also been made assuming $C' = 25$ kPa, $\varphi' = 25^\circ$ in the weathered breccia for some cases.

For new compacted fill, values as previously discussed have been used, i.e. $C' = 25^\circ$, $\varphi' = 25^\circ$ for clay/shale and $C' = 10$ kPa, $\varphi' = 32^\circ$ for sandstone fill.

For the purpose of analysis of the slopes incorporating existing fill it has been assumed that the strength of the fill can be taken to be the same as for the residual soils. For sandy alluvium $C' = 0$ kPa and $\varphi' = 30^\circ$ has been adopted. The adopted values are given in Table 2.
Table 2
Parameters Used for Analysis

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<th>Friction Angle degrees</th>
<th>Density kN/m³</th>
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<tr>
<td>Old fill</td>
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<tr>
<td>Weathered breccia</td>
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<td>1.96</td>
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<tr>
<td>Alluvium</td>
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<tr>
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<tr>
<td>Clay shale fill</td>
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4.0 DESCRIPTION OF ROCK IN QUARRY

4.1 General

The Sydney 1:100,000 Geological Series Sheet 9130 indicates that Old Man's Valley is underlain by volcanic breccia, with the surrounding plateau comprising Hawkesbury Sandstone (see Figure 9a). Hornsby Quarry, situated immediately west of the proposed filling at Old Man's Valley, is sited within the volcanic breccia which is generally called the Hornsby Diatreme. The geology sheet indicates the Hornsby Diatreme to be dumbell shaped and elongate for about 1.5 km in the NE/SW direction and is generally less than 400m wide. The southern extremity of the diatreme is separated from the main body by a sandstone bar across Old Man's Valley. The Thornleigh Diatreme is situated some 200m to the south west (along projection of the long axis) of the Hornsby Diatreme and is separated from it by Hawkesbury Sandstone. The relationship between the Hornsby and Thornleigh Diatremes is not known. They may represent unrelated individual intrusions or they may be related. Further, it is unknown whether the Hornsby Diatreme represents a single intrusion or a number of intrusions. Certainly, the dumbell shape alludes to the possibility of more than one intrusion. If the Hornsby Diatreme represents a number of intrusions, their relationships and effects on one another are unknown.

A diatreme can be defined as "a pipe-like volcanic conduit filled with pyroclastic debris (tuff or lapilli tuff) and blocks of wall rock". Diatremes in the Sydney Basin are thought to be Jurassic age and are generally considered to have resulted from violent intrusions of molten magma into surrounding country rocks which are Hawkesbury Sandstone in this case. Figure 9b outlines hypothesised stages of general development and features of diatremes found in the Sydney Basin.

Figure 1 (site plan) shows the interpolated boundary between the volcanic breccia and the Hawkesbury Sandstone. The location of this boundary has been assessed based on field mapping along creek lines and of surface exposures as shown on Figure 3 undertaken by Coffey & Partners and on the
rock material penetrated by Coffey & Partners' boreholes and test pits, and Golder Associates boreholes (G1 to G3). The top of the breccia was intersected by BH3, BH4 and BH6 of this investigation and was penetrated by boreholes G1, G2 and G3 of Golder Associates' investigation of August 1982. Limited geological mapping of the joints and bedding was also carried out on the exposed rock faces within the quarry.

4.2 Structure

While no mapping of the Hawkesbury Sandstone exposures in the east of Old Man's Valley was undertaken, the Hawkesbury Sandstone typically comprises near horizontal beds of sandstone to about 4m thick which may be internally cross bedded at angles ranging from about 5° to 30° to the horizontal. Joints within the Hawkesbury Sandstone are typically subvertical, with the main joint sets striking NNE-SSW and WNW-ENE.

Exposures of the Hornsby Diatreme in Hornsby Quarry indicate a basinal layering of the diatreme. This basinal layering is particularly well defined in the eastern face of the quarry (see Photographs 5a and 5b). According to Crawford et al (Ref. 1) "although the original crater deposits probably had a slight centoclinal dip, the exaggerated basinal structure observed here is probably due to peripheral drag as the volcanic breccia subsided within the surrounding ring fault".

The bedding planes form weaknesses within the rock seam as evidenced by a number of slides around the quarry (Photograph 6). The largest of these is on the south eastern side of the quarry while there are other smaller ones on the northern side. The orientation of the bedding is therefore important to the stability of the eastern quarry face beneath the proposed filling.

Results of the mapping of bedding planes of the diatreme exposed in the quarry are summarised in Figure 4. The mapping indicates that the dip of the bedding planes in the quarry ranges from less than 10° and up to 75°. Over the northern half of the quarry face, beds generally dip towards the south east quadrant while over the southern half, beds generally dip towards the north east quadrant. Most bedding was observed to be dipping into the eastern face of the quarry, indicating that the centre of the basinal structure or the pipe structure probably lies east of the current quarry. Extrapolation of the measured bedding dip directions suggests that the centre of the basinal structure is situated east of the existing quarry behind the present eastern face of the quarry. The general lack of clear bedding structures in Golder's hole G2 and in Coffey & Partners' hole BH6 is consistent with this assessment of the structure.

A limited survey was conducted of major joints exposed in the eastern face of the quarry on the existing benches at the approximate levels of RL 90m and RL 68m, termed benches 1 and 2 respectively. Only joints with a continuity of greater than 1m were considered.
PHOTOGRAPH 5a - Well developed basinal layering in eastern face of Hornsby Quarry.
PHOTOGRAPH 6 - Bedding plane exposed by slide on south east corner of pit.
Results of the joint survey on benches 1 and 2, individually and combined, are presented on stereonets in Figure 10. The plot for bench 1 indicates that the dominant joint set strikes north-south and is sub-vertical or dips steeply to the west; the minor joint set strikes east-west and dips steeply to north and south, typically to the north. There is also a possible subordinate set striking north-west/south-east and dipping steeply to the south-west, although this may be part of the dominant joint set. Similarly, the plot for bench 2 has the north-south and east-west joints encountered in bench 1.

The combined plot indicates the presence of two main joint sets. Joint set 1, the dominant joint set, strikes north-south (mean strike 001°/181°) and dips steeply (mean dip 86°) to the west. Joint set 2, a subordinate set, strikes east-west (mean strike 088°/268°) and dips steeply (mean dip 77°) to the north and south, typically to the south.

The orientation of joint set 1 appears to correlate with the orientation used by Golder Associates in their report Slope Stability Study, Eastern Face Hornsby Quarry dated August 1982. Observations of the lower benches at the eastern quarry face indicate similar joint orientations to those outlined above. Observations of joint set 1 indicated a spacing between joints typically ranging from 0.6m to 2m.

It should be noted that many low angle joints were intersected in the volcanic breccia in both Coffey & Partners boreholes and Golder Associates boreholes. These did not appear to be well developed in the quarry face. They may have been masked by bedding planes and rock fractures or the structure of the rock mass behind the quarry face may be different to that exposed.

The boundary between the volcanic breccia of the diatreme and the surrounding Hawkesbury Sandstone was not located during the investigation. Hence, the steepness of the junction is uncertain. However, Crawford et al (Reference 1) has indicated that this boundary in other diatremes of the Sydney Basin is commonly characterised by steep sandstone walls.

5.0 DISCUSSION OF SLOPE STABILITY ABOVE QUARRY LEVEL AT SOUTH END

The section chosen for analysis is that at Ch 215m where the creek most closely approaches the toe. The section at Ch 190m is not very different.

As noted in Section 3.2, there is uncertainty regarding the groundwater conditions in this area because of the discrepancy in water levels at BH7 and BH8. Accordingly, two situations have been analysed:

* A continuous groundwater system following the original ground surface to the toe of the fill and then dropping to the creek.

* A dual system with groundwater in the fill and residual/extremely weathered breccia at the old ground surface level down to the toe of the fill, and with groundwater in the underlying highly weathered breccia at a lower level as indicated in BH8.
The results are given in Table 3 and plots of selected analyses are shown in Appendix C. These analyses indicate that the existing factors of safety calculated for the lower quartile strength values are in the range 1.1 to 1.3. If the additional fill was added these values reduce to 1.07 to 1.2. The present factors of safety for failures to the top of the creek bank are about 1.1 to 1.2. It should be noted that the factors of safety are very sensitive to soil parameters and that the test results show a large scatter - a 5° increase in friction angle in the highly weathered breccia increases the factor of safety by about 0.3. Analyses of flatter slopes indicated that the fill would have to be flattened to a 1 in 3 slope to give a factor of safety of 1.5.

It must be concluded that, based on the work to date, the present condition does not have the margin of safety commonly accepted for engineering structures and that the addition of further fill at the top of the batter should not occur without stabilisation measures. These issues are discussed further in the Conclusions.

**Table 3**

**Results of Stability Analyses at Ch 215m**

<table>
<thead>
<tr>
<th>Case</th>
<th>Configuration</th>
<th>Groundwater</th>
<th>Weathered Breccia</th>
<th>Fill (New)</th>
<th>Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C'</td>
<td>Ŷ'</td>
<td>C'</td>
</tr>
<tr>
<td>South 1</td>
<td>To RL 140.85m</td>
<td>Single</td>
<td>40</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1A</td>
<td></td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>South 2</td>
<td>Existing</td>
<td>Single</td>
<td>40</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td></td>
<td>25</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>South 3</td>
<td>To RL 140.85m</td>
<td>Dual</td>
<td>40</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>3A</td>
<td></td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>South 4</td>
<td>Existing</td>
<td>Dual</td>
<td>40</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4A</td>
<td></td>
<td>Failure in EW/Residual only</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Failure in Residual only</td>
<td>1.21</td>
<td></td>
</tr>
<tr>
<td>South 8</td>
<td>Fill flattened</td>
<td>Dual</td>
<td>40</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>to 3:1</td>
<td></td>
<td>25</td>
<td>25</td>
<td>-</td>
</tr>
</tbody>
</table>

6.0 **DISCUSSION OF SLOPE STABILITY AT NORTHERN END**

6.1 **Results at Ch 350**

Several sections have been analysed. The highest is at Ch 350m and results are summarised in Table 3 and plots of selected analyses are given in Appendix C. The proposed slopes show factors of safety of about 1.25 for fill placed directly over the alluvium. A series of analyses was undertaken for various alternative slopes, as shown in Figure 11, using both circular and non-circular analyses. For most of the circular analyses, a fresh rock level was not specified. Experience has shown that although this results in deep failure surfaces which, in reality, would
encounter the rock, the factors of safety are reasonably accurate and can usually be matched by non-circular surfaces which follow the top of the actual rock surface.

Non-circular analyses are time consuming because it is not possible to undertake fully automatic searches for the worst failure surface (a typical slip circle analysis will involve several hundred trials). Nevertheless, some non-circular analyses have been done and these, too, are shown in Figure 11. They show values about 0.1 higher than the corresponding slip circles and if more analyses were done it is expected that this difference would reduce.

The analyses used $C' = 0$ and $\phi' = 30^\circ$ for the alluvium. Replacement of this material near the toe with a layered drain would not substantially improve these strengths and hence the analyses can be taken as applying to the case where the drain is constructed as described later. The water levels used in all analyses assume that the drainage measures described later are implemented and are successful.

Based on the analyses an overall slope of about 2.75:1 is required for a factor of safety of 1.5 at Ch 350m.

<table>
<thead>
<tr>
<th>Case</th>
<th>Slope</th>
<th>Analysis Type</th>
<th>Comment</th>
<th>Fill</th>
<th>Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.75:1</td>
<td>Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.24</td>
</tr>
<tr>
<td>1A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.28</td>
</tr>
<tr>
<td>2</td>
<td>2.25:1</td>
<td>Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.31</td>
</tr>
<tr>
<td>2A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.34</td>
</tr>
<tr>
<td>3</td>
<td>2.50:1</td>
<td>Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.40</td>
</tr>
<tr>
<td>4</td>
<td>2.75:1</td>
<td>Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.42</td>
</tr>
<tr>
<td>5</td>
<td>3:1</td>
<td>Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.47</td>
</tr>
<tr>
<td>5A</td>
<td>3:1</td>
<td>Circular</td>
<td>-</td>
<td>Sandstone</td>
<td>1.49</td>
</tr>
<tr>
<td>6</td>
<td>3:1</td>
<td>Non-Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.60</td>
</tr>
<tr>
<td>3R</td>
<td>2.50:1</td>
<td>Circular</td>
<td>With rock at RL 90.0m</td>
<td>Shale</td>
<td>1.48</td>
</tr>
<tr>
<td>3L</td>
<td>2.78:1</td>
<td>Non-Circular</td>
<td>-</td>
<td>Shale</td>
<td>1.50</td>
</tr>
</tbody>
</table>

**Table 4: Summary of Analyses at Ch 350m**

**NOTE:** All analyses assume drainage measures implemented and successful
6.2 Results at Ch 310m

At this section the existing fill is about 20m back from the creek, with a residual breccia slope between. The data suggests a greater depth of weathering than at Ch 350 (Figure 6). Because of the unknown quality of the fill, a groundwater level at the fill and residual soil surface has been assumed.

A summary of the stability analyses is given in Table 5 and plots of selected analyses are given in Appendix C. A plot of factor of safety versus slope is shown in Figure 12.

The results indicate that the proposed slope is not sufficiently stable and that flattening of the fill slope to 1 in 3 is required to provide a factor of safety of 1.5.

An alternative arrangement using a 1.75:1 slope to a 15m wide berm to RL 115m at the toe was also analysed. With this berm a slope above the berm of 3:1 to RL 139m gave a factor of safety of 1.5.

Reducing the upper level of the fill to RL 130m increases the factor of safety by about 0.05.

<table>
<thead>
<tr>
<th>Case</th>
<th>Configuration</th>
<th>Fill</th>
<th>Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>C310A</td>
<td>2:1 Slope (no rock)</td>
<td>Shale</td>
<td>1.16</td>
</tr>
<tr>
<td>B</td>
<td>2:1 Slope (no rock)</td>
<td>Sandstone</td>
<td>1.07</td>
</tr>
<tr>
<td>C310A1</td>
<td>2.5:1 Slope (no rock)</td>
<td>Shale</td>
<td>1.26</td>
</tr>
<tr>
<td>B1</td>
<td>2.5:1 Slope (no rock)</td>
<td>Sandstone</td>
<td>1.18</td>
</tr>
<tr>
<td>C1</td>
<td>2.5:1 Slope (rock at RL91.5m)</td>
<td>Shale</td>
<td>1.30</td>
</tr>
<tr>
<td>C310A2</td>
<td>2.75:1 Slope (no rock)</td>
<td>Shale</td>
<td>1.32</td>
</tr>
<tr>
<td>B2</td>
<td>2.75:1 Slope (no rock)</td>
<td>Sandstone</td>
<td>1.24</td>
</tr>
<tr>
<td>C2</td>
<td>2.75:1 Slope (rock at RL92.0m)</td>
<td>Shale</td>
<td>1.37</td>
</tr>
<tr>
<td>C310A3</td>
<td>3:1 Slope (no rock)</td>
<td>Shale</td>
<td>1.37</td>
</tr>
<tr>
<td>B3</td>
<td>3:1 Slope (no rock)</td>
<td>Sandstone</td>
<td>1.29</td>
</tr>
</tbody>
</table>
**Table 5 (cont)**

**Summary of Analyses at Ch 310m**

<table>
<thead>
<tr>
<th>Case</th>
<th>Configuration</th>
<th>Fill</th>
<th>Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>C310A4</td>
<td>3.5:1 Slope (no rock)</td>
<td>Shale</td>
<td>1.47</td>
</tr>
<tr>
<td>B4</td>
<td>3.5:1 Slope (no rock)</td>
<td>Sandstone</td>
<td>1.38</td>
</tr>
<tr>
<td>C4</td>
<td>3.5:1 Slope (rock at RL91.0m)</td>
<td>Shale</td>
<td>1.57</td>
</tr>
<tr>
<td>C310A5</td>
<td>3.75:1 Slope (no rock)</td>
<td>Shale</td>
<td>1.54</td>
</tr>
<tr>
<td>B5</td>
<td>3.75:1 Slope (no rock)</td>
<td>Sandstone</td>
<td>1.45</td>
</tr>
<tr>
<td>C5</td>
<td>3.75:1 Slope (rock at RL91.0m)</td>
<td>Shale</td>
<td>1.71</td>
</tr>
<tr>
<td>C310C6</td>
<td>2.5:1 Slope (rock at RL91.0m)</td>
<td>Shale</td>
<td>1.35</td>
</tr>
<tr>
<td>C7</td>
<td>3.0:1 Slope (rock at RL91.0m)</td>
<td>Shale</td>
<td>1.48</td>
</tr>
<tr>
<td>C8</td>
<td>3.25:1 Slope (rock at RL91.0m)</td>
<td>Shale</td>
<td>1.55</td>
</tr>
<tr>
<td>C310C9</td>
<td>1.75:1 Slope to RL115m</td>
<td>Shale</td>
<td>1.53</td>
</tr>
<tr>
<td></td>
<td>(rock at RL91.0m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9A</td>
<td>2:1 Slope to RL115m</td>
<td>Shale</td>
<td>1.69</td>
</tr>
<tr>
<td></td>
<td>(rock at RL91.0m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C310C10</td>
<td>1.75 slope to RL115 then 3.5:1</td>
<td>Shale</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>to RL139 (rock at RL91.0m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10A</td>
<td>As C10 but 2:1 slope</td>
<td>Shale</td>
<td>1.35</td>
</tr>
<tr>
<td>C10B</td>
<td>As C310A4 but to RL130m</td>
<td>Shale</td>
<td>1.52</td>
</tr>
</tbody>
</table>

6.3 **Stability North of Ch 350m**

In this area the designed toe is on the sloping breccia slope. No analyses have been done. However, flattening of the slope will be necessary and this could be done by extending the toe down to the alluvial flat below.

7.0 **Stability of Quarry Slope**

The toe of the fill will come within 50m of the top of the present position of the eastern face of the quarry and would be within 25m of the final development profile for the eastern face at Ch 350m. The critical section for the interaction of the proposed filling and the quarry face appears to be the section of the face north of about Ch 270m.
The structure of the volcanic breccia rock mass behind the eastern face was investigated by Golders in their report of August 1982 in which two fully cored boreholes were drilled to depths of about 50m (refer Cross Section Ch 270m). This information has been supplemented by limited mapping of the quarry face as described in Section 4.0 above. However, the rock mass structure is not well defined other than in the very general sense that the vent plug appears to be behind the eastern face and bedding dips towards it. The structure in detail appears to be quite complex and is difficult to assess without a major rock mechanics study.

The eastern quarry face appears to be well drained in that no significant areas of groundwater seepage were observed following the recent period of consistent rainfall. Apart from this observation and the report of water loss below 42m in Golder borehole G2 there is no factual information on water conditions behind the eastern face.

The Golder report of August 1982 concludes "... the eastern quarry face is therefore considered to remain stable at the slopes, and to the depth, proposed for further development of the quarry". This conclusion is consistent with observations made as part of this study. However, it is not possible to assess stability of the eastern face in a quantitative manner due to the lack of structural data on the rock mass behind the face.

The proposed filling is unlikely to significantly load the quarry face as it now stands, nor is it likely to adversely affect groundwater conditions behind the face. On this basis Golder's conclusion appears reasonable for the quarry face as it now stands. However, if further excavation of the eastern face or significant blasting near the eastern face is to occur then it is recommended that a major rock mechanics study be undertaken to allow a quantitative assessment of face stability before any such activity is allowed to proceed.

8.0 DRAINAGE MEASURES AND CONSTRUCTION PROVISIONS

8.1 Surface Drainage

Stability of the proposed fill is critically dependent on the provision of surface and subsurface drainage measures.

The surface drainage must prevent ponding of surface water and encourage rapid runoff so as to minimise infiltration of water into the fill. Drainage at the rear (eastern) side of the site is inadequate in its present form and must be modified to divert surface water into the drain system. It will, as a minimum, be necessary to provide a concrete cutoff wall to rock across the lowest section to divert the water which now enters the fill and, in the same location, to provide a lined drain to carry concentrated flows direct to the main drain. In addition, all entrances must be substantially upgraded and provided with measures to prevent blockage.
8.2 **Subsurface Drainage - Southern End**

In the area above the existing playing field there are stormwater drainage pipes which must be checked to see if they can sustain the additional loading and if not they must be modified to take the load or removed and other provisions made for surface drainage.

A subsoil drainage blanket should be provided at the base of the existing sandstone cuttings over the length of the cuttings where fill is to be placed against them. These drains should be 4m wide by 0.3m deep and consist of drainage gravel (see specification below). If desired, the shape in cross section may be modified but the cross section area should remain the same. For protection, these should be filled over to a depth of 0.5m by sandy clay or gravelly sand fill as obtained from the adjacent quarry for previous fill at the site. These subsoil drains should be positively drained into the overall drainage system.

In areas where the sandstone cutting shows weathering or fracturing, vertical drainage wicks should be placed and joined into the horizontal drains. Wick drains should be Mebra wick drain 7007 or similar, fastened to the rock face. Alternatively, sand could be placed against the face.

In the area to the south of the existing fill, stripping of the existing slope will produce a series of benches. Subsoil drains of at least 0.5m x 0.5m should be placed at the base of each bench slope, draining out to beyond the fill. A drain should also be placed along the existing southern fill toe. If the base of each slope is in rock the drainage gravel may be placed directly on it and filter cloth laid over the gravel, otherwise the filter cloth should encompass the gravel.

Provision of drainage at the toe of the existing west facing fill slope beneath the present playing field will be dependent on other action taken in this area.

8.3 **Subsurface Drainage - Northern End**

Figure 13 shows a tentative layout for subsurface drainage at the northern end. A large filter cloth protected gravel drain is proposed down the present central depression, extending down to the present edge of filling. Because of the high measured flows at this location, a higher capacity drain is required downstream of this point and a rockfill drainage layer protected by conventional two stage filters is proposed. Prior to placement of this drain the area should be stripped of all alluvium, residual soil and extremely weathered breccia. Dewatering of this excavation will be necessary and, depending on the nature of exposed rock, it may be necessary to slush grout the surface, both to inhibit softening and to minimise seepage into the underlying rock.

Other feeder drains are proposed plus separate drains along the existing road and at the toe of the underlying slope.
It will be essential to include subsoil drainage with any extension to the northern surface water drainage pipe.

Headwalls and pipe outlets are recommended to facilitate clearing of the outlets.

Depending on details of the amended fill design it may prove necessary to modify the drainage details given in Figure 13 and this drawing must be considered as indicative only.

At the exits of the main drains a perforated pipe should be placed back into the drain for 5m and an outlet structure should be built at the end of the drain. These structures are to facilitate cleaning to prevent blocking of the outlets.

As a further measure, the final 1m of fill is to be clay fill compacted to 100% of standard compaction. The purpose of this is to provide a relatively impermeable seal to the top of the fill. If services are planned which might penetrate this later the layer should be deepened.

8.4 Filter Cloth and Drainage Gravel

It is recommended that a non-woven needle punched geotextile be used as the filter cloth, such as BIDIM U14 or similar. Where the base for the drain is uneven a sand layer should be used to provide an even bed for the fabric.

Drainage gravel should consist of durable 20mm stone satisfying the requirements for concrete aggregate. It should contain no more than 2% by weight finer than 5mm. Sand bed material must have less than 5% passing 75 microns.

Graded filter drain material for use in the alluvial area should be of similar quality and to the grading shown in Figure 14. The rock component of the drain may be sandstone provided it is checked and found to be sufficiently durable. Not all sandstone will satisfy this requirement, even when fresh.

If desired, graded filters may be used elsewhere to replace filter cloth.

8.5 Staging and Construction

Prior to placement of fill on the natural surface, all vegetation and topsoil should be removed and the surface graded to an even slope.

The fill should be placed in layers and compacted to a minimum density ratio of 95% by standard compaction. The stability calculations assume the strength of either ripped sandstone or clay/shale fill compacted to this density, and failure to maintain this minimum standard will endanger stability. For the same reason, other forms of fill should not be used without further consultation. Density tests to check fill compaction
should be undertaken in accordance with the publication "Guidelines for the Specification and Testing of Earthworks" prepared by a sub-committee of the Australian Geomechanics Society. In addition, periodic effective strength tests should be done on the actual fill used to check design assumptions.

The staging of construction must be managed such that:

(1) Surface water is diverted around and away from the fill and the subsurface drains.

(b) The disposition of more permeable (e.g. sandstone) and less permeable (e.g. clay) fill must be organised so that water cannot build up within the permeable material. In particular, the placement of more permeable fill behind (i.e. further from the toe) impermeable fill must be avoided. If necessary, additional subsurface drainage should be provided to positively drain permeable zones in the fill.

The main central drain should be constructed prior to filling and be covered by 1m of fill to protect it from erosion.

The herringbone drains should be joined into the main drains and constructed ahead of filling in sections.

Monitoring of groundwater levels and flows from drains should be undertaken on a regular basis.

9.0 CONCLUSIONS

9.1 General

It must be recognised that the placement of fill over natural watercourses above the edge of an operating quarry is an inherently difficult and potentially dangerous undertaking.

Control of surface and subsurface drainage and close attention to fill quality will be essential and must be greatly improved from the present situation.

If ever the drainage systems become inoperative, for example by blocking of drains above the slope, the potential exists for a Coledale style flow slide to develop, and hence ongoing maintenance is essential.

The original proposal does not have an adequate margin of safety against failure. Some suggestions for alternatives are provided for consideration.

9.2 Southern End

The difficulties at this end occur because of poor drainage near the toe of the existing fill and proximity of the steep slope to the creek.
The possibilities for improving drainage at the toe are limited but could consist of placement of a toe drain by excavating in sections. These measures alone would not, however, prove sufficient and consideration must be given to either:

(1) Piping the creek and providing a toe buttress. Subsurface drainage along the creek would be necessary and the pipe would have to be designed very conservatively since overflow could result in scouring of a path to the quarry. The additional fill would add weight to the top of the quarry slope and further studies of this effect would be necessary.

(2) Flattening the existing batter and improving toe drainage.

It is recommended that placement of fill in this southern end be limited to the following until remedial measures are taken:

(a) Placement of fill to the south of the existing fill. The verbal recommendations given for that area should be implemented as noted in Section 8.2.

(b) At the rear of the present playing field not closer than 60m from the present crest. The drainage measures of Section 8.2 must be implemented prior to fill placement.

Additional boreholes should be drilled and piezometers installed to check whether the poor drainage conditions extend all along the toe and whether there is a dual or single groundwater system. Additional strength tests should also be carried out on fill, residual soil and highly weathered rock samples to check the applicability of the values obtained from samples further north. A proposal for this work is given in Appendix D.

9.3 Northern End

The analyses indicate that substantially flatter slopes are required and hence the fill configuration will have to be modified. Preferred configurations should be developed using the guidelines given in Section 6 and further advice sought concerning the stability of the new proposals.

A key issue is the depth of weathering, the actual groundwater regime, and the strength and permeability of the existing fill. Further investigations should be undertaken, including test pits, boreholes, installation of standpipes and additional laboratory testing. A proposal for this work is given in Appendix D.

The drainage measures shown are indicative only. However, the works above the fill at the base of the sandstone slope should be implemented immediately.
9.4 Quarry Face

On the basis of information available, Golder Associates' conclusion appears reasonable. In view of the possible ramifications if the quarry were to be extended, consideration should be given to implementing a rock mechanics study in conjunction with other work. A proposal for this work is given in Appendix E.

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REFERENCES

LEGEND

WET DENSITY

\( t/m^3 \)

- O TPI AT 0.4m 1.99
- △ 0.8m 1.83
- ★ 0.9m 1.88
- ● TP3 AT 1.3m 1.92
- ▲ BH6 AT 1.5-1.58m 2.09
- ~ AVE WET DENSITY 1.96 t/m³

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

HORNSBY SHIRE COUNCIL
OLD MAN'S VALLEY
SHEAR TEST SUMMARY

FIGURE 8

job no. S8463/2
Events in the well-exposed Sydney Basin diatremes can be tentatively correlated with particular levels in the diatreme model of Lorenz (1975). Diagram adapted from Lorenz (1975).
Graded filters shall conform to the requirements for concrete aggregate AS2758.1 except that grading shall be as shown above.

Rockfill shall have not more than 10% by weight finer than 19mm and maximum particle size of 300mm.
**Engineering Log - Borehole**

Client: HORSESHIRE COUNCIL

Principal: OLD MANS VALLEY

Borehole Location: SEE FIGURE 1

Drill Model and Mounting: EDISON 3000 - TRUCK

Hole Diameter: 100mm

Slope: -90 DEG

RL Surface: Approx 1310 m

Datum: AHD

**Notes and Test, etc.**

- **SP** FILL: SAND fine to coarse grained yellow - Brown
- **SC** FILL: SAND fine to coarse grained yellow - Brown CLAY medium plasticity
- **GW** GRAVEL fine to coarse grained brown to grey SAND, fine to coarse CLAY, medium plasticity
- **SC** CLAYEY SAND: fine to coarse grained yellow - brown to brown CLAY, low to medium plasticity

**SUPPORT**

- C casing

**Penetration**

- 123

**Water**

- not measured
- Water level
- Water inflow
- Water outflow

**Acronyms**

- ADT: Auger drilling
- AD: Auger sampling
- R: Roller/Drill
- T: Trencher
- W: Wash-bore
- CT: Cable tool
- HA: Hand auger
- DT: Diabase

**Water Test**

- BS: Bulk sample
- M: Moist
- W: Wet

**Soil Classification**

- VS: Very soft
- S: Soft
- F: Firm
- Stiff
- VSI: Very stiff
- Hard
- Fb: Friable
- VL: Very loose
- L: Loose
- MD: Medium dense
- D: Dense
- VD: Very dense

**Structure and Additional Observations**

- With some GRAVEL
- Becoming gravelly with depth

**Classifications**

- Based on unified classification system

**Moisture**

- Dry
- Moist
- Wet

**Notes**

- Samples and tests
- USG: Undisturbed sample 50 mm diameter
- D: Disturbed sample
- N: Standard penetration test: N" SPT + sample recovered
- No: SPT with solid cone
- V: Vane shear
- P: Pressuremeter
- B: Blank sample
- R: Refusal

**Classification Symbols and Soil Description**

- Plastic limit
- Dense
# Engineering Log - Cored Borehole BH1

**Client:** HORSBY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1

<table>
<thead>
<tr>
<th>Drilling Information</th>
<th>Rock Substance</th>
<th>Rock Mass Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Cores</td>
<td>Core</td>
</tr>
<tr>
<td>NMLC</td>
<td>3.0m</td>
<td>WATER</td>
</tr>
<tr>
<td></td>
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</tr>
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<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**General Defect Description:**

<table>
<thead>
<tr>
<th>Defect</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>JT</td>
<td>70 deg, planar, rough 6.70-6.90</td>
</tr>
</tbody>
</table>

**METHOD**
- AS: auger sampling
- AD: auger drilling
- R: roller/tricone
- W: wireline
- NMLC: core drilling
- NG: core drilling

**POINT LOAD TEST**
- D: diametral
- A: axial

**GRAPHIC LOG/CORE LOSS**
- Drilling Water
- Partial Loss
- Complete Loss
- No Core Recovered

**WEATHERING**
- FR: fresh
- SW: slightly weathered
- MW: moderately weathered
- HW: highly weathered
- EW: extremely weathered

**STRENGTH**
- EL: extremely low
- VL: very low
- L: low
- M: medium
- H: high
- VH: very high

**DEFECTS**
- JT: joint
- PT: parting
- SM: seam
- CL: clay
- RO: rotted
- DC: decomposed
- PL: plane
- IR: irregular
# Engineering Log - Cored Borehole

**Client:** Hornsby Shire Council  
**Project:** Old Mans Valley  
**Borehole Location:** See Figure 1

| Borehole No. | BH1  
|--------------|------|

**Drill Model and Mounting:** Edison 3000 - Truck  
**Borehole Type and Length:** NMLC 3.0m  
**Fluid:** Water  
**Slope:** -90 Deg  
**R.L. Surface:** Approx. 1310 m

## Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Core Cut</th>
<th>Water</th>
<th>R.L. Depth</th>
<th>Graph Ref.</th>
<th>Rock Substance</th>
<th>Rock Mass Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMLC</td>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td>Sandstone</td>
<td></td>
</tr>
<tr>
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<td>10</td>
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<td></td>
<td></td>
<td>15</td>
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</tr>
</tbody>
</table>

**Borehole BH1 Terminated at 8.60 m**

## General Defect Description:

- **Method:**
  - AS: Auger screwing
  - AD: Auger drilling
  - R: Roller/icone
  - W: Washbore
  - NMLC: Core drilling
  - NQ, HQ: Core drilling
- **Graphic Log/Core Loss:**
  - Drilling Water
  - Water Level
  - Water Inflow
  - Flowing Water
- **Point Load Test:**
  - Core Recovered
  - Partial Loss
  - Complete Loss
- **Weathering:**
  - Fresh
  - Moderately
  - Slightly
- **Strength:**
  - Extremely Low
  - Very Low
  - Low
  - Medium
  - High
  - Very High
- **Defects:**
  - Joint
  - Coarse
  - Seam
  - Clay
  - Rough
  - Decomposed
  - Planar
  - Irregular
engineering log - borehole

client: HORNSEY SHIRE COUNCIL
principal: OLD MANS VALLEY
borehole location: SEE FIGURE 1

method
method: ADT
penetration: N=0
support: C
notes: samples
water: -

WATER
- not measured

NOTES
- samples and tests
- undisturbed sample 50 mm diameter
- disturbed sample
- SPT + sample recovered
- SPT with solid cone
- veer shear
- pressure meter
- bulk sample
- refusal
- refusal

CLASSIFICATION
- symbols and soil description
- based on unified classification system
- moisture
- dry
- moist
- wet
- plastic limit

CONSISTENCY/DENSITY INDEX
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fh friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

ADT

EDSON 3000 - TRUCK
hole diameter: 100mm

material
- soil type/plasticity or particle characteristics
- colour, secondary and minor components

M

GW
FILL GRAVEL fine to coarse grained brown sand fine to coarse CLAY low to medium plasticity

GC
FILL GRAVEL fine to coarse grained CLAY medium to high plasticity

< Wp

Clayey sand: fine to coarse grained orange - brown to grey CLAY medium to high plasticity

Extremely weathered sandstone
**Engineering Log - Borehole**

**Client:** HORNSBY SHIRE COUNCIL  
**Project:** OLD MAN'S VALLEY  
**Borehole Location:** SEE FIGURE 1

**Hole Diameter:** 100mm  
**Slope:** -90 DEG  
**RL Surface:** Approx. 1312 m

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes/ Samples/Test, etc.</th>
<th>Soil Type/ Particle Characteristics</th>
<th>Material Notes</th>
<th>Consistency/Density Index</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td></td>
<td></td>
<td>CLAYEY SAND: fine to coarse grained orange - brown to grey CLAY medium to high plasticity</td>
<td>&lt;Wp</td>
<td>Extremely weathered sandstone</td>
<td></td>
</tr>
</tbody>
</table>

**Consistency/Density Index**

- **VS** very soft
- **S** soft
- **F** firm
- **SI** stiff
- **VSt** very stiff
- **H** hard
- **Ff** friable
- **VL** very loose
- **L** loose
- **MD** medium dense
- **D** dense
- **VD** very dense

**Notes and Tests**

- **USG**: Undisturbed Sample 50 mm Diameter
- **D**: Disturbed Sample
- **N**: Standard Penetration Test: N' SPT + sample recovered
- **NC**: SPT with solid cone
- **V**: Vane Shear
- **P**: Pore Pressure
- **B**: Bulk Sample
- **R**: Refusal

**Classification**

- Based on unified classification system

**Moisture**

- **D**: Dry
- **M**: Moist
- **W**: Wet

**ADT**

**Commenced Coring at 10.30m**
# Engineering Log - Cored Borehole

**Client:** HORNSEY SHIRE COUNCIL  
**Principal:** OLD MANS VALLEY  
**Project:** SEE FIGURE 1  
**Borehole Location:**  

**Drill Model and Mounting:** EDSON 3000 - TRUCK  
**Barrel Type and Length:** NMCL - 3.0m  
**Fluid:** WATER  
**Slope:** -90 DEG  
**RL Surface:** Approx 1312 m  

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Substance Description</th>
<th>Rock Type: Grain Characteristics</th>
<th>Colour, Structure, Minor Components</th>
<th>Weathering</th>
<th>Point Load Test (kN)</th>
<th>Defect Spacing (mm)</th>
<th>Defect Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>SANDSTONE: fine to coarse grained, orange, - grey, indistinct bedding</td>
<td></td>
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<tr>
<td>10</td>
<td>Continued from non-core borehole</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>

**General Defect Description:**

**Defects:**
- JT - joint  
- PT - parting  
- SM - seam  
- CL - clay  
- RO - rough  
- DC - decomposed  
- PL - planar  
- IR - irregular

**Method:**
- AS - auger screwing  
- AD - auger drilling  
- W - roller/ticone  
- NL - core drilling  

**Logging:**
- Water level  
- Water inflow  
- Not measured  
- Partial loss  
- Complete loss

**Strength:**
- EL - extremely low  
- VL - very low  
- L - low  
- M - medium  
- H - high  
- VH - very high  
- SH - extremely high

<table>
<thead>
<tr>
<th>Defects</th>
<th>Method</th>
<th>Water Level</th>
<th>Water Inflow</th>
<th>Not Measured</th>
<th>Partial Loss</th>
<th>Complete Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>JT</td>
<td>AS</td>
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<td>CL</td>
<td>NL</td>
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</table>

**General Description:**

- Terminated at 13.30 m
Client: HORSBY SHIRE COUNCIL
Project: OLD MANS VALLEY
Borehole location: SEE FIGURE 1

Drill model and mounting: EDSION 3000 - TRUCK

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Water</th>
<th>Notes Samples, Test, etc</th>
<th>R.L. Depth (m)</th>
<th>Material</th>
<th>Consistency/Consistency index</th>
<th>Consistency/Density Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
<td></td>
<td></td>
<td></td>
<td>0.3-4</td>
<td>SC</td>
<td>&lt; Wp</td>
<td>VS</td>
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<td></td>
<td>1</td>
<td>CL</td>
<td></td>
<td>VSI</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>1.5-2</td>
<td>CM</td>
<td></td>
<td>H</td>
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<td></td>
<td>7</td>
<td>CM</td>
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</tr>
</tbody>
</table>

Notes: Samples and tests
- USO: Undisturbed sample 50 mm diameter
- D: Disturbed sample
- N: Standard penetration test
- N* SPI: SPI + sample recovered
- NC: SPI with solid cone
- V: Vane shear
- P: Pressuremeter
- B: Bulk sample
- R: Refusal

Classifications:
- S: Soft
- F: Firm
- SI: Stiff
- VSI: Very stiff
- H: Hard
- Fb: Frangible
- VS: Very loose
- L: Loose
- MD: Medium dense
- D: Dense
- VD: Very dense

Structure and additional observations:
- FILL Gravel contains breccia fragments
- No resistance ranging to refusal

Other symbols:
- C: casing
- M: mud
- HA: hand auger
- DT: diabase
- B: bit shown by suffix
- T: TC bit
- ADT: auger drilling

Method: auger drilling
Support: C: casing
Penetration: 1
Water: not measured
NOTES: samples and tests
- USO: undisturbed sample 50 mm diameter
- D: disturbed sample
- N: standard penetration test
- N*: SPI + sample recovered
- NC: SPI with solid cone
- V: vane shear
- P: pressuremeter
- B: bulk sample
- R: refusal

Consistency/Density Index:
- VS: very soft
- S: soft
- F: firm
- SI: stiff
- VSI: very stiff
- H: hard
- Fb: frangible
- VS: very loose
- L: loose
- MD: medium dense
- D: dense
- VD: very dense
# Engineering Log - Borehole BH3

**Client:** HONSBY SHIRE COUNCIL  
**Principal:**  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1  
**Hole Diameter:** 100mm  
**Slope:** -90 DEG  
**R.L. Surface:** Apprx 29.9 m  
**Datum:** AHD

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>Notes</th>
<th>Depth</th>
<th>Material</th>
<th>Soil Type, Plasticity or Particle Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>auger drilling</td>
<td></td>
<td></td>
<td></td>
<td>GP</td>
<td>fine to coarse grained brown SAND</td>
</tr>
<tr>
<td></td>
<td>auger screwing</td>
<td></td>
<td></td>
<td></td>
<td>&lt;Wp</td>
<td>H</td>
</tr>
</tbody>
</table>

**Structure and Additional Observations:**

- COMMENCED CORING AT 9.00m

---

**METHOD**
- AS: auger screwing  
- AD: auger drilling  
- R: roller/tricone  
- W: wash bore  
- CT: cable tool  
- HA: hand auger  
- DT: diatrace  

**SUPPORT**
- C: casing  
- M: mud  

**PENETRATION**
- no resistance ranging to refusal

**WATER**
- not measured
- Water Level
- Water Outflow
- Water Inflow

**NOTES**
- Samples and Tests
- USO: undisturbed sample 50 mm diameter
- D: disturbed sample
- N: standard penetration test
- N* SPT + sample recovered
- No SPT with solid cone
- V: vane shear
- P: pressuremeter
- B: bulk sample
- R: refusal

**CLASSIFICATION**
- SYMBOLS AND SOIL DESCRIPTION
- Based on unified classification system

**MOISTURE**
- D: dry
- M: moist
- W: wet
- Wp: plastic limit

**CONSISTENCY/DENSITY INDEX**
- VS: very soft
- S: soft
- F: firm
- SI: stiff
- VSI: very stiff
- H: hard
- Fs: faintly
- VL: very loose
- L: loose
- MD: medium dense
- D: dense
- VD: very dense
### Engineering Log - Cored Borehole

**Client:** HORSBY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1  
**Hole Number:** BH3  
**Sheet:** 3 of 3

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Substance Description</th>
<th>Weathering</th>
<th>Point Load Test (kN)</th>
<th>Defect Spacing (mm)</th>
<th>Defect Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>BRECCIA: medium to coarse grained, light - brown, indistinct bedding.</td>
<td>HW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>BRECCIA: medium to coarse grained, light - grey.</td>
<td>MW</td>
<td>D 20.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>BRECCIA: medium to coarse grained, light - grey.</td>
<td>HW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>BRECCIA: medium to coarse grained, light - brown.</td>
<td>HW</td>
<td>D 30.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Borehole Terminated at:** 11.80 m

**General Defect Description:**

- Fractured zone 9.20-9.35
- Smooth, clean 7mm
- LF, 600deg, irregular, rough 9.50-9.55
- Seam, clay filled 5mm
- Seam, clay filled 10mm
- LF, 600deg, irregular, rough 9.80-9.85
- Fractured zone 10.0-11.20
- Insured <2mm thick in Breccia at 45deg
- Fractured zone 10.50-11.60
- Seam, clay filled 10mm
- Fractured zone 50mm
- LF, 600deg, curved, rough 10.95-11.60
- Fractured zone 11.30-11.35
- Seam, clay, 10mm thick
- Crushed seam 20mm thick
- Crushed seam 10mm thick
- LF, 600deg, planar, rough 11.80-11.85

**Method:** AS = auger screwing  
**Drilling Method:** NMLC = core drilling  
**Casing Used:** barrel withdrawn  
**Drilling Water:** partial loss  
**Core Recovered:** no core recovered

**Weathering:**
- FL – fresh  
- VL – very low  
- L – low  
- MW – moderately  
- M – medium  
- HW – highly  
- VH – very high  
- EW – extremely  
- BH – extremely high

**Defects:**
- JT – joint  
- PT – parting  
- SM – seam  
- CL – clay  
- RO – rough  
- DC – decomposed  
- PL – planar  
- IR – irregular

**Thermal Index:**
- THERMAL INDEX

**Note:** All depths are approximate and subject to drilling and logging conditions.
# Engineering Log - Borehole

**Client:** HORNSBY COUNCIL  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1  
**Drill Model and Mounting:** EDSON 3000 - TRUCK  
**Hole Diameter:** 100mm  
**Slope:** -90 DEG  
**R.L. Surface:** Approx 130.2 m  
**Datum:** AHD  
**Borehole No.:** BH4  
**Office Job No.:** S8463/2  
**Hole Commenced:** 31-1-89  
**Hole Completed:** 31-1-89  
**Logged By:** SRM  
**Checked By:** AS

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>Sample</th>
<th>Test</th>
<th>R.L.</th>
<th>Depth</th>
<th>Soil Type</th>
<th>Plasticity</th>
<th>Party</th>
<th>Condition</th>
<th>Hand</th>
<th>Structure and Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
<td>D</td>
<td>CL</td>
<td>R.L.</td>
<td>&lt;Wp</td>
<td></td>
<td></td>
<td>FILL CLAY medium plasticity dark brown GRAVEL fine to coarse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>GC</td>
<td>R.L.</td>
<td>VSI</td>
<td></td>
<td></td>
<td>FILL SANDY CLAYEY GRAVEL or above SAND fine to coarse</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Support:** C casing  
**Notes:** samples and tests  
**Classification Symbols and Soil Description:**  
- U50: Undisturbed sample 50 mm diameter  
- D: Disturbed sample  
- N: Standard penetration test  
- No: SPT + sample recovered  
- Vc: SPT with solid cone  
- V: Vane shear  
- P: Pressuremeter  
- R: Refusal  
**Moisture:**  
- D: Dry  
- M: Moist  
- W: Wet  
- Wp: Plastic limit  
**Consistency/Density Index:**  
- VS: Very soft  
- V: Soft  
- F: Firm  
- Sli: Slight  
- VSI: Very stiff  
- H: Hard  
- Tr: Triable  
- VL: Very loose  
- L: Loose  
- MD: Medium dense  
- D: Dense  
- VD: Very dense  

**Notes:**  
- "ADT" auger drilling  
- "DI" diabase  
- "W" washpipe  
- "CT" cable tool  
- "HA" hand auger  
- "DT" diabase  
- "S" sample  
- "V" blast  
- "T" TC bit  
- "B" blank bit  
- "e.g., ADT"
## Engineering Log - Borehole BH4

### Client: Hornsby Council
### Project: Old Mans Valley

**Borehole Location:** See Figure 1

### Drill Model and Mounting: EDSON 3000 - TRUCK

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td>auger screwing*</td>
<td>C casing</td>
</tr>
<tr>
<td>AD</td>
<td>auger drilling*</td>
<td>M mud</td>
</tr>
<tr>
<td>R</td>
<td>rotary/ticcone</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>washbore</td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>cable tool</td>
<td></td>
</tr>
<tr>
<td>HA</td>
<td>hand auger</td>
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<td>DT</td>
<td>diabase</td>
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</table>

### Notes
- **RL:** Depth in metres
- **Graph Log:** soil type, plasticity or particle characteristics
- **Uniaxial:** soil type, plasticity or particle characteristics

### Material
- **Material:** soil type, plasticity or particle characteristics
- **Material Notes:** Colour, secondary and minor components

### Soil Classification and Additional Observations
- **Soil Type:** Sandy Clayey Gravel
- **Characteristics:** Fine to course
- **Classification:** SAND
- **Note:** Commened coring at 8.30m

### CONSISTENCY/DENSITY INDEX
- **VS:** Very soft
- **S:** Soft
- **F:** Firm
- **ST:** Stiff
- **VS1:** Very stiff
- **H:** Hard
- **Fb:** Fissile
- **VL:** Very loose
- **L:** Loose
- **MD:** Medium dense
- **D:** Dense
- **VD:** Very dense

### Soil Description
- **Based on Unified classification system**

### Water
- **Not Measured**
- **Water Level**
- **Water Outflow**
- **Water Inflow**

### Support
- **Casing**
- **Mud**
## Engineering Log - Borehole

### Client: Hornsea Shire Council
### Project: Old Mans Valley
### Borehole Location: See Figure 1

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Water</th>
<th>Notes</th>
<th>Depth (m)</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>AD</td>
<td>2</td>
<td>Nil</td>
<td>samples, test, etc</td>
<td>1</td>
<td>GC: Clayey Gravel, Fine to Coarse, Light Brown Clay, Medium Plasticity, SAND Fine to Coarse</td>
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<td>AD</td>
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<td>SC: Clayey Sand, as above, CLAY Low to Medium Plasticity</td>
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<tr>
<td>AD</td>
<td>2</td>
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<td>test</td>
<td>3</td>
<td>CL: Fill, CLAY as above</td>
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<tr>
<td>AD</td>
<td>2</td>
<td>Nil</td>
<td>test</td>
<td>4</td>
<td>Fil contains timber fragments</td>
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</table>

### Notes and Tests
- **US5:** Undisturbed sample 50 mm diameter
- **D:** Disturbed sample
- **N:** Standard penetration test
- **H:** SPT + Sample recovered
- **Hc:** SPT with solid cone
- **V:** Vane shear
- **P:** Pressuremeter
- **B:** Bulk sample
- **R:** Refusal

### Classification Symbols and Soil Description
- Based on unified classification system

### Moisture
- **D:** Dry
- **M:** Moist
- **W:** Wet
- **Wp:** Plastic limit

### Consistency/Density Index
- **VS:** Very soft
- **S:** Soft
- **F:** Firm
- **SI:** Stiff
- **VI:** Very stiff
- **H:** Hard
- **Fb:** Tricky
- **VL:** Very loose
- **L:** Loose
- **MD:** Medium dense
- **D:** Dense
- **VD:** Very dense
# Engineering Log - Borehole

**Client:** HORNSEY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>Samples, Test, etc.</th>
<th>R.L.</th>
<th>Depth</th>
<th>Material</th>
<th>Soil Type/Plasticity or Particle Characteristics</th>
<th>Colour, Secondary and Minor Components</th>
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<tbody>
<tr>
<td>AS</td>
<td>1-2-3</td>
<td>CL</td>
<td>FILL: CLAY as above</td>
<td>M</td>
<td>VSI</td>
<td>M</td>
<td>Coring commenced at 10.55m</td>
<td>[FILL contains timber fragments]</td>
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<td>SC</td>
<td>CLAYEY SAND: fine to coarse grey to orange</td>
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</table>

**Notes and Tests:**  
- USO: Undisturbed sample 50 mm diameter  
- D: Disturbed sample  
- N: Standard penetration test  
- N*: SPI + sample recovered  
- No SPI with solid cone  
- V: Vane shear  
- P: Pressuremeter  
- B: Bulk sample  
- R: Refusal  

**Classification Symbols and Soil Description:**  
- Based on unified classification system  
- Moisture:  
  - D: Dry  
  - M: Moist  
  - W: Wet  
- Consistency/Density Index:  
  - VS: Very soft  
  - V: Stiff  
  - S: Soft  
  - F: Firm  
  - VL: Very loose  
  - L: Loose  
  - MD: Medium dense  
  - D: Dense  
  - VD: Very dense
# Engineering Log - Cored Borehole

**Client:** Horsby Shire Council  
**Project:** Old Mans Valley

**Borehole Location:** See Figure 1

**Drill Model and Mounting:** Edson 3000 - Truck Mounded

**Barrel Type and Length:** NMLC 3.0m

**Fluid:** Water

**Slope:** -90 Deg

**R.L. Surface:** Approximately 35.5 m

## Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Case Lift</th>
<th>Water</th>
<th>R.L.</th>
<th>Depth Meters</th>
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**Substance Description:**

- **Rock Type:** Grain characteristics  
- **Colour:** Structure, minor components

**Point Load Test (MPa):**

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<tr>
<th>Depth (m)</th>
<th>Strength</th>
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**Defect Description:**

- **Type:** Inclination, planarity, roughness
- **Coating, Thickness:**

## Rock Mass Defects

- **Defect Type:** Debris Spacing

**General Description Below:**

**Borehole BH5 Terminated at 13.55 m**

### General Defect Description:

- **Method:**
  - AS: Auger Screwing
  - AD: Auger Drilling
  - NMLC: Core Drilling
  - NQ: Core Drilling

- **Core Loss:**
  - Partial Loss
  - Complete Loss

- **Point Load Test:**

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<th>Point Load Test</th>
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- **Weathering:**
  - EL: Extremely Low
  - VL: Very Low
  - L: Low
  - MW: Moderately
  - HW: Highly
  - VH: Very High

- **Strength:**
  - Jt: Joint
  - Pt: Parting
  - Sm: Seam
  - Cl: Clay
  - Ro: Rough
  - Dc: Decomposed
  - Pl: Planar
  - Ir: Irregular
## Engineering Log - Borehole

**Client:** Hornsby Shire Council  
**Project:** Old Mans Valley  
**Borehole Location:** See Figure 1  
**Boresites:** Edeon 3000 - Truck  
**Hole Diameter:** 100mm

### Drill Method and Mounting
- **Method:** ADV
- **Penetration:** Nil
- **Support:** Nil
- **Notes:** Sampled, tests, etc.
- **R.L.:** Depth
- **Graphic:** Log

### Material
- **Material Identification:**
  - Clayey sand: fine to medium grained dark grey brown clay medium plasticity
  - Sandy clay: low to medium plasticity brown sandy clay fine to coarse
  - Sand: medium to coarse grained grey brown
  - Sandy clay: low to medium plasticity brown to yellow brown sandy clay fine to medium
  - Sandy gravelly clay: medium to high plasticity yellow brown

### Structural and Additional Observations
- **Datum:** AND
- **Topsoil:** Alluvium
- **Residual:** Residual to SW Breccia

### Methodology
- **AS:** Auger screwing
- **AD:** Auger drilling
- **R:** Roller-tricone
- **W:** Water bore
- **CT:** Cable tool
- **HA:** Hand auger
- **DT:** Disturb
- **%:** No resistance ranging to refusal

### Water Levels
- **Casing:** C
- **Mud:** M
- **Water Level:** Measured
- **Blank:** Blank bit
- **V:** V bit
- **T:** TC bit
- **ADT:** Water outflow
- **V:** Water inflow

### Consistency/Density Index
- **VS:** Very soft
- **S:** Soft
- **F:** Firm
- **SI:** Stiff
- **S1:** Very stiff
- **H:** Hard
- **Fl:** Frangible
- **VL:** Very loose
- **L:** Loose
- **MD:** Medium dense
- **D:** Dense
- **VD:** Very dense

### Notes
- Samples and tests
  - US0: Undisturbed sample 50 mm diameter
  - D: Disturbed sample
  - N: Standard penetration test
  - N*: SPT + sample recovered
  - No: SPT with solid cone
  - V: Vane shear
  - P: Pressuremeter
  - Ba: Bulk sample
  - R: Refusal
  - Wp: Plastic limit
**engineering log - cored borehole**

**client:** HORNSEY SHIRE COUNCIL  
**principal:** OLD MANS VALLEY  
**borehole location:** SEE PLAN

**hole commenced:** 20.3.89  
**hole completed:** 20.3.89  
**logged by:** SRM  
**checked by:** AS

**drill model and mounting:** EDISON 3000 - TRUCK  
**slope:** -90 DEG  
**RL Surface:** 95.9 m  
**datum:** AHD

**barrel type and length:** NMLC 3.8m  
**fluid:** WATER  
**bearing:**

<table>
<thead>
<tr>
<th>Drilling Information</th>
<th>Rock Substance</th>
<th>Rock Mass Defects</th>
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</thead>
<tbody>
<tr>
<td><strong>method</strong></td>
<td><strong>substance description</strong></td>
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# Engineering Log - Cored Borehole

**Client:** HORNESBY SHIRE COUNCIL  
**Principal:**  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE PLAN  
**Borehole No.:** BH6  
**Office Job No.:** 58465/2  
**Logged by:** SPM  
**Checked by:** AS  
**Drill Model and Mounting:** EDSON 3000 - TRUCK  
**Barrel Type and Length:** NMLC 3.6m  
**Fluid:** WATER  
**R.L. Surface:** 95.9 m  
**Datum:** AHD  
**Slope:** -90 DEG  

## Drilling Information

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sub substance description</th>
<th>Strength Test</th>
<th>Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>BRECCIA medium to coarse grained, grey, indistinct bedding.</td>
<td>Fractured zone 5mm thick, Two joints intersecting at approx. 70deg</td>
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**Borehole BH6 Terminated at 11.50 m**

## General Defect Description:

- **Method:**
  - AS: auger screwing
  - AD: auger drilling
  - R: roller/tricone
  - W: washbore
  - NMLC: core drilling
  - NO, HQ: core drilling
- **Point Load Test:**
  - D - diametral
  - A - axial
- **Weathering:**
  - FR - fresh
  - SW - slightly weathered
- **Strength:**
  - EL - extremely low
  - V L - very low
- **Defects:**
  - JT - joint
  - PL - planar
  - CM - decomposed
  - RO - rough
  - IR - irregular
  - DC - decomposed
# Engineering Log - Cored Borehole

**Client:** Hornsby Shire Council  
**Project:** Old Mans Valley  
**Borehole Location:** See Drawing No 58463/2-1  
**Borehole No:** BH7  
**Sheet:** 1 of 1

<table>
<thead>
<tr>
<th>Drilling Information</th>
<th>Rock Substance</th>
<th>Rock Mass Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Method</strong></td>
<td><strong>Description</strong></td>
<td><strong>Type</strong>, <strong>Indication</strong>, <strong>Planarity</strong>, <strong>Roughness</strong>, <strong>Coating</strong>, <strong>Thickness</strong>, <strong>Unless Otherwise Noted</strong></td>
</tr>
<tr>
<td>NMLC</td>
<td>Rill: NO CORE gravelly clay red, brown, to yellow, brown.</td>
<td>Core from 3.5 to 4.2m fragmented by joints, clay seams and partings</td>
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<tr>
<td>1</td>
<td>Clay: medium to high plasticity, yellow, brown.</td>
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<td>2</td>
<td>Clay: yellow, brown, fragmented, some thin clay seams</td>
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<tr>
<td>3</td>
<td>NO CORE: 0.75m</td>
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<tr>
<td>4</td>
<td>BRECCIA: yellow, brown, fragmented, some thin clay seams</td>
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<tr>
<td>5</td>
<td><strong>Borehole BH7 Terminated at 4.26 m</strong></td>
<td></td>
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</table>

Standpipe piezometer installed at 3.45m. Slotted from 1.45m to 3.45m. Clay plug at surface.

**General Defect Description:**

**METHOD**  
- Auger drilling  
- Water level  
- Water inflow  
- Not measured  
- Drilling Water  
- Partial loss  
- Complete loss  
- Casing used  
- Barrel withdrawn  

**POINT LOAD TEST**  
- D - diametral  
- A - axial  

**WEATHERING**  
- FR - fresh  
- SW - slightly wet  
- MW - moderately wet  
- HW - highly wet  
- EW - extremely wet  

**STRENGTH**  
- EL - extremely low  
- VL - very low  
- L - low  
- M - medium  
- H - high  

**LOG/LOG CORE LOSS**  
- Core recovered (atching indicates material)  
- No core recovered  

**NO. HQ**  
- JT - joint  
- PT - parting  
- SM - seam  
- CL - clay  
- RO - rough  
- DC - decomposed  
- PL - planar  
- IR - irregular
# Engineering Log - Borehole

**Client:** HORNSEY SHIRE COUNCIL  
**Principal:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1

| Drill Model and Mounting: | EDSON 2000 TRUCK  
| Hole Diameter: | 100mm  

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Notes</th>
<th>Depth</th>
<th>Material</th>
<th>Consistency/Density Index</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
<td>NL</td>
<td></td>
<td>1</td>
<td>CH CLAY: medium to high plasticity red brown</td>
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<td>RESIDUAL</td>
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<td>2</td>
<td>CLAY: medium to high plasticity yellow brown</td>
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<td>EW BRECCIA</td>
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<td>3</td>
<td>BRECCIA: extremely weathered to highly weathered, yellow brown, some core stones and gravel</td>
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<td>EW/HW BRECCIA</td>
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<td>4</td>
<td>BRECCIA: highly weathered yellow - brown, some core stones</td>
<td>H</td>
<td>HW BRECCIA</td>
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</tbody>
</table>

**Notes:**  
- **Method:** ADT  
- **Support:** NL  
- **Material:** CH CLAY: medium to high plasticity red brown  
- **Consistency/Density Index:** RESIDUAL  
- **Additional Observations:** EW BRECCIA, EW/HW BRECCIA

**Consistency/Density Index:**  
- VS: very soft  
- S: soft  
- F: firm  
- SI: stiff  
- VSt: very stiff  
- H: hard  
- Fb: friable  
- VL: very loose  
- L: loose  
- MD: medium dense  
- D: dense  
- VD: very dense

**Symbols and Soil Description:**  
- Based on unified classification system

**MOISTURE:**  
- D: dry  
- M: moist  
- W: wet  
- Wp: plastic limit

**Water:**  
- Water level  
- Water outflow  
- Water inflow

**Casing:**  
- C: casing  
- M: mast

**Penetration:**  
- No resistance ranging to refusal

**Samples and Tests:**  
- USG: undisturbed sample 50 mm diameter  
- D: disturbed sample  
- N: standard penetration test  
- N*: SPT + sample recovered  
- NC: SPT with solid cone  
- V: vane shear  
- P: pressuremeter  
- BS: bulk sample  
- R: refusal
# Engineering Log - Borehole

**Client:** HORSBY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Borehole Location:** SEE FIGURE 1  
**Drill Model and Mounting:** EDSON 2000 TRUCK  
**Hole Diameter:** 100mm

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Notes, Samples, Tests, Etc.</th>
<th>R.L.</th>
<th>Graphic Log</th>
<th>Classification Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
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<td>BRECCIA Highly weathered yellow - brown some corestones</td>
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</table>

**Borehole BH8 Terminated at 9.25m**

Standpipe piezometer installed at 9.25m. Slotted from 7.25m to 9.25m. Clay plug at surface.

**Notes:**
- USB undisturbed sample 50 mm diameter
- D disturbed sample
- N standard penetration test
- N* SPT + sample recovered
- Nc SPT with solid cone
- V vane shear
- P pressuremeter
- B, S bulk sample
- R refusal

**Classification Symbols and Soil Description:**
- Consistency/Density Index
  - VS: very soft
  - S: soft
  - F: firm
  - SI: stiff
  - VSI: very stiff
  - H: hard
  - Fo: foliated
  - VL: very loose
  - L: loose
  - MD: medium dense
  - D: dense
  - VD: very dense

**Moisture:**
- D: dry
- M: moist
- W: wet
- Wp: plastic limit
### Engineering Log - Excavation

**Client:** HORNBY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Pit Location:** SEE FIGURE 1

**Excavation Dimensions:** 3.0 m long  
**Width:** 12 m wide  
**R.L. Surface:** 106.3 m

**设备类型和型号:** KATO HD 1250 SE

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>Water</th>
<th>R.L.</th>
<th>Material</th>
<th>Soil Type/Plasticity or Particle Characteristics</th>
<th>Colour, Secondary and Minor Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>B3</td>
<td>Nil</td>
<td>B3</td>
<td>USG</td>
<td>USG</td>
<td>CL</td>
<td>TOPSOIL: SILTY CLAY brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>USG</td>
<td>USG</td>
<td>CH</td>
<td>GRAVELLY CLAY: high plasticity red brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>USG</td>
<td>CH</td>
<td>GRAVELLY CLAY: high plasticity red brown to yellow brown some moderately weathered breccia core stones</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>USG</td>
<td>BS</td>
<td>BRECCIA extremely weathered/highly weathered, orange brown some large breccia core stones</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>USG</td>
<td>BS</td>
<td>BRECCIA highly weathered red brown to yellow brown some core stones</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>USG</td>
<td>BS</td>
<td>BRECCIA moderately weathered light grey</td>
<td></td>
</tr>
</tbody>
</table>

**Method:**  
- N: Natural exposure  
- X: Existing excavation  
- BH: Backhoe bucket  
- B: Bulldozer blade  
- R: Ripper  
- E: Excavator  
- HA: Hand auger  

**Support:**  
- T: Timbering  
- N: Nil

**Notes:**  
- USG: Undisturbed sample 50 mm diameter  
- D: Disturbed sample  
- N: Standard penetration test  
- NR: SPT + sample recovered  
- NC: SPT with solid cone  
- V: Vane shear  
- P: Pressuremeter  
- BS: Bulk sample  
- R: Refusal

**Classification:**  
Based on unified classification system

**Moisture:**  
- D: Dry  
- M: Moist  
- W: Wet

**Consistency/Density Index:**  
- VS: Very soft  
- S: Soft  
- F: Firm  
- SI: Stiff  
- VS1: Very stiff  
- H: Hard  
- Fl: Friable  
- VL: Very loose  
- L: Loose  
- MD: Medium dense  
- D: Dense  
- VD: Very dense

**Pit TP1 Terminated at 4.70 m near refusal**

**Structure and Additional Observations:**

- HW BRECCIA
- Clay seam moist - wet at 4.40m
- MW BRECCIA

---

**METHOD:**

<table>
<thead>
<tr>
<th>Penetration</th>
<th>Notes</th>
<th>Water</th>
<th>Water Outflow</th>
<th>Water Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3</td>
<td>no resistance ranging to refusal</td>
<td>D: None encountered</td>
<td>*: Not measured</td>
<td>F: Water level</td>
</tr>
</tbody>
</table>

---

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# Engineering Log - Excavation

**Client:** Hornsby Shire Council  
**Project:** Old Mans Valley  
**Pit Location:** See Figure 1  
**Equipment Type and Model:** KATO HD 1250 SE  
**Extraction Dimensions:** 2.5 m long, 1.2 m wide  
**Datum:** AND  
**RL Surface:** 122.9 m

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>Samples, Test, etc.</th>
<th>R.L.</th>
<th>Depth</th>
<th>Penetrometer</th>
<th>Material</th>
<th>Soil Type/Plasticity or Particle Characteristics, Colour, Secondary and Minor Components</th>
<th>Geological Condition</th>
<th>Geotechnical/Geophysical Test</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td></td>
<td>Nil</td>
<td>Nil</td>
<td>Chlorite high plasticity red brown</td>
<td>D</td>
<td>S1</td>
<td>Residual</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BRECCIA highly weathered light grey brown</td>
<td>MD</td>
<td>D</td>
<td>HW BRECCIA</td>
<td></td>
</tr>
</tbody>
</table>

Pit TP2 Terminated at 2.50 m

**Method:** Natural Exposure

**Penetration:** No resistance ranging to refusal

**Water:**
- D: None encountered
- *: Not measured
- N: N/A

**Water Level:**
- Water outflow
- Water inflow

**Classification Symbols and Soil Description:**
- Based on unified classification system

**Consistency/Density Index:**
- VS: Very soft
- S: Soft
- F: Firm
- SI: Stiff
- VSt: Very stiff
- H: Hard
- Fr: Frangible
- VL: Very loose
- L: Loose
- MD: Medium dense
- D: Dense
- VD: Very dense

**Moisture:**
- D: Dry
- M: Moist
- W: Wet
- Wp: Plastic limit

**Notes:**
- Samples and tests
- USG: Undisturbed sample 50 mm diameter
- D: Disturbed sample
- N: Standard penetration test
- *: Sample recovered
- V: Vane shear
- P: Pressure meter
- BS: Bulk sample
- R: Refusal

**CONSISTENCY/DENSITY INDEX:**

VS: Very soft  
S: Soft  
F: Firm  
SI: Stiff  
VSt: Very stiff  
H: Hard  
Fr: Frangible  
VL: Very loose  
L: Loose  
MD: Medium dense  
D: Dense  
VD: Very dense
# Engineering Log - Excavation

**Client:** Hornsby Shire Council  
**Principal:**  
**Project:** Old Mans Valley  
**Pit No:** TP3  
**Sheet:** 1 of 1  
**Office Job No.:** 56463/2

## Excavation Details
- **Equipment Type and Model:** KATO HD 1250 SE  
- **Excavation Dimensions:** 2.5 m long, 1.2 m wide  
- **R.L. Surface:** 10.6 m

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>Samples</th>
<th>Sample Details</th>
<th>Soil Type</th>
<th>Plasticity</th>
<th>Consistency/Density Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>test, etc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>test, etc</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
<td></td>
<td>test, etc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Penetration Details</th>
</tr>
</thead>
</table>
| **Method:** Natural exposure  
| **Penetration:** 1 2 3  

**Notes:**
- **USB undisturbed sample 50 mm diameter**  
- **D disturbed sample**  
- **N standard penetration test**  
- **N+SPT + sample recovered**  
- **Nc SPT with solid cone**  
- **V Vane shear**  
- **P Pressuremeter**  
- **Bb bulk sample**  

**Classification Symbols and Soil Description:**
- Based on unified classification system  
- **Moisture:** D dry, M moist, W wet  
- **Plastic Limit:** Wp

## Additional Observations
- **Structure and Observations:**
  - **5 m north of TP3 another pit was dug exposing a layer of washed sandstone at 1.2m to 2.4 m.**
  - **This was overlain by the sandy clay and was underlain by EW Breccia. A USG core was taken in the sandy clay & cemented sandstone at 5.1m depth.**

**Pit TP3 Terminated at 3.20 m**

---

For more detailed explanation, please refer to the original document.
### Engineering Log - Excavation

**Client:** HORNSBY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Pit Location:** SEE FIGURE 1  
**Office Job No.:** S3463/2  
**Pit No.:** TP4  
**Sheet 1 of 1**

**Equipment Type and Model:** CATERPILLER EXCAVATOR

**Excavation Dimensions:** 1.2 m wide  
**RL Surface:** 94.7 m

---

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>RL</th>
<th>Depth</th>
<th>Graphic Log</th>
<th>Classification</th>
<th>Material</th>
<th>Sampled</th>
<th>Remarks</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
<td></td>
<td></td>
<td>3P</td>
<td>SAND: fine to coarse dark brown grey some clay and gravel</td>
<td>D</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CF</td>
<td>2.69</td>
<td></td>
<td></td>
<td>1/2/3</td>
<td>CLAY: medium to high plasticity yellow brown some breccia core stones</td>
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<tr>
<td></td>
<td></td>
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<td>3.00</td>
<td></td>
<td></td>
<td>1/1/1</td>
<td>BRECCIA moderately weathered yellow</td>
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<td></td>
</tr>
</tbody>
</table>

**Pit TP4 Terminated at 3.00 m**
Near Refusal on slightly weathered Breccia

---

**METHOD**  
- N: Natural exposure  
- X: Existing excavation  
- BH: Backhoe bucket  
- B: Bulldozer blade  
- R: Ripper  
- E: Excavator  
- HA: Hand auger  
- DT: Diatreme  
- T: Timbering  
- N: Nail

**PENETRATION**  
- 1: No resistance ranging to refusal
- 2: None encountered
- 3: Not measured  
- T: Water level  
- H: Water outflow  
- N: Water inflow

**NOTES**  
- Samples and tests  
- US5: Undisturbed sample 50 mm diameter  
- D: Disturbed sample  
- N: Standard penetration test  
- N*: SPT + sample recovered  
- No SPT with solid cone  
- V: Vane shear  
- P: Pressuremeter  
- Ba: Bulk sample  
- R: Refusal

**CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION**

**CONSISTENCY/DENSITY INDEX**

<table>
<thead>
<tr>
<th>Consistency/Density Index</th>
<th>Very Soft</th>
<th>Soft</th>
<th>Film</th>
<th>Stiff</th>
<th>Very Stiff</th>
<th>Hard</th>
<th>Trickle</th>
<th>Very Loose</th>
<th>Loose</th>
<th>Medium Dense</th>
<th>Dense</th>
<th>Very Dense</th>
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<tbody>
<tr>
<td>VS</td>
<td>VS</td>
<td>S</td>
<td>F</td>
<td>St</td>
<td>VS</td>
<td>H</td>
<td>Fb</td>
<td>VL</td>
<td>L</td>
<td>MD</td>
<td>D</td>
<td>VD</td>
</tr>
<tr>
<td>S</td>
<td>very soft</td>
<td>soft</td>
<td>film</td>
<td>stiff</td>
<td>very stiff</td>
<td>hard</td>
<td>trickle</td>
<td>very loose</td>
<td>loose</td>
<td>medium dense</td>
<td>dense</td>
<td>very dense</td>
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<td>Fb</td>
<td></td>
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</tr>
<tr>
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<tr>
<td>MD</td>
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<td></td>
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<td></td>
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<tr>
<td>D</td>
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<td></td>
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</tr>
</tbody>
</table>
**Engineering Log - Excavation**

**Client:** HORNESBY SHIRE COUNCIL  
**Project:** OLD MANS VALLEY  
**Pit Location:** SEE FIGURE 1  
**Pit No:** TP5  
**Sheet:** 1 of 1

**Equipment Type and Model:** CATERPILLER EXCAVATOR

**Extraction Dimensions:** 2.0 m long, 1.2 m wide  
**R.L. Surface:** 99.5 m

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Notes, samples, etc.</th>
<th>R.L.</th>
<th>Depth</th>
<th>Material</th>
<th>Moisture Condition</th>
<th>Consistency/Density Index</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM</td>
<td>NL</td>
<td>NONE ENCOUNTERED</td>
<td></td>
<td></td>
<td>1</td>
<td>SAND; fine to coarse brown grey some gravel</td>
<td>D</td>
<td>M</td>
<td>MD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>CLAY; medium to high plasticity light grey</td>
<td>M</td>
<td>S1</td>
<td>VS1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>CLAY; medium to high plasticity yellow brown</td>
<td>M</td>
<td>S1</td>
<td>VS1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>BRECCIA; Extremely weathered; Highly Weathered yellow brown some core stones</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>BRECCIA; Highly Weathered yellow brown</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>BRECCIA; Moderately Weathered; Highly Weathered light grey to yellow brown</td>
<td>H</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pit TP5 Terminated at 4.30 m**  
Near refusal & near limit of reach

**Method:** Natural exposure  
**Penetration:** No resistance ranging to refusal

**Water:** D = none encountered  
M = water level  
W = water outflow  
U = water inflow

**Classification Symbols and Soil Description:**  
- Based on unified classification system

**Consistency/Density Index:**  
- VS = very soft  
- S = soft  
- F = firm  
- SI = stiff  
- VS1 = very stiff  
- VS2 = very stiff  
- H = hard  
- Fo = friable  
- VL = very loose  
- L = loose  
- MD = medium dense  
- D = dense  
- VD = very dense

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# Engineering Log - Excavation

**Client:** Hornsby Shire Council  
**Project:** Old Mans Valley  
**Pit Location:** See Figure 1

**Equipment Type and Model:** Caterpillar 215B3A Excavator

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration Support</th>
<th>Notes Samples, Test, etc</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphical Log</th>
<th>Material</th>
<th>Material Condition</th>
<th>Standard Penetration Test</th>
<th>Consistency/Density Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH</td>
<td>NE</td>
<td></td>
<td>2.5</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Material:**
- CLAY: medium to high plasticity yellow brown
- BRECCIA: extremely weathered - highly weathered yellow brown some light grey mollified some core stones and gravel
- BRECCIA: moderately weathered light grey

**Structure and Additional Observations:**
- Terminated at 3.60 m
- Near Refusal on slightly weathered Breccia

**Classification Symbols and Soil Description:**
- Based on unified classification system
- Moisture: D dry, M moist, W wet
- Consistency/Density Index: VS very soft, S soft, F firm, SI stiff, VS1 very stiff, H hard, FC friable, VL very loose, L loose, MD medium dense, D dense, VD very dense

**Notes:**
- Samples and tests: USD undisturbed sample 50 mm diameter
- WATER: D none encountered, not measured, V water level, B water outflow, R water inflow

**Consistency/Density Index:**
- VS: very soft
- S: soft
- F: firm
- SI: stiff
- VS1: very stiff
- H: hard
- FC: friable
- VL: very loose
- L: loose
- MD: medium dense
- D: dense
- VD: very dense
# Engineering Log - Excavation

**Client:** Hornsby Shire Council  
**Project:** Old Mans Valley  
**Pit Location:** See Figure 1

### Excavation Dimensions
- **L1**: 2.0 m long  
- **L2**: m wide

### Material
- **Soil Type:** Clayey Sand: fine to coarse grained grey some gravel  
- **Moisture Condition:** M  
- **Hand Penetration:** MD

### Structure and Additional Observations
- **Structure:** Alluvium
  - Very high water inflow
  - Large fine inks in alluvium
- **Residual / EW Breccia**
  - Ew/Hw Breccia

---

**Penetration Table**

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Notes</th>
<th>Soil Sample Test</th>
<th>Soil Type</th>
<th>Moisture Condition</th>
<th>Hand Penetration</th>
<th>Classification</th>
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<tbody>
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<td>M</td>
<td>MD</td>
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<td></td>
<td>Clay</td>
<td>M</td>
<td>MD</td>
<td></td>
</tr>
<tr>
<td>3</td>
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<td>nil</td>
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<td>Clay</td>
<td>M</td>
<td>MD</td>
<td></td>
</tr>
</tbody>
</table>

**Classification**
- Based on Unified Classification System

**Consistency/Density Index**
- VS: Very Soft
- S: Soft
- F: Firm
- SI: Stiff
- VSF: Very Stiff
- H: Hard
- Fd: Frangible
- VL: Very Loose
- Lo: Loose
- MD: Medium Dense
- D: Dense
- VD: Very Dense
**Engineering Log - Excavation**

**Client:** Horsby Shire Council  
**Officer Job No.:** 58463/2  
**Sheet:** 1 of 1  
**Project:** Old Mans Valley  
**Pit No.:** TP8  
**Pit Commenced:** 7.4.89  
**Pit Completed:** 7.4.89  
**Logged By:** AS  
**Checked By:** CPT

**Equipment Type and Model:** Caterpillar 21B SBA Excavator

**Excavation Dimensions:** 20 m long, 12 m wide

**RL Surface:** 110.6 m

**Datum:** AHD

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Notes</th>
<th>Sampling, Test, etc</th>
<th>R.L.</th>
<th>Depth (m)</th>
<th>Material</th>
<th>Compaction</th>
<th>Condition</th>
<th>Strength (kPa)</th>
<th>Structure and Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CH</td>
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<td>EW Breccia?</td>
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<td>BRECCIA</td>
<td></td>
<td></td>
<td></td>
<td>EW/HW Breccia</td>
</tr>
</tbody>
</table>

**特有的水和压力:**
- **WATER:**
  - D: none encountered
  - P: not measured
  - H: water table
  - I: water outflow
  - N: nil

**Notes and Tests:**
- USO: undisturbed sample 50 mm diameter
- D: disturbed sample
- N: standard penetration test
- No: SPI + sample recovered
- Vs: SPI with solid cone
- V: vane shear
- P: pressuremeter
- B: bulk sample
- R: refusal

**Consistency/Density Index:**
- VS: very soft
- S: soft
- F: firm
- SI: stiff
- VS1: very stiff
- H: hard
- Fb: friable
- VL: very loose
- L: loose
- MD: medium dense
- D: dense
- VD: very dense
### Triaxial Shear Test

**Client:** Hornsby Shire Council  
**Location:** Old Man's Valley  
**Date:** 04/04/80  
**Borehole:** BH 6  
**Depth:** 1.50 m  
**Test File #:** 530

**Material Classification:** (CL) Sandy Clay - medium plasticity, mottled yellow grey brown, fine to coarse sand.

---

#### Graph

- **Shear Stress (kPa):** 0, 40, 80, 120, 160, 200, 220, 240  
- **Normal Stress (kPa):** 0, 40, 80, 120, 160, 200, 240, 280, 320

---

#### Test Details

**Type of Test:** Consolidated Undrained with Pore Pressure Measurement  
**Angle of Friction ($\phi'$):** 29°, deg.  
**Cohesion ($C'$):** 4 KPa  
**Wet Density:** 2.000 t/m³  
**Back Pressure:** 200,000 kPa  
**Strain Rate:** 0.007 XMin

**Moisture Contents:**  
- **Initial:** 15.0 %  
- **Top:** 17.2 %  
- **Middle:** 18.3 %  
- **Bottom:** 21.1 %

**Data from Test File No.** 530, 538, 545

---

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[Authorised Signature]
triangular shear test

LABORATORY: SYDNEY

CLIENT: HORNSEA SHIRE COUNCIL
JOB NO: S8463/2

PRINCIPAL: 
TESTED BY: GC

PROJECT: OLD MAN'S VALLEY
DATE: 04/04/89

LOCATION: 
TEST FILE #: 530

BOREHOLE: BH 6
DEPTH: 1.50 - 1.86

FAILURE CRITERIA: PEAK PRINCIPAL STRESS RATIO

MATERIAL CLASSIFICATION: (CL) Sandy CLAY - medium plasticity, mottled yellow grey brown, fine to coarse sand.

---

**TYPE OF TEST:** CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT

**ANGLE OF FRICTION (φ'):** 29 deg. **MOISTURE CONTENTS**

**COHESION (C'):** 45 kPa **INITIAL** 15.0 %

**WET DENSITY:** 2.000 t/m³ **FINAL - TOP** 17.7 %

**BACK PRESSURE:** 200,000 kPa **MIDDLE** 18.3 %

**STRAIN RATE:** 0.007 mm/min **BOTTOM** 21.1 %

DATA FROM TEST FILE No.: 530 539 545

---

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Authorized Signature
triangular shear test

LABORATORY: SYDNEY

CLIENT: HORNSBY SHIRE COUNCIL
PRINCIPAL: 
PROJECT: OLD MAN'S VALLEY
LOCATION: 

BOREHOLE: BH 6
FAILURE CRITERIA: PEAK PRINCIPAL STRESS RATIO

DEPHT: 1.50 - 1.85

MATERIAL CLASSIFICATION: (CL) Sandy CLAY - medium plasticity, mottled yellow grey brown, fine to coarse sand.

TYPE OF TEST: CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT

ANGLE OF FRICTION (φ') = 29.0 deg. MOISTURE CONTENTS
COHESION (c') = 4.0 kPa INITIAL = 15.0 %
DENSITY = 2.000 t/m³ FINAL - TOP = 17.7 %
BACK PRESSURE = 200.000 kPa - MIDDLE = 18.3 %
STRAIN RATE = 0.007 Xmin - BOTTOM = 21.1 %

DATA FROM TEST FILE No. m = 530 538 545

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direct shear test

CLIENT: HORNSBY SHIRE COUNCIL
PRINCIPAL:
PROJECT: OLD MANS VALLEY
LOCATION: HORNSBY

LABORATORY: SYDNEY
JOB NO: 98483/2
TESTED BY: GC
DATE: 26/06/89

BOREHOLE: TP 1
SHEAR STRESS: PEAK
DEPTH: 0.40 - 0.40

MATERIAL CLASSIFICATION:
(CL) Gravelly Sandy CLAY - medium plasticity, moist brown, fine to coarse sand, fine to medium gravel.

Shear stress (kPa) vs. Normal stress (kPa) graph

SHEAR RATE: 0.005 mm/Min
WET DENSITY: 1.89 t/m³
INITIAL MOISTURE CONTENT: 21.60%
COHESION C: ...
ANGLE OF FRICTION: ...

DATA FROM TEST FILE No.s: 634 637 643

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Authorised Signature
direct shear test

<table>
<thead>
<tr>
<th>CLIENT</th>
<th>HORNSBY SHIRE COUNCIL</th>
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</thead>
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<tr>
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</tr>
<tr>
<td>PROJECT</td>
<td>OLD MANS VALLEY</td>
</tr>
<tr>
<td>LOCATION</td>
<td>HORNSBY</td>
</tr>
<tr>
<td>BOREHOLE</td>
<td>TP</td>
</tr>
<tr>
<td>SHEAR STRESS</td>
<td>PEAK</td>
</tr>
<tr>
<td>DEPTH</td>
<td>0.40 -</td>
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</table>

MATERIAL CLASSIFICATION:
(CL) Gravelly Sandy CLAY - medium plasticity,settled brown, fine to coarse sand, fine to medium gravel.

<table>
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<tr>
<th>LABORATORY</th>
<th>SYDNEY</th>
</tr>
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<tbody>
<tr>
<td>JOB NO</td>
<td>S8463/2</td>
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<td>GC</td>
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<tr>
<td>DATE</td>
<td>26/05/89</td>
</tr>
<tr>
<td>TEST FILE #</td>
<td>634</td>
</tr>
</tbody>
</table>

![Graph of shear stress vs strain](image)

- SHEAR RATE: 0.005 mm/Min
- WET DENSITY: 1.99 t/m³
- INITIAL MOISTURE CONTENT: 21.00%
- COHESION: C
- ANGLE OF FRICTION: θ = deg.

DATA FROM TEST FILE No.: 634 637 643

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Authorized Signature
**direct shear test**

**CLIENT**: HORNESBY SHIRE COUNCIL  
**PRINCIPAL**:  
**PROJECT**: OLD MANS VALLEY  
**LOCATION**: HORNESBY

<table>
<thead>
<tr>
<th>BOREHOLE</th>
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<tr>
<td>TP 1</td>
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<table>
<thead>
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<th>SHEAR STRESS</th>
<th>PEAK</th>
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<tbody>
<tr>
<td></td>
<td>0.80</td>
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</tbody>
</table>

**MATERIAL CLASSIFICATION**: (CH) Gravelly Sandy CLAY - high plasticity, red yellow brown, fine to coarse sand, fine gravel.

---

**Normal stress (kPa)**

<table>
<thead>
<tr>
<th>Normal stress (kPa)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
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<tr>
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<tr>
<td>500</td>
</tr>
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</tr>
<tr>
<td>700</td>
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</table>

<table>
<thead>
<tr>
<th>Shear stress (kPa)</th>
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<tbody>
<tr>
<td>0</td>
</tr>
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<td>100</td>
</tr>
<tr>
<td>200</td>
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<td>300</td>
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<tr>
<td>500</td>
</tr>
<tr>
<td>600</td>
</tr>
<tr>
<td>700</td>
</tr>
</tbody>
</table>

**Data from Test File No.**: 633 638 644

**shear rate**: 0.005 mm/min  
**Wet Density**: 1.83 t/m³  
**Initial Moisture Content**: 32.60%  
**Cohesion C**: 25 kPa  
**Angle of Friction**: 26 deg.

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Authorised Signature
direct shear test

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<td>PROJECT</td>
<td>OLD MANS VALLEY</td>
</tr>
<tr>
<td>LOCATION</td>
<td>HORNBY</td>
</tr>
<tr>
<td>BOREHOLE</td>
<td>TP 1</td>
</tr>
<tr>
<td>SHEAR STRESS</td>
<td>PEAK</td>
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<tr>
<td>DEPTH</td>
<td>0.80 - 8.80</td>
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<tr>
<td>MATERIAL CLASSIFICATION</td>
<td>(CH) Gravelly Sandy CLAY - high plasticity, red yellow brown, fine to coarse sand, fine gravel.</td>
</tr>
</tbody>
</table>

![Shear Stress vs Strain Graph]

| SHEAR RATE      | 0.005 mm/Min |
| WET DENSITY     | 1.83 t/m³    |
| INITIAL MOISTURE CONTENT | 32.50 % |
| COHESION C      | 25.00 kPa    |
| ANGLE OF FRICTION | 24.00 deg |

DATA FROM TEST FILE No. 633 638 644

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**direct shear test**

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<td>PROJECT</td>
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<td>LOCATION</td>
<td>HORNSBY</td>
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<tr>
<td>JOB NO</td>
<td>S8483/2</td>
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<tr>
<td>TESTED BY</td>
<td>GC</td>
</tr>
<tr>
<td>DATE</td>
<td>87/06/89</td>
</tr>
<tr>
<td>BOREHOLE</td>
<td>TP 1</td>
</tr>
<tr>
<td>DEPTH</td>
<td>0.00 - 0.90</td>
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<td>SHEAR STRESS</td>
<td>PEAK</td>
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<td>MATERIAL CLASSIFICATION</td>
<td>(CL) Gravelly Sandy CLAY - medium plasticity, mottled yellow red brown, fine to coarse sand, fine to medium gravel. EW</td>
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<table>
<thead>
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<th>Normal stress (kPa)</th>
<th>Shear stress (kPa)</th>
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<tbody>
<tr>
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<tr>
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<tr>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>800</td>
<td>800</td>
</tr>
</tbody>
</table>

| SHEAR RATE | 0.085 mm/Min |
| WET DENSITY | 1.88 t/m³ |
| INITIAL MOISTURE CONTENT | 23.00 % |
| COHESION C | 80 kPa |
| ANGLE OF FRICTION | 32 deg |

DATA FROM TEST FILE No.: 850 858 854

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Authorised Signature
direct shear test

CLIENT : HORNESBY SHIRE COUNCIL
PRINCIPAL : JOB NO : 66463/2
PROJECT : OLD MANS VALLEY TESTED BY : GC
LOCATION : HORNESBY DATE : 87/05/89

BOREHOLE : TP 1 TEST FILE # : 0650
SHEAR STRESS : PEAK DEPTH : 0.90 -
MATERIAL CLASSIFICATION : 0.90
(CL) Gravely Sandy CLAY - medium
plasticity, mottled yellow red brown, fine to coarse sand, fine to medium gravel.

![Graph showing shear stress vs strain]

SHEAR RATE : 0.005 mm/Min
WET DENSITY : 1.88 t/m3 COHESION C : 0.2 kPa
INITIAL MOISTURE CONTENT : 23.00 % ANGLE OF FRICTION : 37 deg.

DATA FROM TEST FILE No.s : 0650 0658 0664

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## Direct Shear Test

**Laboratory:** Sydney

<table>
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<td>Tested By</td>
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<td>Project</td>
<td>Old Mams Valley</td>
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<tr>
<td>Location</td>
<td>Hornsby</td>
</tr>
<tr>
<td>Borehole</td>
<td>TP3</td>
</tr>
<tr>
<td>Shear Stress</td>
<td>Peak</td>
</tr>
<tr>
<td>Depth</td>
<td>1.30 - 1.30</td>
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<tr>
<td>Material Class.</td>
<td>(CL) Gravelly Sandy Clay - medium plasticity, light grey settled red brown, fine to coarse sand, fine gravel. EW BREC</td>
</tr>
</tbody>
</table>

---

### Graph

![Graph showing shear stress vs normal stress](image)

- **Shear Rate:** 0.05 mm/Min
- **Wet Density:** 1.92 t/m³
- **Initial Moisture Content:** 20.00%
- **Cohesion:** C
- **Angle of Friction:** 17° deg.

**Data from Test File No.:** 617 625 629

---

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---
**direct shear test**

<table>
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<td>DATE</td>
<td>21/05/89</td>
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<td>LOCATION</td>
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<td>TEST FILE #</td>
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<tr>
<td>BOREHOLE</td>
<td>TP3</td>
<td>DEPTH</td>
<td>1.30 -</td>
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<td>SHEAR STRESS</td>
<td>PEAK</td>
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**MATERIAL CLASSIFICATION:**
(CL) Gravelly Sandy CLAY - medium plasticity, light grey mottled red brown, fine to coarse sand, fine gravel. EW BREC

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<thead>
<tr>
<th>Strain (%)</th>
<th>Shear Stress (kPa)</th>
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<td>0</td>
<td>0</td>
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<td>1</td>
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<td>6</td>
<td>600</td>
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<tr>
<td>7</td>
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</table>

**SHEAR RATE:** 0.006 mm/min

**WET DENSITY:** 1.92 t/m³

**INITIAL MOISTURE CONTENT:** 20.00%

**COHESION C:** ....kPa

**ANGLE OF FRICTION:** ....deg.

**DATA FROM TEST FILE No., s:** 617 625 629

---

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SOUTH STABILITY

14:42:58  14/6/89

1.07

<table>
<thead>
<tr>
<th>LAYER #</th>
<th>C(kPa)</th>
<th>PHI</th>
<th>RU</th>
<th>RHO(1/m)</th>
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<tbody>
<tr>
<td>1</td>
<td>25.0</td>
<td>25.0</td>
<td>-1.00</td>
<td>2.00</td>
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<tr>
<td>2</td>
<td>5.0</td>
<td>25.0</td>
<td>-1.00</td>
<td>1.96</td>
</tr>
<tr>
<td>3</td>
<td>40.0</td>
<td>20.0</td>
<td>-1.00</td>
<td>1.96</td>
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SOUTH1  SCALE 1: 1000.  - SOUTH1:RL 140.85 ONE WATERTABLE
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<tr>
<th>LAYER #</th>
<th>C (kPa)</th>
<th>PHI</th>
<th>RU</th>
<th>RHO (t/m³)</th>
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<tbody>
<tr>
<td>1</td>
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<td>-1.00</td>
<td>1.96</td>
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<td>40.0</td>
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<td>1.96</td>
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Stability Analysis for section ch350

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<th>C (kPa)</th>
<th>PHI</th>
<th>RU</th>
<th>RHO (1/m³)</th>
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<tbody>
<tr>
<td>1</td>
<td>25.0</td>
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<td>-1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>2</td>
<td>5.0</td>
<td>25.0</td>
<td>-1.00</td>
<td>1.96</td>
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<td>3</td>
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<td>4</td>
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CASE3L  SCALE 1: 1000. - slope TO 171.55
Stability Analysis for section ch310

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<th>PHI</th>
<th>RU</th>
<th>RHO (t/m³)</th>
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<tr>
<td>1</td>
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<td>25.0</td>
<td>-1.0</td>
<td>2.00</td>
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<tr>
<td>2</td>
<td>5.0</td>
<td>25.0</td>
<td>-1.0</td>
<td>1.96</td>
</tr>
<tr>
<td>3</td>
<td>40.0</td>
<td>20.0</td>
<td>-1.0</td>
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RL 139.5m

C310A4 SCALE 1:1000 - SLOPE 1 in 3.5 (NO ROCK)
Stability Analysis for section ch310

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<tr>
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<th>C (kPa)</th>
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<th>RU</th>
<th>RHO (t/m³)</th>
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<tr>
<td>1</td>
<td>25.0</td>
<td>25.0</td>
<td>-1.00</td>
<td>2.00</td>
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<tr>
<td>2</td>
<td>5.0</td>
<td>25.0</td>
<td>-1.00</td>
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<tr>
<td>3</td>
<td>40.0</td>
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<td>-1.00</td>
<td>1.96</td>
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</table>

RL 130.0m

C310A4L  SCALE 1: 1000. - SLOPE 1 in 3.5 (NO ROCK)
Stability Analysis for section ch310

10:22 55  16/6/89

<table>
<thead>
<tr>
<th>LAYER #</th>
<th>C(kPa)</th>
<th>PHI</th>
<th>RU</th>
<th>RHO(t/m³)</th>
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<tr>
<td>1</td>
<td>25.0</td>
<td>25.0</td>
<td>-1.00</td>
<td>2.00</td>
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<tr>
<td>2</td>
<td>5.0</td>
<td>25.0</td>
<td>-1.00</td>
<td>1.96</td>
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<tr>
<td>3</td>
<td>40.0</td>
<td>20.0</td>
<td>-1.00</td>
<td>1.96</td>
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<tr>
<td>4</td>
<td>500.0</td>
<td>40.0</td>
<td>-1.00</td>
<td>2.70</td>
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C310C10  SCALE 1: 1000.  -  SLOPE 1:1.75(BOTTOM) 1:3.5 (TOP)
APPENDIX D

This appendix provides our estimate of costs and fees for undertaking additional geotechnical work as outlined in the report.

The proposed work comprises:

- Drilling, Pitting and sampling (See attached schedule 1)
- Installation of piezometers (See attached schedule 2)
- Test pit excavation
- Observation of piezometers for 1 month after installation
- Laboratory shear testing of fill and natural ground
- Analysis of Data
- Reporting

It is assumed that a water supply will be available on site for drilling water and that an excavator will be available for the recovery of bulk and block samples.

It is envisaged that interaction with Council personnel will be required to arrive at design profiles.

All work would be undertaken in accordance with our Standard Terms of Agreement, a copy of which is included. This estimate does not allow for advice or testing on site during construction.
FURTHER GEOTECHNICAL INVESTIGATION WORK
ESTIMATE OF COSTS AND FEES

1.0 Field Work
Including continuous site attendance, drilling expenses and monitoring of water levels for 1 month-
see attached schedule 1. 54,450.00

2.0 Laboratory Testing
3 Large Shear tests on HW Breccia - allow 9,000.00
6 Triaxial tests on EW Breccia 8,472.00
3 Triaxial tests on existing fill 12 @ 706
3 Triaxial tests on new fill
12 Atterberg limits on EW Breccia and fill @ 95 1,140.00
6 Compaction tests on fill @ 93 558.00
6 Grading tests on fill @ 68.50 411.00
Preparation of samples for triaxial testing 10 @ 63 630.00

3.0 Analysis and Reporting
Principal 120 hours @ 105.00/hr 12,600.00
Senior Geologist 105 hours @ 65.00/hr 6,825.00
Engineer 80 hours @ 55.00/hr 4,400.00
Tracing/Typing etc 54 hours @ 50.00/hr 2,700.00
Costs (Photography etc) 200.00
Mileage - allow 200.00
Computing - allow 3,000.00

$104,586.00
SCHEDULE 1

FIELD WORK - DRILLING PITTING AND SAMPLING

Assumes total metres to be drilled approximately 500m
Assuming average 20m/10hr day = 25 days drilling

1.1 Drilling

<table>
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<tr>
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<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>250 @ 105.00</td>
<td>26</td>
<td>250.00</td>
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<tr>
<td>Core Boxes</td>
<td>90 @ 25.00</td>
<td>2</td>
<td>250.00</td>
</tr>
<tr>
<td>PVC - piezometers</td>
<td>Allow</td>
<td>2</td>
<td>000.00</td>
</tr>
<tr>
<td>Bentonite Pellets</td>
<td>Allow</td>
<td>5</td>
<td>00.00</td>
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<tr>
<td>O&amp;O samples</td>
<td>30 @ 15.00</td>
<td>4</td>
<td>50.00</td>
</tr>
<tr>
<td>Geologist/Engineer</td>
<td>250 @ 65.00</td>
<td>16</td>
<td>250.00</td>
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<tr>
<td>Travel</td>
<td>Allow</td>
<td>3</td>
<td>00.00</td>
</tr>
<tr>
<td>Borehole Logs</td>
<td>70 pages @ 35.00/pg</td>
<td>2</td>
<td>450.00</td>
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</table>

*Note: Provision needs to be made for water for drilling. Either Council provide water chart or Drilling Contractor provide water chart at extra cost not included above.

1.2 Monitoring Water Levels

Allow 2 x 5hr visits/week for 1 month

<table>
<thead>
<tr>
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<th>Hours/Allow</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>Geologist/Engineer</td>
<td>40 @ 65.00</td>
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<td>600.00</td>
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<tr>
<td>Travel</td>
<td>Allow</td>
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</table>

2 700.00

1.3 Test Pitting for Bulk and Block Samples

Geologist/Engineer Allow 2 x 10hrs @ 65.00

1 300.00

*Note: assumes use of excavator is available from Council free of charge.
SCHEDULE 2

BOREHOLE LOCATIONS - PIEZOMETER LOCATIONS & LEVELS

(see Plan)

Note: Fresh rock assumed to be approximately RL90m

Ch 105m
Piezometer in residual soil - say 2m deep ) both at toe of
Piezometer in HW Breccia - say 8-10m deep ) existing fill embankment

Ch 150m
Piezometer in fill - say 6 - 8m deep )
Piezometer in HW Breccia - say 10 - 12m deep ) all drilled on existing field
Piezometer in Fr Breccia - say 60 - 65m* deep )

Piezometer in residual soil - say 2m deep ) both at toe of existing
Piezometer in HW Breccia - say 8-10m deep ) fill embankment

Ch 190m
Piezometer in residual soil - say 2m deep ) both at toe of existing
Piezometer in HW Breccia - say 8 - 10m deep ) fill embankment

Ch 230m
Piezometer in fill - say 6 - 8m deep )
Piezometer in HW Breccia - say 10 - 12m deep ) all drilled on existing field
Piezometer in Fr Breccia - say 60 - 65m* deep )

Piezometer in residual soil - say 2m deep ) drilled adjacent to existing
Piezometer in Fr Breccia - say 30 - 35m deep ) BH8.

Piezometer in HW Breccia - say 8 - 10m deep - ) drilled at toe of existing
fill downhill of BH7

Piezometer in alluvium - say 1 - 2m deep ) drilled in creek bed -
proline
Piezometer in Fr Breccia - say 12 - 15m+ deep )
Ch 270m
Piezometer in HW Breccia - say 4 - 8m deep - }near north west toe of existing fill embankment

Ch 310m
3 Piezometers in Fill - say 4 - 8m deep } all drilled on existing
Piezometer in HW Breccia - say 10 -12m deep } filled area
Piezometer in Fr Breccia - say 45 - 50m* deep }
Piezometer in EW/Residual soil - say 2m deep } both to be drilled
Piezometer in HW Breccia - say 6 - 8m deep } adjacent to TP3
Piezometer in HW Breccia - say 4 - 6m deep - }adjacent to creek

Ch 330m/Existing Creek
3 Piezometers in Fill - say 4 - 6m deep } all drilled on existing
Piezometer in HW Breccia - say 10 - 12m deep } filled area
Piezometer in EW Breccia/Residual soil - say 2m deep } drilled south of creek
Piezometer in MW Breccia - say 4 - 6m deep } approx. 15m east of BH6
Piezometer in EW Breccia - say 3m deep }
Piezometer in Fr Breccia - say 30 - 35m# deep } Creek adjacent to N/S

Ch 350m
Piezometer in HW Breccia - say 4 - 8m deep - }Approximately midway TP1 & TP2
Piezometer in HW Breccia - say 4 - 8m deep }drilled on knoll near TP1
Piezometer in Fr Breccia - say 15 - 20m deep }
Piezometer in Fr Breccia - say 25 - 30m* deep }drilled on alluvial
Piezometer in Fr Breccia - say 2m deep }
Piezometer in Fr Breccia - say 25 - 30m* deep } floodplain near TP6

* 20-25m into Fresh Breccia
# 15-20m into Fresh Breccia
+ 2-5m into Fresh Breccia
Proposed Borehole/Piezometer location including rock/soil material in which piezometer will be installed.
APPENDIX E

This appendix provides our estimate of costs and fees for undertaking a rock mechanics study of the eastern quarry face area.

The proposed work includes:

. Geological and structural mapping of the eastern face and portion of the adjoining faces of the quarry over the full height. This would extend and support the work done to date.

. Drilling four inclined cored boreholes and orientation of core. The number and locations should be reviewed after the mapping.

. Measurement of water levels in boreholes.

. Analysis and reporting of data.

Work would be undertaken in accordance with our Standard Terms of Agreement (Rev 89/3), a copy of which is given in Appendix D.

It is assumed that a single proposed quarry plan is to be analysed.
ROCK MECHANICS STUDY FOR QUARRY FACE

1.0 Field Work

1.1 Line Mapping of Eastern Quarry Face

Allow 6 x 10 hr days for geologist and technician

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<th>Hours</th>
<th>Rate</th>
<th>Cost</th>
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<td>Technician</td>
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Total: 6,670.00

1.2 Drilling 4 inclined and oriented boreholes

For planning purposes assume two holes each at Ch 190m and Ch 310m. Assume at each location one hole inclined to east and one to west. Assume total drilling at Ch 190m of 200m and Ch 310 of 180m.

Assume 15m/10 hr day drilling and orienting core.

380m @ 15m/day = 25 days

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<tr>
<th>Activity</th>
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<tbody>
<tr>
<td>Drilling</td>
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<td>105.00</td>
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<tr>
<td>Core boxes</td>
<td>72</td>
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<td>PVC - piezometers</td>
<td>allow</td>
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<td>1,500.00</td>
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<tr>
<td>Geologist</td>
<td>250</td>
<td>65.00</td>
<td>16,250.00</td>
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<td>Travel</td>
<td>allow</td>
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<tr>
<td>Borehole logs</td>
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2.0 Processing field data

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Total: 3,120.00

Drilling

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<tr>
<td>Engineer/Geologist</td>
<td>32</td>
<td>60.00</td>
<td>1,920.00</td>
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<tr>
<td>Report Production Staff</td>
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Total: 3,120.00
3.0 Reporting and Analysis

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<td>Senior Engineer/</td>
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<td>Senior Geologist</td>
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TOTAL: $11,175.00

NOTE: An arrangement for provision of water for drilling will have to be made. Either Council provide water chart or Drilling Contractor provide water chart at extra cost. No provision for this has been made above.