APPENDIX B

Soils Surveys Engineering Pty Ltd
Acid Sulfate Soil & Contamination Investigation

SOIL SURVEYS

PROJECT NO. 204-4808

JULY 2004

WALTER ELLIOTT HOLDINGS PTY LTD

ACID SULFATE SOIL & CONTAMINATION INVESTIGATION

PROPOSED FILLING

LOT 156 CREEK STREET

HASTINGS POINT

SOIL SURVEYS

Soil Surveys Engineering Pty Limited
Specialists in Applied Geotechnics
A.B.N. 70 054 043 631
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Gold Coast Office
Job No: 204-4808
Ref: 4808a
Author: Patrick Kidd

3 August 2004

Walter Elliott Holdings Pty Ltd
C/- Blueland Engineers
PO Box 6389
Tweed Heads South, NSW 2486

ATTENTION: MR MARTIN FINDLATER

Dear Sir,

RE: ACID SULFATE SOIL & CONTAMINATION INVESTIGATION - PROPOSED FILLING, LOT 156 CREEK STREET, HASTINGS POINT.

Enclosed is a copy of our report for the above project dated July, 2004. Three copies of the report have been issued.

Authority to proceed with the investigation was received from Mr Walter Elliott by correspondence dated 2 June 2004.

Should you have any queries regarding this report, please do not hesitate to contact Patrick Kidd or Albert Rutten at our Gold Coast Office.

Yours faithfully,

A. M. RUTTEN (RPEQ 2202)

for and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

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1.0 INTRODUCTION

This report presents the results of a factual acid sulfate soil and contamination investigation carried out by Soil Surveys Engineering Pty Limited in June, 2004 to assess the subsurface conditions for proposed filling at the Lot 156 Creek Street, Hastings Point.

The factual investigation was carried out at the request of Mr Martin Findlater of Blueland Engineers with only the results of laboratory testing requested to be reported as per the details set out in Blueland Engineers' letter dated 7 May 2004.

Authorisation to proceed with the investigation received from Walter Elliott Holdings Pty Ltd was dated 2nd June, 2004.

2.0 PROPOSED DEVELOPMENT

It is understood that the filling and potential construction of the subdivision is likely to require selective excavation and stripping to about 1.0m below the existing ground surface level.

3.0 SCOPE OF SERVICES

The scope of services provided by Soil Surveys Engineering Pty Limited for the acid sulfate soil investigation as detailed in our proposal 203-4095p dated
19th May, 2003 was directed towards assessment of the following:-

- The nature and type of upper level subsurface materials in the area of the site
- Collection of samples and laboratory testing for Actual and Potential Acid Sulfate Soils, (AASS) and (PASS).
- Collection of samples and laboratory testing with respect to contamination on site.

4.0 INVESTIGATION METHOD

4.1 Field Investigation

To provide the required evaluations the following field investigation was undertaken, generally to the details as nominated in Blueland Engineers' brief dated 7 May 2004.

- Drilling and sampling of 16 bores to depths of 2.0m and 6 bores to 2.5m BH's 1 to 6 using a Jacro 105 drilling rig, note that bore 1 to 6 were drilled to 6.0m depth , however acid sulfate samples were only collected from the upper 2m. Sample locations were dispersed across the entire site where the works are proposed.
- Drilling and sampling of 75 locations using hand equipment.

All work including the soil classification descriptions and field sampling was carried out in general accordance with the following procedures:-

AS1726 - 1993	Geotechnical Site Investigations
AS1289	Methods of Testing Soils for Engineering Purposes
Tweed Local Environment Plan 2000 - Clause 35	
ASSMAC	Acid Sulfate Soil Manual

Notes relating to this report, borehole record sheets, and a site plan detailing borehole and sampling locations are included in the appendices.

Fieldwork was carried out on the 21st to the 24th June, 2004. All soil samples were transferred to a chilled esky for transport to the laboratory.

4.2 Laboratory Assessments

4.2.1 Soil

A staged testing program was carried out on recovered soil samples as follows:-

Test Method	Test Objective
ph_l, ph_{lox} and Reaction to CHI	Qualitative screening
TAA (Total Actual Acidity)	Quantitative - acid trail
CRS (Chromium Reducible Sulfur)	Quantitative - sulfur trails
Heavy Metals As, Cd, Cu, Pb, Hg, Zn, Cr, Ni	Quantitative screening
Organochlorine & Organophosphate Pesticides	Quantitative screening

pH_F, pH_{FOX}, TPA, TAA and CRS testing was carried out in accordance with procedures outlined in ASSMAC, "Acid Sulfate Soil Manual". Heavy Metals, Organochlorine and Organophosphate Pesticides testing was carried in accordance with Australian Standards.

Laboratory test results are summarised in Section 5.5 and certificates are included in Appendix 'C'.

Laboratory Assessments

Laboratory assessments were undertaken by the following laboratories:-

Acid Sulfate Soils

- Soil & Water Laboratories Pty Limited — 19 Finchley Street, Milton, Qld, Ph: 07) 3503 9063

- ALS Environmental — 32 Shand Street, Stafford, Qld, Ph: 07) 32437222

5.0 INVESTIGATION FINDINGS

5.1 Site Description

The site of the proposed development is located to the west of the town of Hastings Point, on the southern side of Creek Street. The site is bounded by a creek to the east, west and south and by residential properties and Creek Street to the north.

At the time of the investigation, the site was occupied by a caravan in the central northern portion of the site, elsewhere the site was clear of existing structures. Vegetation generally consisted of low height grass cover with scattered trees around the edges of the site with some small clumps of trees also towards the edges of the site. A drain is present on the site flowing from south to north in the western end of the site. The banks of the drain are lined with Melaleuca trees.

At the time of the investigation the site was being used to graze horses. Access to the site is via a gate off Creek Street.

5.2 Regional Geology

The coastal landforms, of which this site forms part, are essentially dependent on the basement geology and the river erosion and deposition processes. Low rises in the flood plain in this area are commonly residual soils and shallow rock (mainly phyllite and metasandstone), while the relatively flat flood plains consist of alluvial soils.

The reason for two systems side by side is explained in terms of Pleistocene ice ages when, at times, the level of the sea was some 100 metres lower than the present level. Major rivers then entered the sea somewhere on the continental shelf. Progressive rising and falling sea levels resulted in depositional and erosional processes.

Prominent along the low lying areas of the eastern, northern and north-western coasts of Australia, particularly below RL 5.0 AHD, iron sulfide layers are found. These sulfide layers formed when the sea level rose and inundated the land. Seawater containing sulfate mixed with land sediments. These sulfide sediments, when exposed to air oxidise to produce sulfuric acid, thus the term Acid Sulfate Soils.

5.3 Subsurface Conditions

The natural subsurface conditions encountered in the boreholes were relatively consistent between bore locations and were dominated by an alluvial sequence comprising upper level interbedded silty sands and sands with occasional clayey sand and very occasional silty clay lenses encountered to the depths investigated.

5.4 Groundwater

Groundwater was noted in all boreholes except BH16 ranging from 0.1 to 1.55m depth with steady water levels recorded at depths ranging from 0.55 to 1.85m.

5.5 Laboratory Testing - Soils

A total of 80 soil samples were submitted to a staged acid sulfate testing program as follows and 22 combined samples were submitted for contamination testing:-

5.5.1 Preliminary Screening Tests

Testing was carried out on representative soil samples recovered from the boreholes to provide preliminary qualitative assessment of the presence of acid sulfate soils (ASS). This testing was in the form of assessing the pH of the sample before and following oxidation with 30% hydrogen peroxide (H_2O_2). This test involved measuring a known quantity of soil sample from a particular depth in the strata; the field pH (pH_F) of the sample was then measured and recorded. Following this, a uniform volume of hydrogen peroxide was then added to the sample. Each sample was left to react / oxidise for 1 hour and the pH following oxidation (pH_{FOX}) was recorded.

This is a quick, qualitative assessment of the potential acidity of the soil. Reactivity to hydrochloric acid (HCl) was also assessed as a qualitative determination of the neutralising carbonate content including calcium carbonate (shells) within the soil. The results of these screening tests were used as an additional tool in determining which soil samples should be further assessed by quantitative laboratory testing.

Laboratory test certificates containing screening (qualitative) test results of pH_F and pH_{FOX} are presented in Appendix 'C', where $pH_F < 4.0$ generally indicates actual A.S.S. and $pH_{FOX} < 3.0$ indicates potential A.S.S.

5.5.2 Quantitive Tests

A total of 20 CRS & TAA analyses (Chromium Reducible Sulphur and Total Actual Acidity), were carried out on recovered soil samples based on the results of the screening tests to quantify the actual and potential acid hazard within the soils.

TAA is a measure of the soils existing acidity prior to oxidation of sulfidic material. The CRS test quantifies the sulfur trail.

Table 1 presents a summary of quantitative test results. Laboratory test certificates are presented in Appendix 'C'.

TABLE 1 QUANTITATIVE TEST RESULTS SUMMARY

Borehole No.	Depth (m)	Classification (AS1726-1993)	TAA [1] (mole H^{+}/t)	SCR [2] (%)
BH1	0	Silty Sand (SM)	10	0.00
BH2	2.0m	Silty Sand (SM)	10	0.04
BH3	1.0m	Sand (SP)	5	0.00
BH4	2.0m	Sand (SP)	0	0.09
BH5	1.0	Silty Sand (SM)	10	0.02
BH5	2.0	Silty Sand (SM)	10	0.05
BH6	2.0	Silty Sand (SM)	13	0.12
BH7	1.0	Silty Sand (SM)	10	0.06
BH8	0.5	Silty Sand (SM)	5	0.01
BH9	0.0	Silty Sand (SM)	13	0.01
BH9	1.0	Sandy Sand (SM)	58	0.44
BH10	2.0	Silty Sand (SM)	10	0.12
BH11	1.5	Silty Sand (SM)	18	0.05
BH12	0.5	Sand (SP)	3	0.01
BH13	0.0	Silty Sand (SM)	5	0.01
BH13	2.0	Silty Sand (SM)	25	0.15
BH14	2.0	Silty Sand (SM)	23	0.09
BH15	0.0	Silty Sand (SM)	5	0.02
BH15	2.0	Silty Sand (SM)	10	0.04
BH16	2.0	Silty Sand (SM)	15	0.1

Note:
1) Total Actual Acidity
2) Chromium Reducible Sulfur

6.0 DISCUSSION OF RESULTS

6.1 Soil Classification

The majority of samples recovered from the field investigation program were classified as silty sand (SM) and Sand (SP).

An appraisal of the topography and soil classification suggested that there is potential for acid sulfate conditions to develop across the site.

6.2 Results of Laboratory Testing

Results of screening tests (pH_F pH_{FOX}) generally confirmed the indications of the soil classifications.

The test results indicate acid sulfate soils are present, as actual and potential acid sulfate soils. Actual acid sulfate soils are due to oxidation as the water table fluctuates and potential acid sulfate soils have limited previous oxidation.

Generally pH_F values ranged between 2.6 and 7.7 with pH_{FOX} values ranging between 1.3 and 6.9.

Results of qualitative laboratory testing, ie. TAA and CRS tests indicated existing and potential Acid Sulfate Soils (ASS) to be present on the site.

It is understood that further interpretation of results and the preparation of an Acid Sulfate Management Plan (ASMP) will be undertaken by Blueland Engineers as requested.

7.0 CONTAMINATION TESTING

Contamination testing was carried out on 22 combined samples as requested.

Testing was carried out by ALS Environmental and results are presented in Appendix D.

8.0 LIMITATIONS

We have prepared this factual report for use by **WALTER ELLIOT HOLDINGS PTY LTD** and **BLUELAND ENGINEERS** in accordance with currently accepted environmental and geotechnical guidelines. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for use by parties other than **WALTER ELLIOT HOLDINGS PTY LTD** their associated consultants. It may not contain sufficient information for the purposes of other parties or for other uses.

Soil Surveys Engineering Pty Limited offers a documentation review service to verify that the intent of recommendations is properly reflected in the A.S.M.P. It is recommended that clients avail themselves of this service; our standard rates will apply.

P. KIDD

A. M. RUTTEN (RPEQ 2202)

for and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

APPENDICES

APPENDIX A
NOTES RELATING TO THIS REPORT

INTRODUCTION

These notes are provided by Soil Surveys Engineering Pty Limited (the Company) to complement the geotechnical report in regard to classification methods and field procedures. Not all notes are necessarily relevant to all reports.

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

DESCRIPTION AND CLASSIFICATION METHODS

Soils - The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726-1993 (Geotechnical Site Investigations), where appropriate. In general, descriptions cover the following properties - soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the dominant particle size and behaviour as set out in AS 1726-1993.

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, shear vane, laboratory testing or engineering examination. The strength terms are defined in AS1726-1993 Table A4.

Non-cohesive soils are classified on the basis of relative density usually based on insitu testing or engineering examination (see AS1726-1993 Table A5).

Rocks - Rock types are classified by their geological names (AS1726-1993 Table A6), together with

Table 1 Estimated strength descriptions given to rock based on engineering examination

Strength Term	Approximate Qu (MPa)
Extremely Weak	< 1.0
Very Weak	1.0 - 5.0
Weak	5.0 - 25
Medium Strong	25 - 50
Strong	50 - 100
Very Strong	100 - 250
Extremely Strong	> 250

Ref ISRM "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses"

descriptive terms regarding weathering (AS1726-1993 Table A9), strength (refer Table 1 below), defects (AS1726-1993 Table A10), etc. Where strength testing (ie Point Loads) is carried out, AS1726-1993 Table A8 is used. Where relevant, further information regarding rock classification is attached.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon sample disturbance, (information on strength and structure).

Undisturbed samples are taken by pushing a thin walled sample tube, usually 50mm diameter (U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength, volume change potential and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

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

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application.

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

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

Continuous Spiral Flight Augers - The borehole is advanced using 75 to 300 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the augers. Information from the drilling (as distinct from specific sampling) is of relatively lower reliability due to remoulding, inclusion of cuttings from above or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table has a lower reliability than augering above the water table. Various drill bits are attached to the base of the augers during the drilling. The depth of refusal of the different bit types can provide information as to the strength of the material encountered. Generally two different bit types are used. The 'V' bit is a V shaped steel bit and the 'TC' bit is a tungsten carbide tipped screw type bit.

Wash Boring - The borehole is usually advanced by a rotary bit with water or fluid pumped down the hollow drill rods and returned up in the space between the rods and the soil or casing, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration. More accurate information on soil strata is gained by regular testing and sampling using the Standard Penetration Test (SPT) and undisturbed thin walled tube samples (U50).

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

Continuous Core Drilling - A continuous core sample is obtained using a diamond or tungsten carbide tipped core barrel. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable method of investigation. In rocks, NMLC coring (nominal 52 mm diameter) is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses is determined on site by the supervisor. If the location of the loss is uncertain, it is placed at the top end of the run, when the core is placed in a storage tray and recorded on the log.

Standard Penetration Tests - Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" - Test 6.3.1.

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

In the case where full penetration is obtained with successive blow counts for each 150 mm of, say 4, 6 and 7 blows, the record shows,

4, 6, 7 N = 13

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

15, 30/40mm

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

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

A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid SPT are shown as "N_c" on the borehole logs, together with the number of blows per 150 mm penetration.

Cone Penetration Tests - Test Method - Cone Penetration Tests (CPT) are carried out in accordance with AS 1289 Test 6.5.1-1977, using an electrical friction-cone penetrometer.

The test essentially comprises the measurement of resistance to penetration of a cone of 35.7 mm diameter pushed into the soil at a rate of 10-20 mm per second by hydraulic force. The resistance to penetration is recorded in terms of pressure on the end area of the cone (cone resistance, q_c, in MPa) and friction on the side of the 135 mm long sleeve immediately above the top of the cone (friction resistance, f_s, in kPa). These forces are measured by electrical transducers (strain gauges) within the cone device. The ratio between friction resistance and cone resistance is also calculated as a percentage, ie.-

$$\textit{Friction Ratio (FR)} = \frac{\textit{Friction Resistance}, f_s\ (kPa) \times 100}{\textit{cone resistance}, q_c\ (kPa)}$$

The friction ratio, FR, is generally low in sands (less than 1% or 2%) and generally higher in clays (say 3% or more). The interpretation of sandy clays, clayey sands and material with a high silt content is more difficult, but intermediate values (between 1% and 3%) would be expected. Highly organic clays and peats generally have a friction ratio in excess of 5%.

Static cone data is recorded in the field on disc for later presentation using computer aided drafting.

The equipment can be operated from any conventional drill rig. A total applied load in the range of 4 to 10 tonnes is required for practical purposes, although lighter loads may be used. The cone penetrometers are available with various capacities of cone resistance ranging up to 100 MPa for general purpose investigations, while a range of 0 to 10 MPa can be used where more sensitive investigations of soft clay are required.

The cone resistance value provides a continuous measure of soil strength or density, and together with the friction ratio, provide very useful indications of the presence of narrow bands of geotechnically significant layers such as thin, soft clay layers or lenses of sand which might otherwise be missed using conventional drilling methods.

The lithology of the encountered soils is interpreted from static cone data and is generally presented on the static cone log sheets.

It is important to note that the lithology is interpreted information and is based on research by Schmertmann (1970), Sanglerat (1972), Robinson and Campinalli (1986), modified to suit local conditions as indicated by borehole information and laboratory testing.

As soils generally change gradually it is sometimes difficult to accurately describe depths of strata changes, although greater accuracy is obtained with the static cone compared with conventional drilling. In addition, friction ratios decrease in accuracy with low cone resistance values, and in desiccated soils. As a result, some overlap and minor discrepancies may exist between static cone and nearby borehole information.

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

The DCP comprises a Cone of 20 mm diameter with 30 degree taper attached to steel rods of smaller section.

The cone end is driven with a 9 kg hammer falling 510 mm (AS. 1289 Test 6.3.2). The test was developed initially for pavement subgrade investigations, and empirical correlations of the test results with California Bearing Ratio have been published by various Road Authorities. The Company has developed their own correlations with Standard Penetration tests and Density Index tests in sands.

LOGS

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

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

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

GROUNDWATER

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

- Although groundwater may be present in lower permeability soils, it may enter the hole slowly or perhaps not at all during the time the hole is open.
- A localized perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be bailed out of the bore and mud must be washed out of the hole or "reverted" if water observations are to be made.

More reliable measurements can be made by use of standpipes which are read after stabilizing at periods ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

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

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

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms and the attached explanatory notes summarize important aspects of the Laboratory Test Procedures adopted.

ENGINEERING REPORTS

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

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. Since the test sites in any exploration represent a very small proportion of the total site and since the exploration only identifies actual ground conditions at the test sites, even under the best circumstances actual conditions may vary from those inferred to exist. No responsibility is taken for:-

- Unexpected variations in ground and/or groundwater conditions.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of other persons.
- Any work where the company is not given the opportunity to supervise the construction using the Companies designs/recommendations.

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

<u>SITE ANOMALIES</u>

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

<u>REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES</u>

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances, where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

<u>REVIEW OF DESIGN</u>

Where major civil or structural developments are proposed <u>or</u> where only a limited investigation has been completed <u>or</u> where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer. We would be happy to assist in this regard as an extension of our investigation commission.

<u>SITE INSPECTION</u>

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

i) Site visits during construction to confirm reported ground conditions

ii) Site visits to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, the stability of a filled or excavated slope; or

iii) Full-time engineering presence on site.

In the vast majority of cases it is advantageous to the principal for the geotechnical engineer who wrote the investigation report to be involved in the construction stage of the project.