coffey geotechnics
SPECIALISTS MANAGING THE EARTH

PROPOSED SUBDIVISION AT KINGS AVE TERRIGAL

Prepared For

Crighton Properties Pty Ltd

GEOTKARI02083AA-AC
13 February 2008

URBAN CAPABILITY ASSESSMENT WITH RESPECT TO SLOPE RISK

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
Unit 17, Mount Penang Parklands Carinya Road Somersby
NSW 2250 Australia

13 February 2008

Crighton Properties Pty Ltd
PO Box 3369
TUGGERAH NSW 2259

Attention: Peter Childs

Dear Peter

RE: PROPOSED SUBDIVISION AT KINGS AVENUE, TERRIGAL

URBAN CAPABILITY ASSESSMENT WITH RESPECT TO SLOPE RISK

Coffey Geotechnics Pty Ltd is pleased to present our urban capability assessment report for a proposed subdivision off Kings Avenue at Terrigal.

Should you have any questions regarding this report, please contact Ben Seaford on 4340 1811.

For and on behalf of Coffey Geotechnics Pty Ltd

Report prepared by:

Ben Seaford

Engineering Geologist

Authorised Signatory:

Strider Duerinckx

Senior Engineering Geologist

Distribution List for Final Report: Original copy Coffey Geotechnics Pty Ltd

1 copy Coffey Geotechnics Pty Ltd

4 copies Crighton Properties Pty Ltd (3 hardcopies, 1 electronic)

CONTENTS

CONTENTS

1 INTRODUCTION

This report presents the results of a geotechnical assessment carried out by Coffey Geotechnics Pty Ltd (Coffey) for Crighton Properties Pty Ltd (Crighton) at the site of a proposed subdivision off Kings Avenue at Terrigal. The investigation was carried out in response to Gosford City Council (GCC) letter reference 3744897, forwarded to Coffey by Crighton.

The purpose of the work was to assess the suitability of the site for proposed residential subdivision with respect to risk of slope instability. This report provides an assessment of the risk of slope instability at the site in its existing condition and the risks associated with subdivision development. Recommendations for individual lot development are beyond the scope of this assessment.

The brief required specifications needed for the local environmental study for the rezoning application. The specifications pertaining to geotechnical issues were contained in Paragraph 3(a) and requested that the report contains assessment of:

- Description and analysis of the slopes, soils and topographical features of the site and its immediate surrounds with particular reference to GCC DCP 163 'Geotechnical Requirements for Development Applications';
- Identification of slopes, soils and topographical features which might impose constraints to future development or require specialised engineering approaches to address site constraints; and
- Location of land displaying slopes in excess of 20%.

Other geotechnical considerations, such as footing requirements, settlement, pavement design, bearing capacity, soil chemistry, soil and groundwater contamination, and the effects of mine subsidence, are beyond the scope of this assessment. These matters will be addressed at a future design stage.

2 PREVIOUS INVESTIGATIONS

In 1992 and 1993 Coffey conducted slope instability risk assessments on different parts of the site (Ref: GO540/1-AB and GO652/1-AB). A total of twenty five test pits were excavated to depths up to 3.3m. Subsurface conditions on slopes generally comprised shallow topsoil and slopewash overlying residual clays and weathered rock. Valley floors were generally underlain by relatively deep alluvium.

Slopes observed were generally between 5° to 18° with locally steeper slopes (up to 35°) in gully flanks. Minor slumping and erosion was observed on some of the gully flanks. Each respective area was assessed as having a “moderate” risk of overall slope instability based on the classification system that Coffey Geoscieces adopted at the time (based on system published in Australian Geomechanics News, Number 10, 1985).

Copies of the previous reports by Coffey have been included in Appendix C.

3 PROPOSED DEVELOPMENT

The entire site is about 50ha. It is understood that the proposed subdivision involves the construction of 146 residential lots with some allotments set aside for community space and future development. Plans of the proposed development by Geolyse (Ref: 403089 Sheets D01 to D13) were provided.

4 SCOPE OF ASSESSMENT REQUIRED BY GCC

Gosford City Council (GCC) Development Control Plan No.163 (DCP163) *'Geotechnical Requirements for Development Applications'* nominates four categories of properties and the associated minimum geotechnical assessments required to support Development Applications.

The categories are defined in Tables M1 and M2 of DCP163 and are based primarily on site geology and general slope conditions. For the geology and slope conditions assessed (outlined below), the site in its current condition is considered to be a Category 2 (medium hazard) site.

A Category 2 site requires a Class 2 geotechnical report (as defined by GCC) to support future DA for the site. Coffey has prepared a report that conforms to the Class 2 guidelines.

5 METHODOLOGY

The slope risk assessment was based on the following:

- A review of relevant geology maps and previous reports referenced in Section 2 of this report;
- Observations of surface features on the property and the surrounding area by a Principal Geotechnical Engineer on 28 November 2007;
- Twenty test pits excavated across the site to depths up to 2.5m. Test pits were generally excavated in only areas where development is proposed.

The engineering logs of the test pits are presented in Appendix A, together with explanation sheets defining the terms and symbols used. Reduced levels shown on the engineering logs were inferred from contour levels on the plan prepared by Geolyse. Test pits were located using tape measurements from site features shown on the plan by Geolyse.

The risk of slope instability has been assessed from the observed site conditions using methods consistent with those presented in the Australian Geomechanics Society publication Landslide Risk Management Concepts and Guidelines, in Australian Geomechanics News, March 2000. Based on those methods, the risks to property associated with slope instability on the subject site have been assessed using the terms presented in Coffey Attachment 1, 'Classification of Risk of Slope Instability', which has been adapted from the classification system formulated by the Australian Geomechanics Society and published in Australian Geomechanics News, Number 10, 1985.

6 SITE CONDITIONS

6.1 Local Geology

The Gosford 1:25000 Geological Map (unpublished) indicates that the locality is underlain by rocks belonging to the Terrigal Formation of the Narrabeen Group, consisting of interbedded lithic sandstone and siltstone.

6.2 Surface Features

The site is situated on the north eastern flank of a moderately to steeply undulating ridge. This site features three roughly northeast/southwest trending spurs which forms the northeastern extent of the Kincumba Mountain Reserve. The site is located on the southern side of Kings Avenue. Existing residential development is located to the east and west, and to the north of Kings Avenue.

The three spurs are located in the western, central and eastern portions of the site. The eastern and western spurs extend only partway across the site with the central spur intersecting the entire length of site. The crest of the central spur has been cleared for power lines. Two broad valleys occupy the areas between the spurs.

The vegetation comprises paddocks cleared of trees, light woodland areas cleared of undergrowth with grass cover and localised scrub areas. Woodland areas comprise mature native trees with the area further to the south, beyond the property boundary, being moderately vegetated by mature native species. Tree trunks are generally vertical. Some lantana and blackberry scrub occur at scattered locations around the site. Site drainage (runoff and infiltration) was judged to be good. No evidence of seepage (spring activity) was observed, except locally near the eastern boundary, however this appears to be related to runoff from adjacent development.

6.3 Terrain Elements

Based on the site surface features and inferred subsurface profiles from the test pits, the site has been split up into three Land Areas. The inferred Land Areas are shown on Figure 2.

6.3.1 Land Area 1 (LA1)

LA1 comprises the valley floors and flatter footslopes located in the central eastern and central western portions of the site. The valleys are grassed paddocks. Two dams are located in the centre of the eastern valley. The valley floors are generally flat but minor slopes of about 10° were recorded where the flanks of the surrounding spurs intersect with valley floor.

Table 1 presents the inferred geotechnical model for LA1, based on test pits TP13 and TP15 and test pits from the previous investigations referenced in Section 2.

TABLE 1 – INFERRED GEOTECHNICAL UNITS FOR LA1

Unit	Typical Properties
Alluvium/Colluvium	Silty SAND and Clayey SAND, fine to medium grained, low plasticity. Ranging from 1.5m thick to greater than 3.5m thick.
Residual Soil	Sandy CLAY, low to medium plasticity, stiff to very stiff consistency. Fine to medium grained sand.

In summary, test pits excavated in LA1 generally encountered deep soils comprising silty sand colluvial soil overlying low to medium plasticity sandy clays. It is likely that the soil depth in LA1 in the western portion of the site will encounter similar soil depths.

Groundwater inflows were not encountered in test pits excavated in LA1, in this episode of fieldwork but minor flows were encountered in the western valley in 1992.

6.3.2 Land Area 2 (LA2)

LA2 encompasses the flanks of each spur and the steeper terrain to the south. Field slope measurements ranged from about 12° to 28°. Steeper slopes were observed further to the south of the proposed development.

Table 2 presents the inferred geotechnical model for LA2, based on test pits TP1 to TP3, TP5, TP6, TP8 to TP11, TP14 and TP16 to TP20.

TABLE 2 – INFERRED GEOTECHNICAL UNITS FOR LA2

Unit	Typical Properties
Colluvium	Silty SAND/SAND/Silty clayey SAND, fine to medium grained, low plastic clay fines. Thickness range between 0.2m to 1m.
Residual Soil and Extremely Weathered Rock	Sandy CLAY/CLAY/Silty CLAY, medium to high plasticity, grey-orange-red, generally very stiff to hard consistency, some fine to medium gravel. Grades into extremely weathered sandstone. Thicknesses range between 0.2m and 1.3m.
Distinctly Weathered Rock	SANDSTONE, inferred below the depth of excavator refusal. Estimated to be very low to medium strength, highly to moderately weathered. Excavator refusal was generally between 0.7 to 2m below the existing surface level.

6.3.3 Land Area 3 (LA3)

LA3 comprises the crest of the central spur extending through the centre of the site. The crest is relatively flat with slopes extending gently in all directions at a maximum of about 8°. A stand of dense native trees was observed on the central eastern portion of the spur.

Table 3 presents the inferred geotechnical model for LA3, based on test pits TP4, TP7, TP12, TP16 and TP17.

Some scattered sandstone outcrops were observed at the crest of the ridge, and rock was generally encountered at shallower depths in LA3 compared to LA1 and LA2.

TABLE 3 – INFERRED GEOTECHNICAL UNITS FOR LA3

Unit	Typical Properties
Colluvium	Silty SAND/Clayey SAND, fine to medium grained, low plastic clay fines. Gravelly CLAY of low to medium plasticity in TP12 and TP16. Thickness range between 0.2m to 0.8m.
Residual Soil and Extremely Weathered Rock	SAND, Clayey SAND, CLAY/Silty CLAY, medium to high plasticity, grey-orange-red, generally very stiff to hard consistency, fine to medium grained sand, some fine to medium gravel. Grades into extremely weathered sandstone. Thicknesses range between 0.5m and 1.1m.
Distinctly Weathered Rock	SANDSTONE, inferred below the depth of excavator refusal. Estimated to be very low to medium strength, highly to moderately weathered. Excavator refusal was between 0.9 to 1.6m depth.

6.4 Slopes Greater than 20%

GCC DCP 163 'Geotechnical Requirements for Development Applications' requires identification of land with slopes in excess of 20%. Geolyse Plan 403089 Sheet D03 shows slopes on site that exceed 20%. This plan is included as Figure 3. The land is part of LA2.

7 LABORATORY TESTING

Three undisturbed (U50 tube) samples of clay were assessed for shrink / swell potential (AS1289 7.1.1). The results of shrink / swell index (I_{ss}) testing are included in Appendix B and summarised in Table 4.

TABLE 4 – SUMMARY OF SHRINK / SWELL INDEX (I_{SS}) TEST RESULTS

Location	Depth (m)	I_{ss} (%)
TP4	0.8 – 1.1	1.3
TP8	0.9 – 1.2	2.0
TP12	0.7 – 1.0	2.0

8 SLOPE RISK ASSESSMENT

8.1 Definitions

A qualitative risk assessment involves identification of the hazard event, and a qualitative estimation of the consequences and frequency of occurrence of the event.

The terms used in the risk assessment process are defined below:

Hazard: A condition with the potential for causing an undesirable consequence.

Consequence: Outcome arising from a hazard, expressed as loss or damage.

Risk: A term combining the probability and severity or consequence of any event causing adverse effects to property or the environment.

8.2 Property Elements at Risk

The principal elements at risk for the identified hazard would be the proposed roads and houses. The following consequence assessment addresses the risks associated with potential damage to these structures.

The consequences associated with loss of life of occupants of the dwelling are a separate issue and are not addressed by this urban capability assessment.

8.3 Hazard Identification

Deep seated, large scale slope instability is not expected to occur naturally due to the shallow depth to weathered bedrock and the generally good drainage. The principal hazards that could potentially impact on a proposed development would include shallow slumping of colluvium in existing steeper slopes, or deeper slumping that could be mobilised by excessively deep or steep cuttings and deep filling associated with the subdivision development.

8.4 Risk Evaluation for Existing Site Conditions

In assessing risk, the descriptors used are from Australian Geomechanics Society publication Landslide Risk Management Concepts and Guidelines, Australian Geomechanics News, March 2000.

Consequence	Medium
Likelihood/Frequency	Possible in LA2 Unlikely in LA1 and LA3
Risk	Medium in LA2 Low in LA1 and LA3

In accordance with GCC requirements the geotechnical assessment is summarised in Table 5.

TABLE 5 – SUMMARY OF GEOTECHNICAL ASSESSMENT

Site Data	LA1	LA2	LA3
Location	Valley floors	Spur flanks	Spur crest
Likely Site Classification (AS 2870)	Class P Potential soft soils	Class P Potential slope risk	Class S or M Depending on soil depth
Land Slope	Flat to ~ 15°	12° to 28°	Up to 8°
Underlying Bedrock	Rnt (Terrigal Formation)		
Soils	Deep Silty SAND colluvial and residual CLAY soils	Shallow Silty SAND colluvial and residual CLAY soils	
Type of Stability Risk	Deposition from slumps in LA2	Slumping of colluvium Slips from excessive cutting and filling	Slips from excessive cutting and filling
Risk Assessment (Note 1)	Low	Medium	Low
Drainage	Judged to be good, occurring by runoff and infiltration	Judged to be good, occurring by predominately by runoff with some infiltration	Judged to be good, occurring by some runoff and infiltration
Risk from Adjacent Land	Medium	Low	Low
Geotechnical Inspections Required During Construction	Yes		

Note 1: Using the terminology defined in Attachment 1 ‘Classification of Risk of Slope Instability’

8.5 Geotechnical Risk Management for Subdivision Development

The proposed subdivision is considered feasible from a slope risk viewpoint. However, subdivision development on the site may increase the risk of instability. Nevertheless, Coffey consider that after subdivision development the risk of slope instability should not exceed the risks assessed in Table 5 above provided that development is carried out in accordance with good hillside practice (as set out in Attachments 2 and 3) and the geotechnical recommendations below.

The following recommendations are specific to the proposed subdivision development shown on the drawing by Geolyse Ref: 403089 Sht D01-D13 supplied. Theses plans show the proposed road alignments and lot layout. Long sections and selected cross sections are provided, but road chainages are not indicated on the plans provided so it is difficult to determine the proposed location of the specific cuts or fills.

8.5.1 Road Excavations

For general consistency with the reports referenced in Section 2, Coffey recommends that excavation should generally be limited to less than 1.5m vertical depth with excavation batters not steeper than 2H:1V.

In the plans provided, the long sections show excavation in excess of 1.5m depth at the centreline for:

- Road 01 Ch 70m to 110m (depth locally up to about 2.2m)
- Road 04 Ch 0m to 20m (depth locally up to about 2.5m)
- Road 04 Ch 400m to 540m (depth locally up to about 4m)
- Road 06 Ch 0m to 10m (depth locally up to about 3m)

Where these cuts occur across the slope, deeper cuts than indicated above may occur on the upslope side of the road. Other cuttings in excess of the general maximums indicated above may also occur locally on the upslope side of the roads, and should also be investigated.

Deep cuttings are likely to intersect weathered rock. Steeper batters than 2H:1V may be feasible, but retaining walls may be preferable depending on specific assessment.

Where cuts exceed 1.5m depth, further investigation will be required to assess the risk associated with deeper excavation, the need for engineer designed retaining walls and suitable types of wall construction for the slope and subsurface conditions.

For excavations to 2.5m depth investigation by backhoe may suffice, but for excavations greater than 2.5m, cored boreholes are likely to be necessary. The scope of investigation needed at each location will depend on the local slope and ground conditions.

8.5.2 Fill Embankments

Fill embankments for road construction should not exceed 1.5m vertical height with batters not steeper than 1V:2H and protected against erosion, or supported by engineer designed retaining walls.

Where filling is required to exceed 1.5m depth, specific investigation is recommended to assess the impact on slope stability. The cross sections provided show deeper filling is required at:

- Road 01 in the vicinity of Ch 310m (about 3m fill)
- Road 01 in the vicinity of Ch 530m (about 2.5m fill)
- Road 03 in the vicinity of Ch 75m (about 3.5m fill with batters at 1H:1V)
- Road 04 in the vicinity of Ch 290m (about 1.7m fill)
- Road 08 in the vicinity of Ch 320m (about 3.2m fill)

There is also a risk of embankment instability where roads cross potential soft soils in LA1 if significant embankments are constructed. Presently the embankments do not appear to exceed 1m at the centrelines.

Fill areas should be prepared by removing topsoil, and benching into the slope to create a level platform on which to place fill. Fill should be compacted in accordance with GCC specifications under Level 1

monitoring as described in AS 3798. Fill batters should be constructed by overfilling and then cutting back to the required slope.

8.5.3 Building platforms

Cutting and filling for building platforms for houses should be limited to a maximum depth of 1m unless site specific investigation and geotechnical assessment is conducted. The cut and fill batters should be battered at 1V:2H or flatter and protected against erosion, or supported by properly designed and constructed retaining walls as described below.

8.5.4 Retaining Walls

Retaining walls in excess of 1m height should be designed by a structural engineer familiar with the site conditions and should be designed for surcharge loading from slopes and structures and other existing or future improvements in the vicinity of the wall.

Excavations for the construction of retaining walls up to 1.5m high may adopt a temporary excavation batter of 1V:1H provided that appropriate construction planning, control of drainage and staged excavation minimises the extent of unsupported excavation. Excavations in excess of 1.5m high will require specific assessment as outlined in Section 8.5.1.

Adequate subsurface and surface drainage should be provided behind all retaining walls unless they are designed to resist hydrostatic pressures. Any subsoil drainage used on site behind retaining walls should at a minimum consist of filter sock-wrapped slotted pipe surrounded in free-draining, coarse granular backfill and should be provided around the perimeter of all excavations. Subsoil drains should be fitted with flushing and clean out points. Gradient along all drains should be sufficient to promote self-cleaning.

8.5.5 Drainage and Sewage Disposal:

Guidelines for surface and subsurface drainage are provided in the attachments to this report.

There should be no disposal of stormwater or liquid wastes on site, without further specific geotechnical assessment.

9 OTHER GEOTECHNICAL CONSIDERATIONS

9.1 Reactive Soils

The results of the shrink/swell testing indicate that the clay material encountered onsite is generally of low to moderately reactivity. It is considered that clay from cuts on site can be used as general fill. It is recommended that any material won from cuts on the site be inspected by a geotechnical authority prior to placement.

9.2 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are soils containing significant concentrations of pyrite, which when it oxidises, generates sulfuric acid. Unoxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, and the soils are said to be actual ASS (AASS).

Pyritic soils typically form in waterlogged, saline sediments deposited during the Holocene period (10,000 years ago to present day). Typical these soils occur in environments below about RL 5m AHD such as tidal flats, salt marshes, mangrove swamps and bottom sediments in coastal rivers and creeks.

Disturbance of acid sulfate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH and produce acid salts, which affects vegetation and aquatic life and can produce aggressive soils that may be detrimental to concrete and steel in buildings and services.

The Gosford 1:25000 Scale Acid Sulfate Soil Risk Map (Reference 1) indicates that the site is not in an area known to have occurrence of Acid Sulfate Soils.

Based on the site geology, site elevation (above RL11m) and ASS risk map review, actual or potential ASS are not likely to be encountered within the areas of the site proposed for development. Based on this observation and the proposed development details, it is considered that no ASS Management Plan is required.

10 CONCLUSION

The scope of work for this assessment was to identify soil and landscape limitations for urban development to address slope issues raised by GCC. No significant areas of instability were noted over the area. Based on the results of this assessment, it is considered that the land is generally suitable for the type of urban use proposed subject to the geotechnical constraints on development detailed in section 8.5.

11 LIMITATIONS

The onus is on the owner, potential owner or interested parties to decide whether the assessed level of risk of slope instability is acceptable taking into account likely economic consequences of the risk and the recommended geotechnical constraints.

The findings contained in this report result from methodologies used in accordance with normal practices and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. If site conditions encountered during construction vary significantly from those discussed in this report, Coffey should be advised.

Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

Guidance on the uses and limitations of this assessment is presented in the attached document '*Important information about your Coffey Report*', in accordance with which this report should be read.

REFERENCES

1 Department of Land and Water Conservation (1997), Gosford 1:25000 Acid Sulfate Soil Risk Map, Edition 2

2 Ahern C R, Stone Y and Blunden B (1998) Acid Sulfate Soil Manual, Acid Sulfate Soils Management Advisory Committee, Wollongbar, NSW, August.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

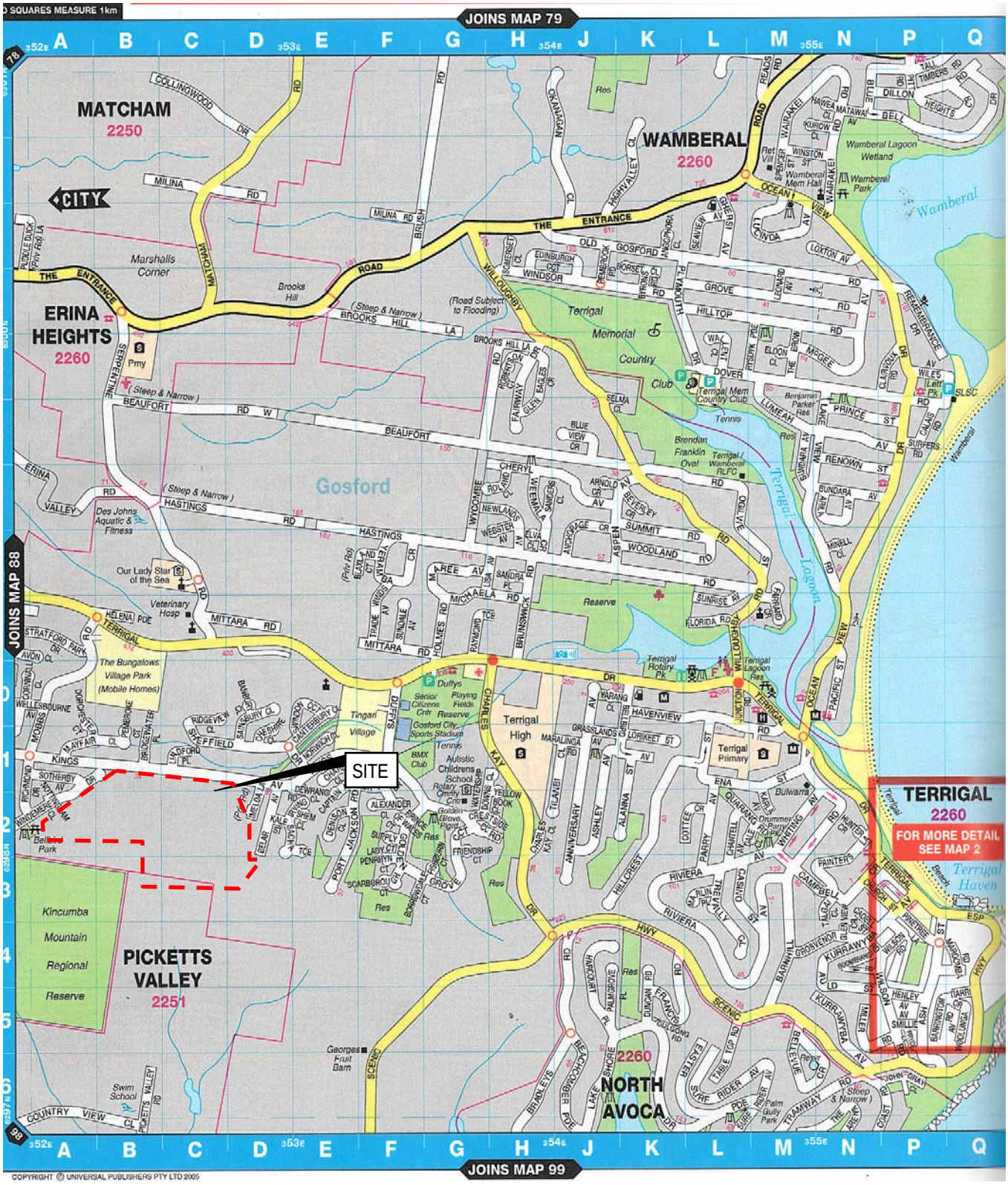
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

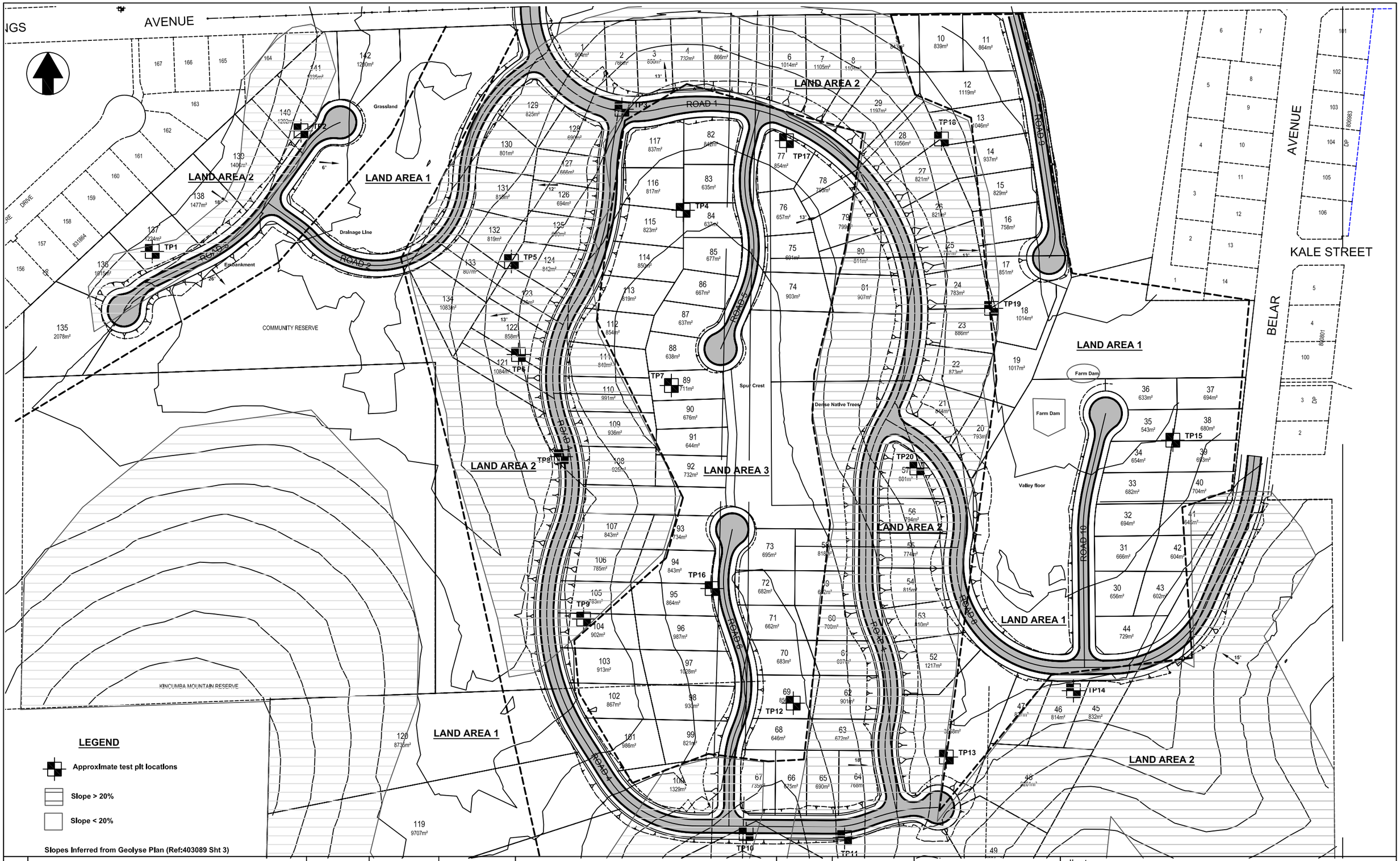
* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures



Reference: Map 89 of UBD Central Coast Street Directory (2006 edition)

drawn	**BS**	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	**CRIGHTON PROPERTIES PTY LTD**
approved			project:	**PROPOSED SUBDIVISION KINGS AVENUE, TERRIGAL URBAN CAPABILITY ASSESSMENT**
date	**20/12/07**		title:	**SITE LOCATION**
scale	**NTS**		project no: **GEOTKARI02083AA**	figure no: **FIGURE 1**
original size	**A4**			



revision	description	drawn	approved	date

0 5 10 20 30
Horizontal Scale (metres)

0 5 10 20 30
Vertical Scale (metres)

drawn	BS
approved	RMT
date	30/11/07
scale	AS SHOWN
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

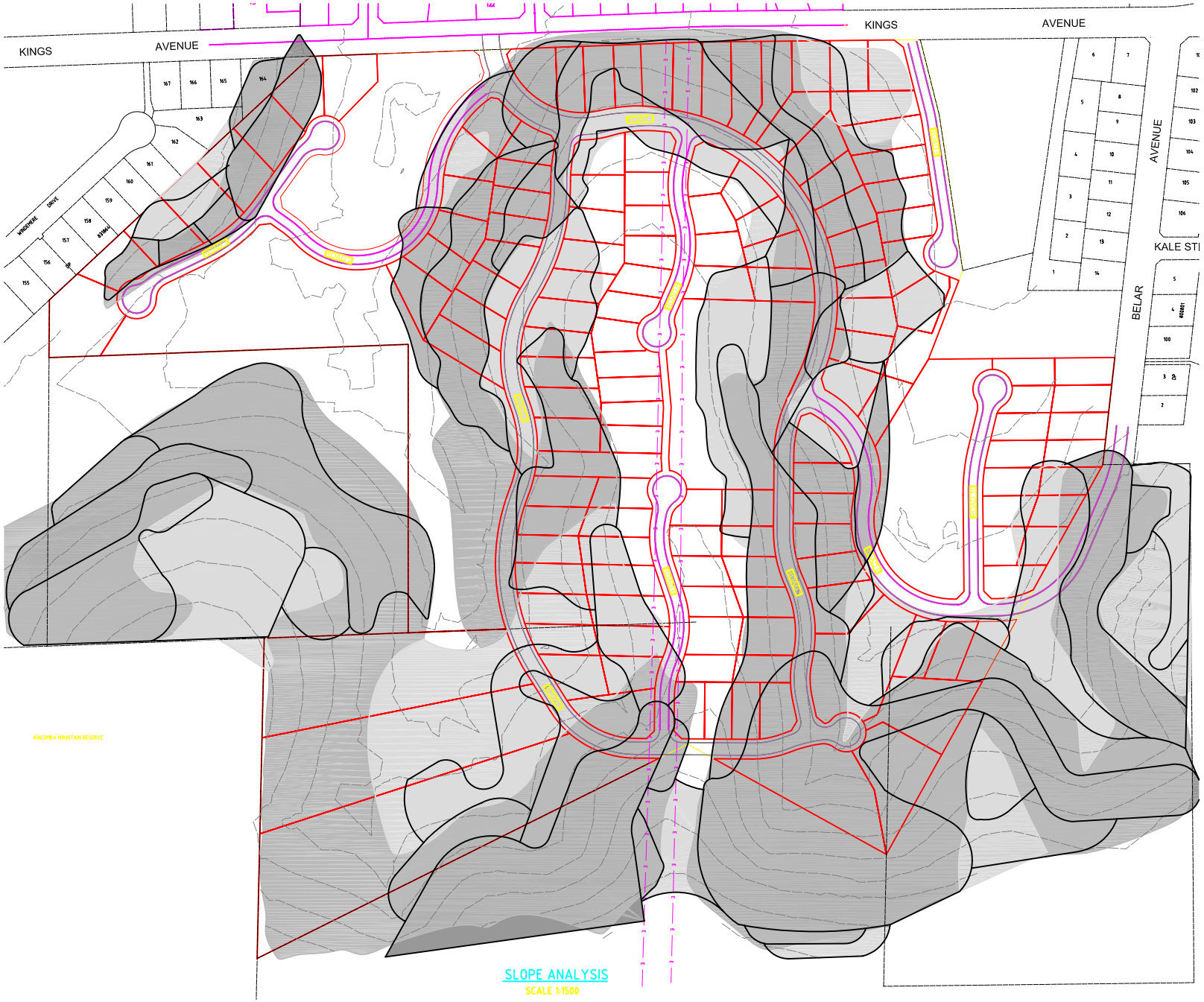
client: CRIGHTON PROPERTIES PTY LTD

project: PROPOSED SUBDIVISION
KINGS AVENUE, TERRIGAL
URBAN CAPABILITY ASSESSMENT

title: SITE PLAN AND INVESTIGATION LOCATIONS

project no: GEOTKARI02083AA

drawing no:/figure no: FIGURE 2



SLOPE ANALYSIS

SCALE 1:1500

APPROVAL

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.MGR	DETAILS
A	15/04/2004					ISSUED FOR INCLUSION IN SUBMISSION
B	23/06/2004					ISSUED FOR CLIENT APPROVAL
C	29/06/2004					REISSUE FOR CLIENT APPROVAL

CHECKED/APPROVED	NAME	SIGNATURE	DATE
SURVEY BASEPLAN	CAHILL & CAMERON	-	26/11/03
DRAFTING	JIM ARMSTRONG		29/06/04
DESIGNER	JIM ARMSTRONG		29/06/04

CP Logo & Tag.JPG

CRIGHTON PROPERTIES PTY. LTD.
PO BOX 344
TERRIGAL, NSW, 2260
Ph. 4365 2822
Fax. 4365 1631

GEOLYSE
NEWCASTLE
1st FLOOR
4 CROWN STREET
NEWCASTLE, NSW 2300
P.O. BOX 766
NEWCASTLE, NSW 2300
Ph. 02 4927 5055
Fax. 02 4927 5787
newcastle@geolyse.com
www.geolyse.com

PROJECT: REZONING SUBMISSION
KINGS AVENUE - TERRIGAL, N.S.W.

DRAWING: SLOPE ANALYSIS

PROJECT NUMBER:	403089	12D FILE:	DATUM: A.H.D.
DRAWING NUMBER:	403089_D03	AUTOCAD FILE:	ORIGINAL: A1 SIZE
STATUS:	APPROVAL	Sheet 03 of 13 Sheets	

Appendix A

Engineering Logs and Explanation Sheets

coffey

Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

coffey

Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
		SILTS & CLAYS Liquid limit less than 50	**DRY STRENGTH**	**DILATANCY**	**TOUGHNESS**			
			None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Modium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP001**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa (100 200 300 400)	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine to medium grained, dark brown. Grading to	D			COLLUVIUM
						1.0		CH	**CLAY:** High plasticity, orange with some red mottling.	<<Wp	VSt/H	×	RESIDUAL High dry strength
						1.5			Red colour increasing at 1.5m			×	Sandstone floater at 1.1m in northern portion of the pit
									Test pit TP001 terminated at 1.6m			×	Refusal on extremely to highly weathered sandstone at 1.6m
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP002**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine to medium grained, pale brown. Fine to medium grained angular sandstone and iron gravel.	D			COLLUVIUM Moderate root system to 0.3m
						1.0		CH	**Sandy CLAY:** Medium to high plasticity, orange and red, fine grained sand. Extremely weathered sandstone gravel at base of test pit.	<Wp	VSt/H	× × × × × ×	RESIDUAL
						1.5			Test pit TP002 terminated at 1.5m				Refusal on interpreted highly weathered sandstone at 1.5m
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT GEOTKARI02083AA.GPJ COFFEY.GDT 13.2.08

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP003**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
E		N	None			0.0		SM	**Silty SAND:** Fine to medium grained, dark brown.	M			COLLUVIUM Moderate root system to 0.3m
								SP	**SAND:** Fine to medium grained, pale grey and pale orange, some low plasticity clay fines.				
						0.5		CH	**Sandy CLAY:** Medium to high plasticity, orange, fine grained sand.	<Wp	VSt/H	×	RESIDUAL
									Test pit TP003 terminated at 0.7m				Refusal on interpreted highly weathered sandstone at 0.7m
						1.0							
						1.5							
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP004**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
E		N	None Observed					SM	**Silty SAND:** Fine grained, dark brown.	M			COLLUVIUM Thick root system to 0.7m
						0.5		SC	**Silty Clayey SAND:** Fine to medium grained, brown-grey-dark red, low plasticity clay fines.				
				U_{50}		1.0		CL-CH	**Silty CLAY:** Medium plasticity, grey with some pale orange. Sandstone gravel content increasing with depth.	<<Wp	VSt/H	×	RESIDUAL
									Test pit TP004 terminated at 1.1m				Refusal at 1.1m on clayey gravel interpreted as extremely weathered sandstone
						1.5							
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP005**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information						material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa (100 200 300 400)	structure and additional observations
E		N	None		0.5		SM	**Silty SAND:** Fine grained, dark brown. Becoming pale grey with depth.	M			COLLUVIUM Thick root system to 0.2m
							CH	**CLAY;** High plasticity, dark orange, some fine to medium grained angular sandstone gravel.	<<Wp	VSt/H	×	RESIDUAL Refusal on gravel at 0.8m
					1.0			Test pit TP005 terminated at 0.8m				interepreted as being highly weathered sandstone
					1.5							
					2.0							
					2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT GEOTKARI02083AA.GPJ COFFEY.GDT 13.2.08

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP006**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
E		N	None			0.5		SM	**Silty SAND:** Fine grained, dark brown. Some fine to medium grained angular gravel from 0.4m.	M			COLLUVIUM Thick root system to 0.4m
								CL-CH	**Silty CLAY:** Medium plasticity, orange and red mottling. Sandstone gravel at 0.8m	<<Wp			RESIDUAL
						1.0 1.5 2.0 2.5			Test pit TP006 terminated at 0.9m				Refusal on gravel at 0.9m interepreted as being highly weathered sandstone

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP007**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None			0.5		SC	**Silty Clayey SAND:** Fine to medium grained, pale brown, low plasticity clay fines.	M			COLLUVIUM
								SC	**Clayey SAND:** Fine to coarse grained, pale brown and pale orange.	M			RESIDUAL
								SP	**SAND:** Fine to coarse grained, orange and red. Fine to coarse sandstone gravel throughout.		VD		EXTREMELY WEATHERED SANDSTONE
						1.0 1.5 2.0 2.5			Test pit TP007 terminated at 0.9m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description
based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP008**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine to medium grained, dark brown, some fine to coarse grained angular sandstone gravel.	D			COLLUVIUM Some sandstone cobbles and boulders in top 0.4m
						1.0		CH	**Silty CLAY:** High plasticity, orange and grey. Sandstone gravel content increasing with depth.	<<Wp	VSt/H	× × × × ×	RESIDUAL
						1.5			Test pit TP008 terminated at 1.5m				Refusal on gravel at 1.5m
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TESTPIT GEOTKARI02083AA.GPJ COFFEY.GDT 13.2.08

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP009**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: **Crighton Properties Pty Ltd**

Date started: **28.11.2007**

Principal:

Date completed: **28.11.2007**

Project: **Proposed Subdivision**

Logged by: **BS**

Test pit location: **Refer to Figure**

Checked by: **RMT**

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.0		SM	**Silty SAND:** Fine grained, dark brown.	M			COLLUVIUM Thin root system
								SC	**Clayey SAND:** Fine to medium grained, grey, low plasticity clay fines.	M			
						0.5		CL-CH	**Gravelly CLAY:** Medium plasticity, brown with some orange and red, fine to medium grained angular sandstone gravel.	>Wp			COLLUVIUM/RESIDUAL
						1.0		CH	**Silty CLAY:** Medium to high plasticity, pale grey and pale orange.	<Wp		×	RESIDUAL
						1.5			Some fine to medium grained angular sandstone and iron from 1.4m			× × × ×	
						2.0						×	Very slow progress in clay and gravel
						2.5			Test pit TP009 terminated at 2m				

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP010**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine to medium grained, dark brown. Some fine to medium grained angular sandstone from 0.4m.	D			COLLUVIUM
						1.0		CH	**CLAY:** Medium to high plasticity, pale grey with red and orange mottling. Some fine to medium grained sandstone gravel from 1m.	>Wp		× × ×	RESIDUAL
						1.5 2.0 2.5			Test pit TP010 terminated at 1.2m			×	Refusal on gravel at 1.2m interepreted as being highly weathered sandstone

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT GEOTKARI02083AA.GPJ COFFEY.GDT 13.2.08

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP011**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***28.11.2007***

Principal:

Date completed: ***28.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine grained, dark brown.	D			COLLUVIUM Thick root system top 0.2m
						1.0		SP	**SAND:** Fine to medium grained, orange. Fine to coarse grained sandstone gravel from 1m. Pale grey and red colour at 1m.	D	VD		RESIDUAL
						1.5 2.0 2.5			Test pit TP011 terminated at 1.1m				Refusal on gravel at 1.1m interepreted as being highly weathered sandstone

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP012**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.0		SM	**Silty SAND:** Fine grained, brown, some fine to medium grained angular gravel.	D			COLLUVIUM
								CL	**Gravelly CLAY:** Low to medium plasticity, dark red, fine grained angular gravel.	<Wp			COLLUVIUM/RESIDUAL
						0.5		CH	**CLAY:** Medium to high plasticity, pale grey and orange and red mottling, some silt.	<=Wp	VSt/H	×	RESDIUAL
						1.0		CH	**Silty CLAY:** High plasticity, pale grey with some red and orange mottling.	<<Wp	VSt/H	×	
						1.5			Test pit TP012 terminated at 1.6m			×	Refusal on sandstone in northern end of TP at 1.6m
						2.0							
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description
based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP013**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine grained, dark brown.	D			COLLUVIUM Thin root system throughout
						1.0		SM	**Silty SAND:** Fine grained, pale brown.	M			
						1.5		SC	**Clayey SAND:** Fine to medium grained, pale grey and orange, medium plasticity clay fines.	M			
						2.0							
						2.5							

Test pit TP013 terminated at 2.5m

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP014**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine grained, dark brown. Some fine to coarse grained up to cobble size sandstone from 0.5 - 0.8m.	D			COLLUVIUM Thin root system throughout
						1.0		CH	**CLAY:** Medium to high plasticity, orange and red mottling, some fine to medium grained angular ironstone gravel.	<Wp	VSt/H	× × × ×	RESIDUAL
						1.5		CH	**Silty CLAY:** High plasticity, pale grey with some red-orange mottling.	<Wp			Fine to coarse sandstone gravel from 1.7m
						2.0			Test pit TP014 terminated at 1.8m				Refusal on gravel at 1.8m interepreted as being highly weathered sandstone
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TESTPIT GEOTKARI02083AA.GPJ COFFEY.GDT 13.2.08

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP015**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: **Crighton Properties Pty Ltd**

Date started: **29.11.2007**

Principal:

Date completed: **29.11.2007**

Project: **Proposed Subdivision**

Logged by: **BS**

Test pit location: **Refer to Figure**

Checked by: **RMT**

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine to grained, dark brown.	D			COLLUVIUM
								SM	**Silty SAND:** Fine to medium grained, pale brown, some low plasticity clay fines.	M			
						1.0		SC	**Clayey SAND:** Fine to medium grained, orange, low to medium plastic fines.	M			COLLUVIUM/RESIDUAL
						1.5			Red colour rising from about 1.5m Grading into				
						2.0		CL	**Sandy CLAY:** Low to medium plasticity, orange and red, fine to medium grained sand.	>Wp	St/Vst	× × ×	RESIDUAL
						2.5			Test pit TP015 terminated at 2.5m				

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description
based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP016**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.0		SM	**Silty SAND:** Fine grained, dark brown.	M			COLLUVIUM
						0.5		CL-CH	**Gravelly CLAY:** Medium plasticity, pale grey and red, fine to medium grained angular gravel, some silt.	<Wp	St/Vst	×	COLLUVIUM/RESIDUAL
						1.0						×	
								CH	**Silty CLAY:** Medium to high plasticity, pale grey with some red mottling.	<Wp	VSt/H	×	RESIDUAL
						1.5						×	
									Test pit TP016 terminated at 1.6m			×	
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP017**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed					SM	**Silty SAND:** Fine to medium grained, grey, some fine to medium grained angular gravel.	D			COLLUVIUM Thick root system
						0.5		CH	**CLAY:** High plasticity, grey-orange-red mottling, some silt.	<<Wp	VSt/H	× × ×	RESIDUAL High dry strength
						1.0		CH	**Silty CLAY:** Medium to high plasticity, pale grey with orange and red mottling, some fine to medium grained angular gravel.	<Wp	VSt/H	×	
									Test pit TP017 terminated at 1.1m			×	Refusal on gravel at 1.1m interepreted as being highly weathered sandstone
						1.5							
						2.0							
						2.5							

Sketch

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
S shoring N nil

penetration
1 2 3 4
no resistance ranging to refusal

water
water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
V vane shear (kPa)
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP018**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
E		N	None Observed					SM	**Silty SAND:** Fine to medium grained, brown.	D			COLLUVIUM Thick root system
						0.5		CL-CH	**Sandy CLAY:** Medium plasticity, pale orange and pale grey, fine to medium grained sand. Grading to	<Wp	VSt/H	×	RESIDUAL
						1.0		CL-CH	**CLAY:** Medium plasticity, pale orange and pale grey.	<Wp		×	
								CH	**CLAY:** High plasticity, pale grey with some pale orange.	<Wp	VSt/H	×	Very slow progress in high plastic clay
									Test pit TP018 terminated at 1.3m			×	
						1.5							
						2.0							
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description
based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP019**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine grained, dark brown.	D			COLLUVIUM
								SM	**Silty SAND:** Fine to medium grained, pale brown, some low plasticity clay fines.	M			
						1.0		CL-CH	**CLAY:** Medium plasticity, orange and red.	<=Wp	VSt/H		RESIDUAL
								CH	**CLAY:** High plasticity, pale grey with red and orange mottling, some silt.	>Wp			
						1.5			Test pit TP019 terminated at 1.5m				Very slow progress in high plastic clay
						2.0							
						2.5							

Sketch

method

N	natural exposure
X	existing excavation
BH	backhoe bucket
B	bulldozer blade
R	ripper
E	excavator

support

S shoring N nil

penetration

1 2 3 4 — no resistance ranging to refusal

water

water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
V	vane shear (kPa)
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **TP020**

Sheet 1 of 1

Project No: **GEOTKARI02083AA**

Client: ***Crighton Properties Pty Ltd***

Date started: ***29.11.2007***

Principal:

Date completed: ***29.11.2007***

Project: ***Proposed Subdivision***

Logged by: ***BS***

Test pit location: ***Refer to Figure***

Checked by: ***RMT***

equipment type and model: Kubota 4t | Pit Orientation: | Easting: m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.6m wide | Northing: m | datum: AHD

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
E		N	None Observed			0.5		SM	**Silty SAND:** Fine grained, dark brown.	M			COLLUVIUM
								SC	**Clayey SAND:** Fine to medium grained, pale orange and grey mottling, low plasticity clay fines. Grading to	M			COLLUVIUM/RESIDUAL
						1.0		CL CH	**Sandy CLAY:** Low to medium plasticity, pale orange and grey mottling, fine to medium grained sand. **CLAY:** High plasticity, orange.	=Wp		× × ×	RESIDUAL
						1.5			Test pit TP020 terminated at 1.1m				Refusal on sandstone floater
						2.0							
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration
1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description
based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Appendix B

Laboratory Results

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 17 Mt Penang Parklands, Kariong NSW 2250
Ph: (02) 4340 1811 Fax: (02) 4340 1411

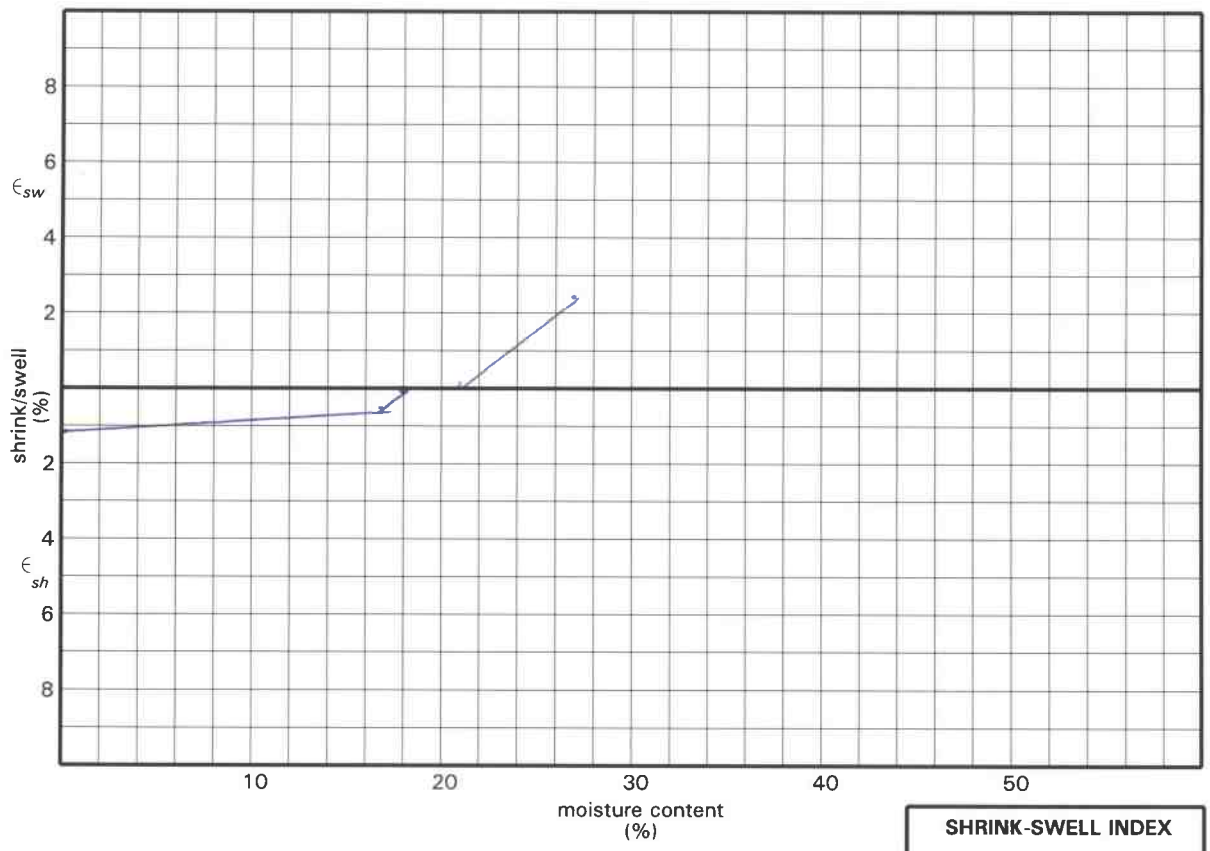
shrink swell index test

client : *Crighton Properties Pty Ltd*
job no : *GEOTKARI02083AA*
principal :
laboratory : *GOSFORD*
project : *Proposed Subdivison*
report date : *December 07, 2007*
location : *King Av, Terrigal*
test report no. : *DEC07-02*

test procedure : *AS1289.7.1.1*

borehole : *TP4* depth : *0.8-1.1* date tested : *30/11/07*
material classification : *(CL/CH) Silty CLAY, medium plasticity, grey-brown, trace roots.*

SWELL TEST					SHRINK TEST			
swell on saturation (%)	moisture content (%)		estimated unconfined compressive strength (kPa)		shrink on drying %	estimated inert material present %	extent of crumbling during shrinkage	extent of cracking during shrinkage
	before test	after test	before test	after test				
2.4	*21.1*	*27.2*	*>400*	*200*	*1.1*	*<5%*	*Minor*	*Moderate #*



SHRINK-SWELL INDEX
I_{ss} = *1.3* %

remarks: *#: Transverse*

NATA Accredited Laboratory No. 431
Approved Signatory: *Brian Miller*
Date : *7 December 2007*

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 17 Mt Penang Parklands, Kariong NSW 2250
Ph: (02) 4340 1811 Fax: (02) 4340 1411

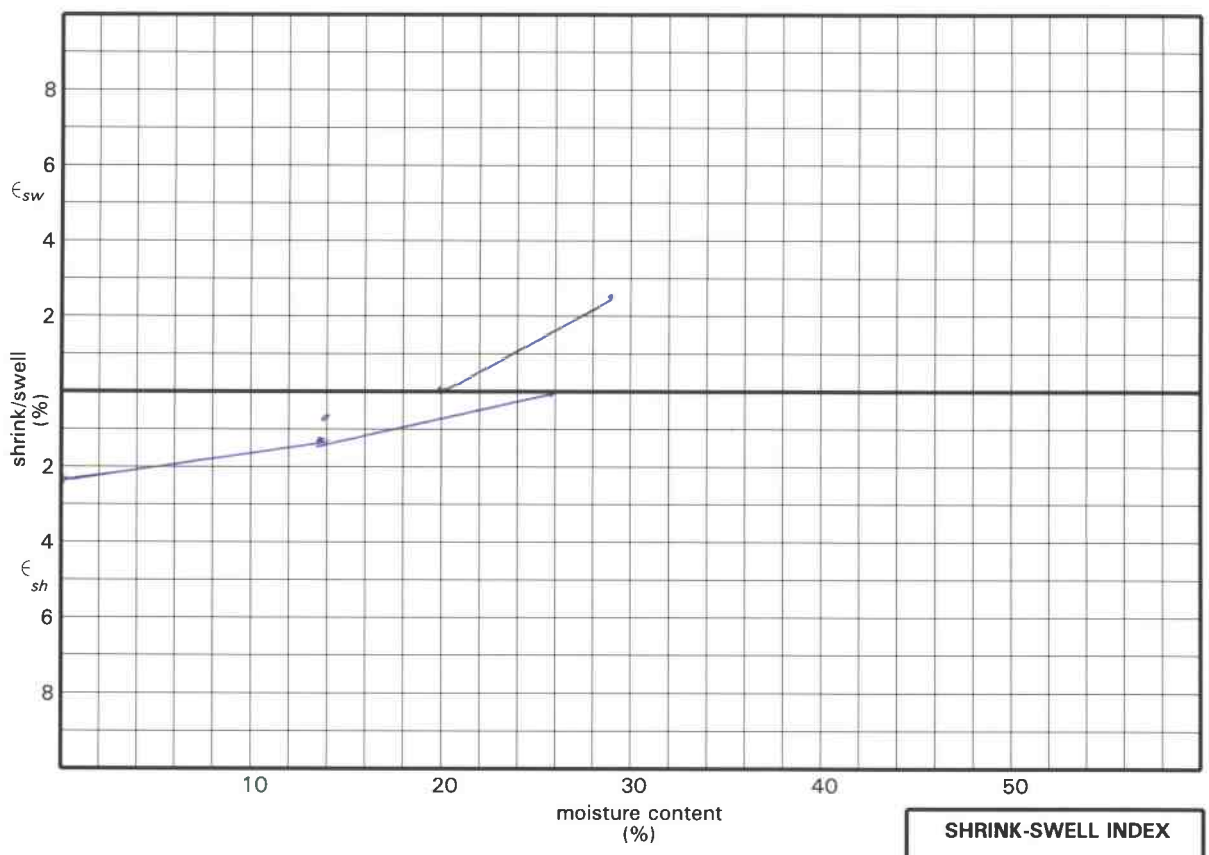
shrink swell index test

client : *Crighton Properties Pty Ltd*
job no : *GEOTKARI02083AA*
principal :
laboratory : *GOSFORD*
project : *Proposed Subdivison*
report date : *December 07, 2007*
location : *King Av, Terrigal*
test report no. : *DEC07-02/2*

test procedure : *AS1289.7.1.1*

borehole : *TP8* depth : *0.9-1.2* date tested : *30/11/07*
material classification : *(CH) Silty CLAY, high plasticity, grey with orange/brown mottling, trace of organic materials, roots(0.5-5mm diameter).*

SWELL TEST					SHRINK TEST			
swell on saturation (%)	moisture content (%)		estimated unconfined compressive strength (kPa)		shrink on drying %	estimated inert material present %	extent of crumbling during shrinkage	extent of cracking during shrinkage
	before test	after test	before test	after test				
2.6	*19.7*	*28.9*	*>400*	*250*	*2.3*	*<5%*	*Moderate*	*Minor ##*



SHRINK-SWELL INDEX
I_{ss} = *2.0* %

remarks: *#: Transverse & longituinal.*

NATA Accredited Laboratory No. 431
Approved Signatory: *Brian Miller*
Date : *7 December 2007*

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 17 Mt Penang Parklands, Kariong NSW 2250
Ph: (02) 4340 1811 Fax: (02) 4340 1411

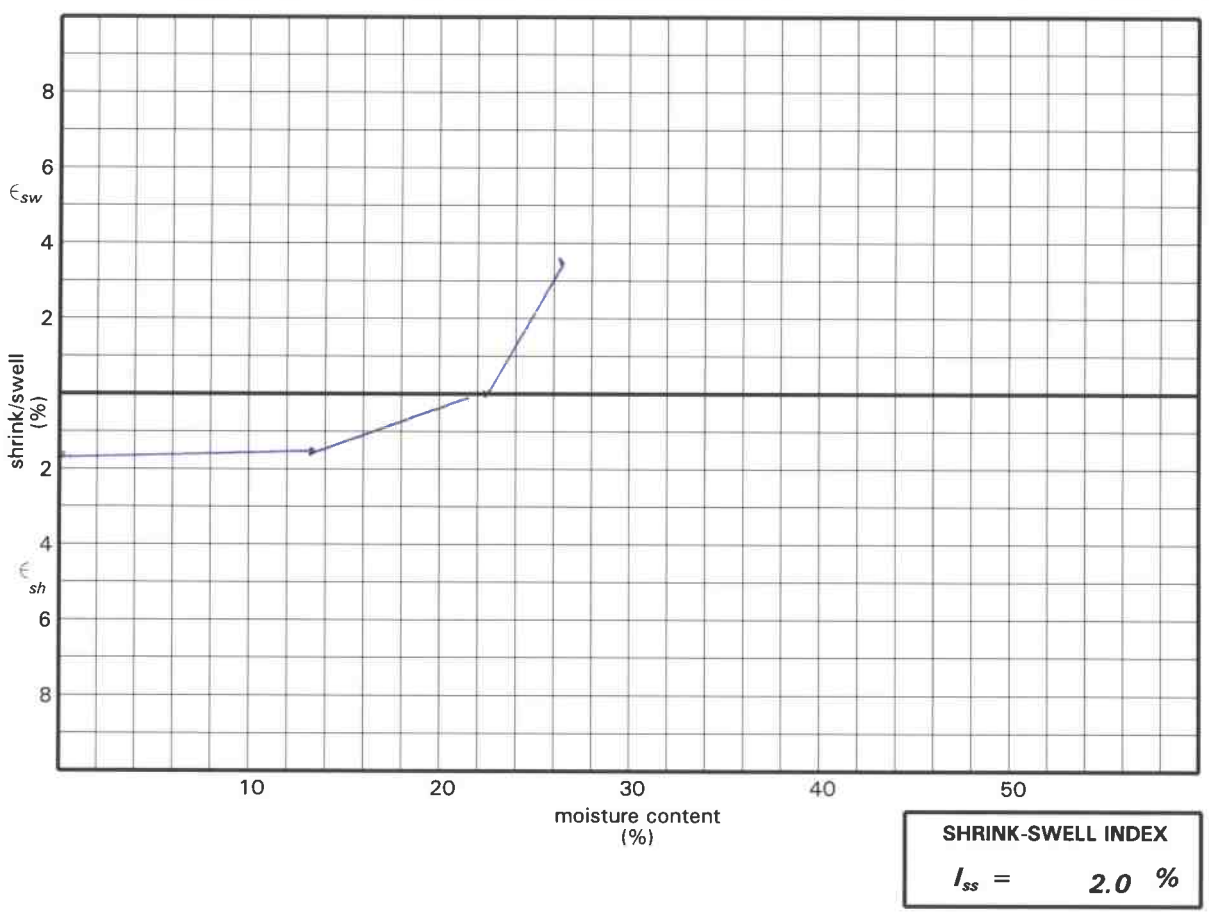
shrink swell index test

client : *Crighton Properties Pty Ltd*
job no : *GEOTKARI02083AA*
principal :
laboratory : *GOSFORD*
project : *Proposed Subdivison*
report date : *December 07, 2007*
location : *King Av, Terrigal*
test report no. : *DEC07-01/3*

test procedure : *AS1289.7.1.1*

borehole : *TP12* depth : *0.7-1.0* date tested : *30/11/07*
material classification :
(CL/CH) Silty sandy CLAY, medium plasicity, orange/brown, some fine to medium grained gravel.

SWELL TEST					SHRINK TEST			
swell on saturation (%)	moisture content (%)		estimated unconfined compressive strength (kPa)		shrink on drying %	estimated inert material present %	extent of crumbling during shrinkage	extent of cracking during shrinkage
	before test	after test	before test	after test				
3.7	*22.3*	*26.4*	*>400*	*330*	*1.7*	*<5%*	*Minor*	*Moderate #*



SHRINK-SWELL INDEX
I_{ss} = *2.0* %

remarks: *#: Transverse*

NATA Accredited Laboratory No. 431
Approved Signatory: *Brian Miller*
Date : *7 December 2007*

Appendix C

Copy of reports GO540/1-AB and GO652/1-AB

CRIGHTON PROPERTIES PTY LTD

PROPOSED SUBDIVISION
LOT 22 KARALTA ROAD, PART PORTION 104
TERRIGAL
GEOTECHNICAL ASSESSMENT

REPORT NO.GO540/1-AB MARCH, 1992

Coffey Partners International Pty Ltd

Consulting Engineers
in the Geotechnical Sciences

Coffey Partners International Pty Ltd
ACN 003 692 019

Consulting Engineers
in the geotechnical sciences

42 Hills Street
Gosford New South Wales
Australia 2250

Fax (043) 23 6477
Telephone (043) 23 3585

Your Reference

Our Reference GO540/1-AB MGD:SG

Date 13th March, 1992

The Manager
Crighton Properties Pty Ltd
26 Dalgetty Crescent
GREEN POINT NSW 2251

ATTENTION: MR GEOFFERY COX

Dear Sir

RE: Proposed Subdivision, Lot 22 Karalta Road, Terrigal

We are pleased to submit our report on geotechnical studies carried out for the above proposed subdivision.

The site is assessed to have a Moderate Risk of overall slope instability and is unlikely to be affected by landslip provided development is carried out in accordance with the recommendations of this report. Geotechnical constraints on residential development have been outlined in Section 4.2 and are not considered to be of an unusual nature.

Please do not hesitate to contact the undersigned if you have any queries regarding this report.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

R J KING

CONTENTS

1.0 INTRODUCTION

This report presents an assessment of slope stability carried out for Crighton Properties Pty Ltd on Lot 22 (Part Portion 104) Karalta Road, Terrigal. The work was commissioned by Mr Geoffery Cox of Crighton Properties Pty Ltd. A 1:900 scale contour plan of the lot was provided by Cahill & Cameron Pty Ltd.

It is understood that development plans have not been finalised for the site. However, it is understood to be likely that development will include residential allotments on moderately steep portions of the site, several large lakes with adjacent residential construction in low lying generally flat portions of the site and possibly terraced/split level units on the steeper portions of the site. It is also understood that roads are to be aligned generally across hillslopes on the steeper areas of the site.

This report assesses the suitability of the lot for development from a geotechnical viewpoint, provides a risk assessment in relation to slope stability and provides geotechnical constraints for development.

2.0 FIELDWORK

Field work initially involved a walk-over survey/site appraisal by a Senior Engineering Geologist on the 26th February, 1992, in which surface features were mapped. Utilising this information a program of test pitting was carried out on the 3rd March, 1992 by a Geotechnical Engineer to assess subsurface profiles.

Eleven test pits (TP1 to TP11) were excavated to depths ranging from 1.5m to 3.4m by a rubber tyred backhoe. The approximate location of the test pits is shown on Drawing No.GO540/1-1, together with the results of surface mapping. Test pit levels have been interpolated from the contour plan (A.H.D.).

Engineering Logs of the test pits are presented in Appendix A, together with explanation sheets defining the terms and symbols used.

Groundwater conditions were noted at the time of field work in test pits which were open only for a short time. Variations may occur due to fluctuations in rainfall, temperature and other factors.

3.0 SITE DESCRIPTION

3.1 Topography, Drainage & Vegetation

Topographically, the lot is situated in an area of moderate to steeply undulating terrain on the north-eastern end of a prominent south-west trending ridgeline. A secondary rounded spur/ridgeline forms the eastern site boundary.

Valley formation along two incised gullies has resulted in the existing site landform. Two prominent gullies originate at the upper slopes of the above ridgeline and fall to the north/north-east to join in the central part of the site. The combined watercourse discharges to the north of the site, into a broad flat watercourse that drains to the east towards Duffy's Road.

Valley side slopes across the site are convex in profile with surface slopes generally 10° over the upper slopes increasing up to 15° over the lower slopes. Surface slopes of 5° to 9° occur along the crest and upper slopes of the ridgeline that trends along the eastern lot boundary. The base of the above valley side slopes are characterised by;

* Flat alluvial areas of surface slope less than 3° adjacent to the watercourses across the central to northern part of the site. The transition from the valley side slopes to the flat alluvial areas is marked by a sharp concave slope break, or

* Steep gully side slopes ranging from 25° to 35°. The gullies are V-shaped in profile and are incised up to an estimated 5m to 6m in depth.

The site has been undersrcubbed with vegetation currently comprising mainly grasses with a sparse to moderate cover of mature eucalypts. The gullies and gully sides are generally covered with thick vegetation which includes palms and lantana.

Existing development on the site comprises a transmission easement along the eastern boundary and two small "farm" dams at the confluence of the two watercourses. The dams have been breached during recent heavy rain, most likely the result of piping at the contact between earth embankment and 600mm diameter concrete overflow pipes. A unformed section of Karalta Road runs along the northern site boundary.

3.2 Geology & Subsurface Conditions

Geologically, the site is situated in the Triassic Age Gosford Formation which is characterised by sandstone (often lithic) and siltstone rock types.

On the basis of surface features and subsurface conditions encountered in the test pits, the site can be divided into two units, namely

* UNIT A - comprising predominately residual soils overlying sandstone/siltstone rock at about 1m to 1.5m depth,

* UNIT B - comprising deep alluvial soils up to or greater than 3.5m in depth.

The approximate extent of the above units is shown on Drawing No.GO540/1-1.

The subsurface profile encountered within Unit A (Test Pits 1,2,3,5,6,7 and 11) can be summarised as follows;

* TOPSOIL: Comprising Silty SAND to depths ranging from 0.25m to 0.5m; fine to coarse grained, with some gravel, moist, overlying

* SLOPEWASH: Where encountered, comprising Gravelly Sandy CLAY of low plasticity and Gravelly Clayey SAND to depths generally of 0.5m and locally up to 0.9m, moist, overlying

* RESIDUAL: Comprising CLAY, Sandy CLAY and Gravelly Sandy CLAY to depths ranging from 1.1m to 2.0m, medium to high plasticity, with some sandstone rock fragments, estimated very stiff to hard consistency, overlying

* ROCK: Comprising SANDSTONE and SILTSTONE, extremely to highly weathered. Backhoe refusal on sandstone was encountered in Test Pits 1,5,6,7 and 11 at depths ranging from 1.5m to 2.8m.

The subsurface profile encountered within Unit B (Test Pits 4,8,9 and 10) can be summarised as follows;

* ALLUVIUM: Comprising interbedded Silty Clayey SAND, Clayey SAND and Sandy CLAY to depths up to or greater than 3.4m; sand mostly fine grained, clays are of low to medium plasticity, moist; overlying topsoil appears to be up to 0.5m thick.

Fill, probably from underscrubbing operations and comprising Gravelly Silty SAND mixed with timber and charcoal, was encountered at the crest of steep gully banks in Test Pits 4 and 9 to depths of 0.6m and 0.4m respectively.

Minor groundwater seepage/inflows was only encountered in Test Pit 10 at about 1.0m depth.

4.0 SLOPE STABILITY ASSESSMENT

4.1 Risk Assessment

No evidence of overall slope instability was observed during the walk-over survey and backhoe test pitting. Minor localised instability was noted along some very steep gully banks where small scale slumping and erosion has occurred.

On the basis of the features of geology, topography and drainage presented in Section 3.0, the site is assessed as having a Moderate Risk of overall slope instability as defined in the attached Table 1. The risk of localised instability associated with future cuts and fills is assessed as moderate and can be limited by adopting the recommendations of this report.

4.2 Geotechnical Constraints on Development

4.2.1 Area for Development

From a slope stability viewpoint, the entire site is considered suitable for development undertaken in accordance with good hillside construction practices and sound engineering principles as outlined in the attached Table 2.

There should be specific geotechnical investigation to assess local stability and foundation parameters for any proposed development along or adjacent to the steep to very steep gully banks. It is recommended that this constraint apply to the area situated within a line that projects upwards at 2H:1V (26.5°) from the toe of gully banks.

4.2.2 Type of Structure

Flexible structures of timber, brick veneer or similar construction would be preferred on the Unit A hillslopes. Development should be designed to accommodate natural slope profiles with split level or suspended designs so as to limit the need for slope modification.

There are no particular geotechnical constraints on the type of structures within the flat Unit B alluvial areas or for structures founded on rock on the Unit A hillslopes provided they are supported on footings designed and constructed in accordance with AS2870 "Residential Slabs and Footings".

4.2.3 Foundation Types

Foundations should be designed and constructed in accordance with the recommendations and advice of AS2870 "Residential Slabs and Footings".

Pad/strip or pier and beam footing systems are considered appropriate for split level structures on Unit A moderate to steep hillslopes. Stiffened raft or piered slab footing systems may also be adopted provided the resulting slope modifications comply with the geotechnical constraints set out below. It is recommended that foundations for structures on slopes in excess of 4H:1V (14°) be taken to rock.

Strip/pad, stiffened raft or piered footing systems would be appropriate for residential structures located within the flat Unit B alluvial areas. Further geotechnical work will be required to assess foundation parameters within Unit B areas for structures other than conventional one or two storey residences and for structures located adjacent to steep gully banks (Refer to 4.2.1).

4.2.4 Excavation

Within Unit B areas and Unit A areas with hillslopes less than 4H:1V (14°) excavations should preferably not exceed 1.5m depth and should be either supported by a properly designed and constructed retaining wall or battered no steeper than 2H:1V and protected from erosion. Within Unit A areas with hillslopes greater than 4H:1V (14°) excavations should preferably not exceed 1m depth.

Excavations exceeding the above recommended depths should be supported by engineer designed retaining walls or battered as directed after assessment by a qualified geotechnical engineer.

4.2.5 Filling

The maximum depth of fill on residential lots should preferably be limited to 1.5m and should be either supported by a properly designed and constructed retaining wall or battered no steeper than 2H:1V and protected from erosion.

Engineering supervision and testing will be required where fill is to be regarded as "controlled fill" in accordance with AS2870 "Residential Slabs and Footings". Allowance should be made for an average 0.5m depth of stripping within the flat Unit B alluvial areas and for a 0.2m to 0.4m depth of stripping within Unit A hillslope areas. A prepared surface will need to be benched/stepped into the natural slope when placing fills on slopes exceeding 4H:1V (14°). Fill should be placed in layers having a maximum loose thickness of 200mm to 300mm depending on the type of fill and compaction equipment. Each fill layer should be thoroughly and uniformly compacted to a minimum dry density ratio (AS1289 5.4.1-1982) of 95% Standard within 2% of Standard Optimum moisture content. Further advice should be sought if deep gully areas are to be infilled as higher compaction standards may be warranted.

Residual clay soils and weathered rock excavated during road construction would be suitable for use as fill on residential lots if placed at a moisture content within 2% of Standard Optimum. However, consideration should be given to the reactivity of clay fills in relation to potential shrink-swell movements. Further investigation and advice will be required to enable comment on the suitability of the above materials for use in water retaining embankments. As a guideline, such materials should have at least 30% passing the 75 micron sieve, a Plasticity Index not less than 15% and should be non-dispersive (Emerson Class 3 or better).

4.2.6 Retaining Walls

Retaining walls should be designed for surcharge loading from sloping ground and/or structures above the wall. Adequate subsurface and surface drainage must be provided behind all retaining walls. Retaining walls in excess of 1.5m in height should be designed by an engineer.

4.2.7 Access/Site Clearance

The subdivision layout should be such that all residential lots have potential driveway access at a grade of 4H:1V or less. Any required slope modifications should comply with the above recommendations.

4.2.8 Drainage & Sewerage Disposal

Stormwater should be prevented from ponding adjacent to structures. All collected stormwater runoff should be piped into a street or inter-allotment drainage system that discharges into existing watercourses in a controlled manner that limits erosion.

Domestic effluent should be connected to a reticulated sewerage system or to a pump-out septic system. There should be no on-site disposal of domestic effluent.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

Reprinted by Coffey Partners International Pty Ltd 1989

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT *

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by The Institution of Engineers Australia, National Headquarters, Canberra, 1987.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

Published by

ASFE THE ASSOCIATION OF ENGINEERING FIRMS PRACTICING IN THE GEOSCIENCES

8811 Colesville Road/Suite G106/Silver Spring, Maryland 20910/(301) 565-2733

Reprinted by Coffey Partners International Pty Ltd 1989

0788, 3M

TABLE 1. CLASSIFICATION OF RISK OF SLOPE INSTABILITY

ASSESSMENT OF RISK

A landslip (or landslide) is a downslope movement of a soil or rock mass as a result of shear failure at the boundaries of the moving mass. The dominant movement is lateral and failure takes place over a relatively short period. Soil creep, which is slow and occurs without a well defined failure surface, is not included as a landslip.

Natural hill slopes are formed by processes which reflect the site geology, environment and climate. These processes include downslope movement of the near surface soil and rocks; in geological time all slopes are unstable. The area of influence of these downslope movements may range from local to regional and are rarely related to property boundaries. The natural processes may be affected by human intervention in the form of construction and related activities.

It is not technically feasible to assess the stability of a particular site in absolute terms such as stable or unstable. However the degree of risk of slope movement can be assessed by the recognition of surface features supplemented by limited information on the regional and local subsurface profile and with the benefit of experience gained in similar geological environments. The degree of risk is categorised below.

CLASSIFICATION OF RISK OF LANDSLIP WITHOUT DEVELOPMENT

CLASS	EXPLANATION
LOW	A landslip is very unlikely
MODERATE	A landslip is unlikely
HIGH	There is some risk of a landslip

CONSEQUENCES OF HILLSIDE CONSTRUCTION

It must be accepted that the risks associated with hillside construction are greater than construction on level ground in the same geological environment. The impact of development may be adverse and imprudent construction techniques can increase the potential for movement.

Australian Standard AS 2870 - 1986 provides a damage classification that relates to essentially vertical movements of masonry walls and is thus not directly applicable to hillside movements. In the absence of a suitable classification for hillside movements the range of damage categories from negligible to very severe can be used as a general guide for damage potential related solely to landslip.

CLASS	DEVELOPMENT CONSTRAINTS	DAMAGE POTENTIAL EXTENT	DAMAGE POTENTIAL PROBABILITY
LOW	Good Hillside Practice	Slight	Very Low
MODERATE	Good Hillside Practice and site specific restrictions	Slight Moderate	Low Very Low
HIGH	No development unless major engineering remedial works	Moderate Severe	High Moderate

Damage to structures may occur due to a number of causes additional to that attributable to landslip. In the absence of a landslip slight damage might be expected even for good construction. If a landslip occurs damage would probably reach at least a moderate level.

	GOOD ENGINEERING PRACTICE	POOR ENGINEERING PRACTICE
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the Risk of Instability and Implications for Development in mind.	Plan development without regard for the Risk of Instability.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements.
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use and compact clean fill materials. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may become unstable. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOUNDATIONS	Support on or within rock where practicable. Use rows of piers or strip foundations oriented up and down slope. Design for lateral creep pressures. Backfill foundation excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide generous falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some low risk areas. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant.	
SITE VISITS	Site Visits by consultant may be appropriate during construction.	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident seek advice. If seepage observed, determine cause or seek advice on consequences.	

This table is an extract from GEOTECHNICAL RISKS ASSOCIATED WITH HILLSIDE DEVELOPMENT as presented in Australian Geomechanics News, Number 10, 1985 which discusses the matter more fully.

APPENDIX A

results of field investigation

descriptive terms soil and rock

Explanation · Sheet 1

SOIL DESCRIPTIONS

Classification of Material based on Unified Classification System (refer SAA Site Investigation Code AS1726–1975 Add. No. 1 Table D1).

Moisture Condition based on appearance of soil

dry	Looks and feels dry; cohesive soils usually hard, powdery or friable, granular soils run freely through hands.
moist	Soil feels cool, darkened in colour; cohesive soils usually weakened by moisture, granular soils tend to cohere, but one gets no free water on hands on remoulding.
wet	Soil feels cool, darkened in colour; cohesive soils weakened, granular soils tend to cohere, free water collects on hands when remoulding.

Consistency based on unconfined compressive strength (Qu) (generally estimated or measured by hand penetrometer).

term	very soft	soft	firm	stiff	very stiff	hard
Qu kPa		25	50	100	200 -	400

If soil crumbles on test without meaningful result, it is described as **friable.**

Density Index (generally estimated or based on penetrometer results).

term	very loose	loose	medium dense	dense	very dense
density index I_D %	15	35	65	85	

ROCK DESCRIPTIONS

Weathering based on visual assessment

term	criterion
Fresh:	Rock substance unaffected by weathering.
Slightly Weathered:	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Moderately Weathered:	Rock substance affected by weathering to the extent that staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Highly Weathered:	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and signs of chemical or physical decomposition of individual minerals are usually evident. Porosity and strength may be increased or decreased when compared to the fresh rock substance, usually as a result of the leaching or deposition of iron. The colour and strength of the original fresh rock substance is no longer recognisable.
Extremely Weathered:	Rock substance affected by weathering to the extent that the rock exhibits soil properties. i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.

Strength based on point load strength index, corrected to 50 mm diameter · Is(50) (refer I.S.R.M., Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1). (Generally estimated: x indicates test result).

classification	extremely low	very low	low	medium	high	very high	extremely high
Is (50) MPa	0.03	0.1	0.3	1	3	10	

The unconfined compressive strength is typically about 20 x I_{S50} but the multiplier may range, for different rock types, from as low as 4 to as high as 30.

Defect Spacing

classification	extremely close	very close	close	medium	wide	very wide	extremely wide
spacing m	0.03	0.1	0.3	1	3	10	

Defect description uses terms contained on AS1726 table D2 to describe nature of defect (fault, joint, crushed zone, clay seam (etc.) and character (roughness, extent, coating etc.).

Incorporated in NSW

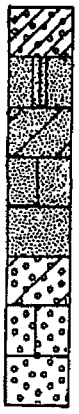
graphic symbols soil and rock

COFFEY

Explanation Sheet 2

SOIL

- Asphaltic Concrete or Hotmix
- Concrete
- Topsoil
- Fill
- Peat, Organic Clays and Silts (Pt, OL, OH)
- Clay (CL, CH)
- Silt (ML, MH)
- Sandy Clay (CL, CH)
- Silty Clay (CL, CH)

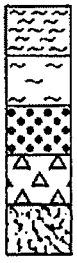


- Gravelly Clay (CL, CH)
- Sandy Silt (ML)
- Clayey Sand (SC)
- Silty Sand (SM)
- Sand (SP, SW)
- Clayey Gravel (GC)
- Silty Gravel (GM)
- Gravel (GP, GW)

ROCK

- Claystone (massive)
- Siltstone (massive)
- Shale (laminated)
- Sandstone (undifferentiated)
- Sandstone, fine grained
- Sandstone, coarse grained
- Conglomerate

- Limestone
- Coal
- Dolerite, Basalt
- Tuff
- Porphyry
- Granite
- Pegmatite



- Schist
- Gneiss
- Quartzite
- Talus
- Alluvium

SEAMS

Seam >0.1 m thick (on a scale 1:50)

Seam 0.01 m to 0.1 m thick (on a scale 1:50)

INCLUSIONS (Special purposes only)

- Rock Fragments
- Swamp

- Ironstone Gravel, Laterite
- Shale Breccia in Sandstone

Water Level

Surfaces ——— Known Boundary — — — Probable Boundary ——?——? Possible Boundary

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP1
sheet 1 of 1

office job no: GOSFORD GO540/1

client: CRIGHTON PROPERTIES PTY LTD
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104 KARALTA ROAD, TERRIGAL
pit location: REFER TO DRAWING NO.GO540/1-1

pit commenced: 02/03/92
pit completed: 02/03/92
logged by: SGF
checked by: RJK

equipment type and model: MF 50D Backhoe
excavation dimensions: 3.0m long, 0.6 m wide

R.L. surface: Approx. 22 m
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED				SM	SILTY SAND, fine to coarse, black, some fine to coarse gravel	M			TOPSOIL
					1		CL	GRAVELLY SANDY CLAY, medium plasticity, brown, sand mostly fine, fine to coarse gravel	M > Wp	VSt		RESIDUAL One floating boulder and some cobbles
										VSt/H		
								SANDSTONE, coarse grained, orange stained yellow				ROCK - extremely weathered
					2			TP1 terminated at 1.7m depth.				
					3							
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 cm 75 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP2
sheet 1 of 1

office job no: GOSFORD G0540/1

client: ORIGHTON PROPERTIES PTY LTD
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104 KARALTA ROAD, TERRIGAL
pit location: REFER TO DRAWING NO.G0540/1-1

pit commenced: 02/03/92
pit completed: 02/03/92
logged by: SGF
checked by: RJK

equipment type and model: MF 50D Backhoe
excavation dimensions: 3.0 m long, 0.6 m wide

R.L. surface: Approx. 25 m
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 kPa 200 300 400	structure and additional observations
BH		NIL	NONE ENCOUNTERED		0		SM	GRAVELLY SILTY SAND, fine to coarse, black, fine to coarse gravel becoming	M			TOPSOIL
							CL	GRAVELLY SANDY CLAY, low plasticity, brown-grey, fine sand				SLOPEWASH
							CL/CH	CLAY/SANDY CLAY, high plasticity, orange-brown, some red staining, sand fine, trace to some fine to coarse gravels	M > Wp	H		RESIDUAL
					1			SILTY CLAY/SILTSTONE, low plasticity, white & red	M	Fb		ROCK Extremely weathered -some rock structure becoming rock
					2			TP2 terminated at 1.9m depth (refusal on highly weathered siltstone).				
					3							
					4							

key
\ natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 76 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP3
sheet 1 of 1

office job no: GOSFORD G0540/1

client: CRIGHTON PROPERTIES PTY LTD
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104 KARALTA ROAD, TERRIGAL
pit location: REFER TO DRAWING NO.G0540/1-1

pit commenced: 02/03/92
pit completed: 02/03/92
logged by: SGF
checked by: RJK

equipment type and model: MF 50D Backhoe
excavation dimensions: 3.0 m long, 0.6 m wide

R.L. surface: Approx. 45 m
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	depth m	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		NIL	NONE ENCOUNTERED		0		SM	GRAVELLY SILTY SAND, fine to coarse, black, fine to coarse gravel	M			TOPSOIL
							CL	GRAVELLY SANDY CLAY, low plasticity, grey-brown, fine to coarse gravel				SLOPEWASH
							CL/CH	CLAY, medium to high plasticity, yellow, some silt /fine sand	M > Wp	VSt		RESIDUAL Numerous large tree roots
					1			CLAY, as above but becoming red-brown mottled yellow-white		H		
								SILTSTONE, white with red and orange staining	M	H/Fb		ROCK Extremely weathered
					2					Fb		ROCK Extremely to highly weathered
								TP3 terminated at 2.2m depth.				
					3							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil

penetration 1 2 3
no resistance
ranging to refusal

water
10 Jan 76 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP4
sheet 1 of 1

office job no: GOSFORD GO540/1

client: CRIGHTON PROPERTIES PTY LTD
pit commenced: 02/03/92
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104
KARALTA ROAD, TERRIGAL
pit completed: 02/03/92
pit location: REFER TO DRAWING NO.GO540/1-1
logged by: SGF
checked by: RJK

equipment type and model: MF 50D Backhoe
R.L. surface: Approx. 23 m
excavation dimensions: m long, 0.6 m wide
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	100 200 300 400 kPa hand penetrometer	structure and additional observations
BH		NIL	NONE ENCOUNTERED				SM	GRAVELLY SILTY SAND, fine to coarse, black	M			TOPSOIL/FILL -with pieces of timber, charcoal, rock and clay
					1		SC	SILTY CLAYEY SAND, mostly fine, brown, low plasticity				ALLUVIUM
					2		SC/CL	SILTY CLAYEY SAND, brown and grey mottled becoming locally sandy CLAY, low plasticity				
					3		SC	CLAYEY SAND, fine to medium, mottled grey with black silty/ charcoal inclusions		Fb		Some weakly cemented structure below 2.7m depth.
					4			TP4 terminated at 3.2m depth.				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B buildozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil

penetration 1 2 – no resistance ranging to refusal

water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP5
sheet 1 of 1

office job no: GOSFORD G0540/1

client: CRIGHTON PROPERTIES PTY LTD
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104 KARALTA ROAD, TERRIGAL
pit location: REFER TO DRAWING NO.G0540/1-1

pit commenced: 02/03/92
pit completed: 02/03/92
logged by: SGF
checked by: RJK

equipment type and model: MF 50D Backhoe
excavation dimensions: 3.0 m long, 0.6 m wide

R.L. surface: Approx. 53 m
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	depth m metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED		0		SM	SILTY SAND, mostly fine, black, gravel fine to coarse	M			TOPSOIL
							SC	GRAVELLY CLAYEY SAND, brown				SLOPEWASH
							CL	CLAY, medium plasticity, orange-brown, some fine sand and fine to coarse gravel increasing with depth	M > Wp	H		RESIDUAL
					1					VSt		Some rock structure below 0.9m depth
								SILTY SANDSTONE, pale grey-white,		Fb		ROCK Extremely to highly weathered
								TP5 terminated at 1.5m (practicle refusal on highly weathered SILTY SANDSTONE).				
					2							
					3							
					4							

Key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP6
sheet 1 of 1

office job no: GOSFORD GO540/1

client:	CRIGHTON PROPERTIES PTY LTD	pit commenced:	02/03/92
	PROPOSED SUBDIVISION, LOT 22 PART PORTION 104	pit completed:	02/03/92
project:	KARALTA ROAD, TERRIGAL	logged by:	SGF
pit location:	REFER TO DRAWING NO.GC540/1-1	checked by:	RJK

equipment type and model: MF 50D Backhoe — R.L. surface: Approx. 37 m
excavation dimensions: 3.0m long, 0.6 m wide — datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED				SM	SILTY SAND, mostly fine, trace of gravel, black -becoming- grey-brown, clayey and gravelly	M			TOPSOIL SLOPEWASH
					1		CL/CH	SANDY CLAY, medium to high plasticity, orange-brown, sandy mostly fine, some fine to coarse gravel	M > Wp	H		RESIDUAL Some large sandstone boulders
					2			SANDY CLAY/SILTSTONE-SANDSTONE, fine grained, red-orange & grey white mottling	M	Fb		RESIDUAL/ROCK Extremely weathered
								SILTSTONE, white with red-orange staining, massive, clayey, trace of fine sand				ROCK Extremely weathered
					3			SANDSTONE, coarse, yellow stained white				ROCK Highly weathered
								TP6 terminated at 2.8m depth (refusal on sandstone).				
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP7
sheet 1 of 1

office job no: GOSFORD GO540/1

client:	CRIGHTON PROPERTIES PTY LTD	pit commenced:	02/03/92
project:	PROPOSED SUBDIVISION, LOT 22 PART PORTION 104 KARALTA ROAD, TERRIGAL	pit completed:	02/03/92
pit location:	REFER TO DRAWING NO.GO540/1-1	logged by:	SGF
		checked by:	RJK

equipment type and model: MF 50D Backhoe
R.L. surface: Approx. 26 m
excavation dimensions: 3.0m long, 0.6 m wide
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED				SM	SILTY SAND, mostly fine, black, some gravel with depth	M			TOPSOIL
							SC/CL	CLAYEY SAND/SANDY CLAY, fine, low plasticity, brown, local gravel				SLOPEWASH
					1		CH	SANDY CLAY, medium plasticity, red-orange and brown mottled, fine to medium becoming gravelly with depth	M > Wp	VSt		RESIDUAL With increasing number of sandstone boulders.
					2			SANDSTONE, medium to coarse, yellow	M			ROCK Highly weathered
								TP7 terminated at 2.1m depth (refusal on sandstone).				
					3							
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil

penetration 1 2 3 — no resistance ranging to refusal

water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP8
sheet 1 of 1

office job no: GOSFORD G0540/1

client:	CRIGHTON PROPERTIES PTY LTD	pit commenced:	02/03/92
project:	PROPOSED SUBDIVISION, LOT 22 PART PORTION 104 KARALTA ROAD, TERRIGAL	pit completed:	02/03/92
		logged by:	SGF
pit location:	REFER TO DRAWING NO.G0540/1-1	checked by:	RJK

equipment type and model: MF 50D Backhoe — R.L. surface: Approx.22.5m

excavation dimensions: 3.0 m long, 0.6 m wide — datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED		1		SC	SILTY CLAYEY SAND, fine, grey at first becoming brown, low plasticity	M			ALLUVIUM
							SC/CL	CLAYEY SAND/SANDY CLAY, as above but becoming locally sandy clay, mottled grey and brown,	(M > Wp)			
					2		CL	SANDY CLAY, low plastiicty, mottled orange-red and brown-grey		Fb		
					3							small black carbonaceous inclusions, possibly charcoal
								TP8 terminated at 3.4m depth.				
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP9
sheet 1 of 1

office job no: GOSFORD GO540/1

client: CRIGHTON PROPERTIES PTY LTD
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104
pit location: KARALTA ROAD, TERRIGAL
REFER TO DRAWING NO.GO540/1-1

pit commenced: 02/03/92
pit completed: 02/03/92
logged by: SGF
checked by: RJK

equipment type and model: MF 50D Backhoe
excavation dimensions: 3.0 m long, 0.6 m wide

R.L. surface: Approx. 20 m
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	100 200 300 400 kPa hand penetrometer	structure and additional observations
BH		NIL	NONE ENCOUNTERED		0		SM	SILTY SAND, mostly fine, dark grey- brown	M			TOPSOIL/ FILL
								SILTY SAND, fine, grey-brown, some clay				ALLUVIUM
					1		SP/SC	SAND, fine, yellow-grey, some silt/clay fines	D/M	Fb		
							SC	CLAYEY SAND, as above but increased clay fines and with brown mottles	M			
					2		CL	SANDY CLAY, medium plasticity, mottled grey and brown-orange, mostly fine sand	M > Wp	St/ VSt		
					3			TP9 terminated at 2.9m depth.				
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support: T timbering, N nil
penetration: 1 2 3 — no resistance ranging to refusal
water: 10 Jan 73 water level on date shown; water inflow; water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP11
sheet 1 of 1

office job no: GOSFORD G0540/1

client:	CRIGHTON PROPERTIES PTY LTD	pit commenced:	02/03/92
	PROPOSED SUBDIVISION, LOT 22 PART PORTION 104	pit completed:	02/03/92
project:	KARALTA ROAD, TERRIGAL	logged by:	SGF
pit location:	REFER TO DRAWING NO.G0540/1-1	checked by:	RJK

equipment type and model: MF 50D Backhoe
R.L. surface: Approx. 27 m
excavation dimensions: 3.0 m long, 0.6 m wide
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth m	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED				SM	SILTY SAND, mostly fine, black, some gravel	M			TOPSOIL with sandstone boulders
					1		CL	GRAVELLY SANDY CLAY, medium plasticity, red-orange, fine to coarse sand and gravel	M > Wp	H		RESIDUAL Sandy clay with sandstone boulders
								SANDSTONE, medium to coarse grained, brown stained yellow	M			ROCK Highly weathered
					2			TP11 terminated at 1.6m depth (refusal on sandstone).				
					3							
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests.
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP10
sheet 1 of 1

office job no: GOSFORD G0540/1

client: CRIGHTON PROPERTIES PTY LTD
pit commenced: 02/03/92
pit completed: 02/03/92
project: PROPOSED SUBDIVISION, LOT 22 PART PORTION 104
KARALTA ROAD, TERRIGAL
logged by: SGF
pit location: REFER TO DRAWING NO.G0540/1-1
checked by: RJK

equipment type and model: MF 50D Backhoe
R.L. surface: Approx.23.5m
excavation dimensions: 3.0 m long, 0.6 m wide
datum: AHD

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		NIL					SM	SILTY SAND, mostly fine, black becoming dark grey, some fine to coarse gravel	M			TOPSOIL/SLOPEWASH
												ALLUVIUM
					1		SC/CL	CLAYEY SAND/SANDY CLAY, low plasticity, mostly fine, mottled brown-grey	M/W			minor inflow
									M	VSt/St		
								—becoming				
					2		CL	SANDY CLAY, medium plasticity, mottled grey and red-brown, some gravel	M > Wp			
					3			TP10 terminated at 3.0m depth.				
					4							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
OT diatube

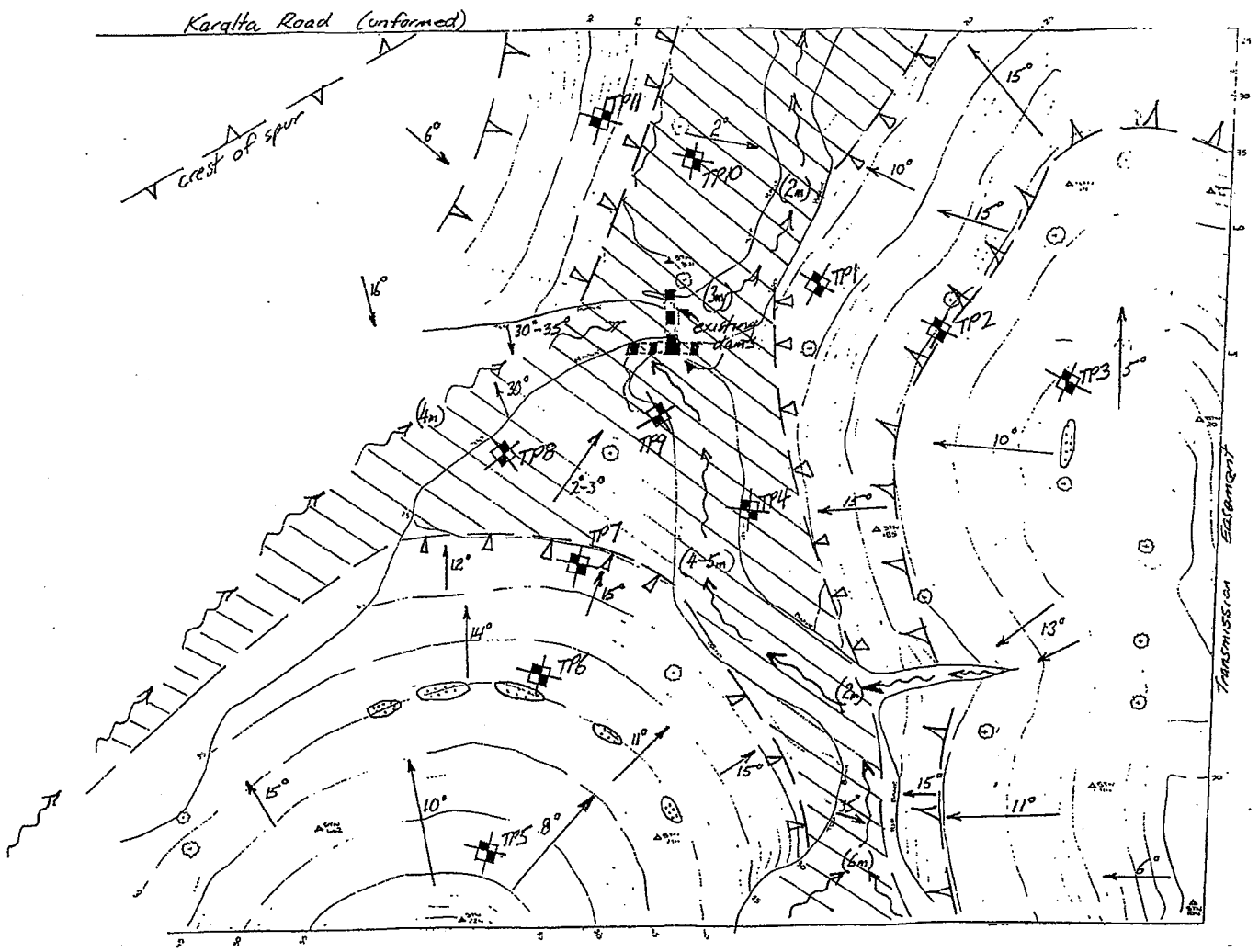
support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

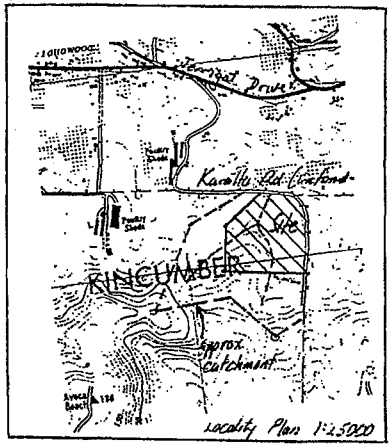
notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
N: SPT with solid cone
V vane shear
P pressuremeter
Bs bulk sample
R refusal

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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense





LEGEND

- Approximate location of test pit
- 10° direction and fall of ground surface
- (2m) Watercourse (estimated depth of incision in metres)
- Sharp concave slope change
- Rounded convex slope change
- Sandstone outcrop
- approximate extent of Unit B areas (Unit A areas are unhatched)

Coffey Partners International Pty Ltd Consulting Engineers in the geotechnical sciences
Incorporated in NSW

scale (metres) 20 0 20 40 60 80 100

revision	description	drawn	approved	date

drawn	RJK
checked	
date	13·2·92

CRIGHTON PROPERTIES PTY LTD
PROPOSED SUBDIVISION
LOT 22 OF PART PORTION 104 KARALTA ROAD
TERRIGAL
SITE PLAN

COFFEY

drawing no. G0540/1-1
job no. G0540/1

CRIGHTON PROPERTIES PTY LTD
PROPOSED SUBDIVISION
LOT 2 BELAR AVENUE, TERRIGAL

STABILITY ASSESSMENT

REPORT NO GO652/1-AB 7 MAY 1993

Coffey Partners International Pty Ltd

Consulting Engineers
in the Geotechnical Sciences

Coffey Partners International Pty Ltd
A.C.N. 003 692 019

Consulting Engineers
in the geotechnical sciences

42 Hills Street
Gosford New South Wales
Australia 2250

Fax (043) 23 6477
Telephone (043) 23 3585

Your Reference

Our Reference GO652/1-AB BAS:EB

Date 6 May 1993

The Manager
Crighton Properties Pty Ltd
28 Dalgetty Crescent
GREEN POINT NSW 2251

ATTENTION: MR GEOFFREY COX

Dear Sir

RE: PROPOSED SUBDIVISION - LOT 2 BELAR AVENUE, TERRIGAL

We are please to submit our report on geotechnical studies carried out for the above proposed subdivision.

The site is assessed to have a Medium Risk of overall slope instability and is unlikely to be affected by landslip provided development is carried out in accordance with the recommendations of this report. Geotechnical constraints on residential development have been outlined in Section 4.2.

Please do not hesitate to contact the undersigned should you have any queries regarding this report.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

B A STEPHENS

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents an assessment of slope stability carried out for Crighton Properties Pty Ltd on Lot 2 Belar Avenue, Terrigal. The work was commissioned by Mr Geoffrey Cox of Crighton Properties Pty Ltd. A 1:1000 scale contour plan of the lot was provided by Cahill & Cameron Pty ltd.

It is understood that development plans have not been finalised for the site. However, it is understood the proposed development is to comprise approximately 60 residential allotments. It is understood from the supplied drawings that the roads are to be aligned generally across the hillslopes in the steeper sections of the site.

This report assesses the suitability of the lot for development from a geotechnical viewpoint, provides a risk assessment in relation to slope stability and provides geotechnical constraints for development.

2.0 FIELDWORK

Fieldwork involved a walk over assessment, surface mapping and a program of test pitting to assess surface features and subsurface profiles. This work was carried out on the 4th May, 1993 by a Geotechnical Engineer from this Company.

Fourteen test pits (TP1 to TP14) were excavated to depths ranging from 0.6m to 3.3m by a rubber tyred backhoe. The locations of the test pits are shown on Drawing No. GO652/1-1, together with the results of the surface mapping. Test pit levels have been interpolated from the contour plan provided. The test pits were located by Cahill & Cameron Pty Ltd.

Engineering logs of the test pits are presented in Appendix A, together with explanation sheets defining the terms and symbols used in their preparation.

3.0 SITE DESCRIPTION

3.1 Topography, Drainage and Vegetation

Lot 2 occupies an "L" shaped area of approximately eight hectares. Topographically, the site comprises a valley with a generally north-west to north aspect. The terrain is moderate to steeply sloping around the central drainage depression which crosses the site in a north-westerly direction. A northerly trending spur is located in the west of the site adjacent to the western boundary.

Groundslopes at the site vary from about 3° to 7° to the horizontal near the drainage depression, to 15° to 18° to the horizontal in the higher slopes. The contour plan provided shows the site elevation to vary from about RL22m AHD in the north of the site to greater than RL70m in the south of the site.

The area of the proposed residential development is generally open and well grassed, with the exception of an area to the east of the site and on a northerly facing slope towards the centre of the site where these areas are moderately wooded. Heavily wooded areas with thick undergrowth, generally corresponding to the steeper areas, are located on the properties adjoining the site.

Existing development comprises a dwelling and horse stable located in the north-east of the site. Cuts of up to 3m are located to the east of the above structures. The horse stable appears to be founded partly on fill materials won from these cuts.

Access to the site is via a dirt track from the end of Belar Avenue located to the north. This track appears to have been formed by cutting and filling and runs across the slope of the hill.

Other man made features on the site include an existing farm dam located near the centre of the northern boundary.

3.2 Geology and Subsurface Conditions

The 1:25000 Geological Map of Gosford indicates the site to be underlain by lithic-quartz to quartz sandstone, siltstone, minor sedimentary breccia, claystone and conglomerate of the Terrigal Formation.

On the basis of the surface features and the subsurface conditions encountered in the test pits, the site can be divided into two units, namely;

- Unit A - Comprising predominantly slopewash and residual soils overlying sandstone/siltstone rock at about 0.7m to 1.7m depth; and
- Unit B - Comprising alluvial soils up to or greater than 2.4m in depth, overlying deeply weathered residual soils to depths in excess of 3.3m.

The approximate extent of the above units is shown on Drawing No. GO652/1-1.

The subsurface profile encountered in Unit A (Test Pits 3 to 14) can be summarised as follows;

TOPSOIL/SLOPEWASH: Comprising Silty Sand, fine to medium grained, light grey and grey, some roots, observed unit depth varied from 0.2m to 0.8m; overlying

RESIDUAL:	CLAY, medium plasticity, orange brown and red brown, very stiff, observed unit thickness varied from 0 to 1.3m; overlying
BEDROCK:	SANDSTONE and SILTSTONE, extremely to highly weathered. Backhoe refusal on sandstone was encountered in Test Pits 4, 6 to 10 and 12 to 14.

The subsurface profile encountered within Unit B (Test Pits 1 and 2) can be summarised as follows;

TOPSOIL:	Silty SAND, fine to medium grained, light grey to grey, some roots, observed unit thickness varied from 0.2m to 0.3m; overlying
SLOPEWASH/ALLUVIUM:	Clayey SAND/Sandy CLAY, fine to medium grained, medium plasticity, orange brown and red brown, observed unit thickness varied from 0.7m to 1.6m; overlying
RESIDUAL:	CLAY, medium plasticity, red brown, orange brown and light grey, observed unit thickness was approximately 1m; overlying
BEDROCK:	SANDSTONE, fine to coarse grained, extremely to highly weathered, orange brown and red brown. Bedrock was encountered at depths between 2.0m to greater than 3.3m.

No groundwater inflows were observed during the test pitting. It should be noted that pits were open only for a short time and variations may occur due to fluctuations in rainfall, temperature and other factors.

4.0 SLOPE STABILITY ASSESSMENT

4.1 Risk Assessment

No evidence of overall slope instability was observed during the walk over assessment and backhoe test pitting. Minor localised instability was observed in steep cuts upslope of the horse stable where slumping appears to have occurred.

On the basis of the features of geology, topography and drainage presented in Section 3.0, the site is assessed as having a Medium Risk of overall slope instability as defined in the attached Table 1. The risk of localised instability associated with future cuts and fills in assessed as moderate and can be limited by adopting the recommendations of this report.

4.2 Geotechnical Constraints on Development

4.2.1 Area for Development

From a slope stability viewpoint, the entire site is considered suitable for development undertaken in accordance with good hillside construction practices and sound engineering principles as outline in the attached Table 2.

4.2.2 Type of Structure

Flexible structures of timber, brick veneer or similar construction would be preferred on the Unit A hillslopes. Development should be designed to accommodate natural slope profiles with split level or suspended designs so as to limit the need for slope modification.

There are no particular geotechnical constraints on the type of structures within the flat Unit B alluvial area or for structures founded on rock on the Unit A hillslopes, provided they are supported on footings designed and constructed in accordance with AS2870 "Residential Slabs and Footings".

4.2.3 Foundation Types

Foundations should be designed and constructed in accordance with the recommendations and advice of AS2870 "Residential Slabs and Footings".

Further site specific assessment will be required to assess foundation characteristics within the Unit B alluvial soils. In particular, shrink-swell potential of these soils should be addressed due to the thickness of alluvial and residual soils.

Pad/strip or pier and beam footing systems are considered appropriate for split level structures on Unit A moderate to steep hillslopes. Stiffened raft or piered slab footing systems may also be adopted provided the resulting slope modifications comply with the geotechnical constraints set out below. It is recommended that foundations for structures on slopes in excess of 4H:1V (14^0) be taken to rock.

Strip/pad, stiffened raft or piered footing systems would be appropriate for residential structures located within the flat Unit B alluvial areas.

4.2.4 Excavation

Excavations in soil should preferably not exceed 1.0m depth and battered no steeper than 2H:1V and protected from erosion. Excavations greater than 1.0m should be supported by a properly designed and constructed retaining wall.

Excavations exceeding the above recommended depths should be supported by engineer designed retaining walls or battered as directed after assessment by a qualified Geotechnical Engineer.

4.2.5 Filling

The maximum depth of fill on residential lots should preferably be limited to 1.0m and battered no steeper than 2H:1V and protected from erosion. Filling greater than 1.0m should be supported by a properly designed and constructed retaining wall.

Engineering supervision and testing will be required where fill is to be regarded as "controlled fill" in accordance with AS2870 "Residential Slabs and Footings". Allowance should be made for an average 0.5m depth of stripping within the flat Unit B alluvial areas and for a 0.2m to 0.4m depth of stripping within Unit A hillslope areas. A prepared surface will need to be benched/stepped into the natural slope when placing fills on slopes exceeding 4H:1V (14^0). Fill should be placed in layers having a maximum loose thickness of 200mm to 300mm depending on the type of fill and compaction equipment. Each fill layer should be thoroughly and uniformly compacted to a minimum dry density ratio (AS1289 5.4.1-1982) of 95% Standard within 2% of Standard Optimum moisture content.

Residual clay soils and weathered rock excavated during road construction would be suitable for use as fill on residential lots if placed at a moisture content within 2% of Standard Optimum. However, consideration should be given to the reactivity of clay fills in relation to potential shrink-swell movements.

4.2.6 Retaining Walls

Retaining walls should be designed for surcharge loading from sloping ground and/or structures above the wall. Adequate subsurface and surface drainage must be provided behind all retaining walls. Retaining walls in excess of 1.0m in height should be designed by an engineer.

4.2.7 Access/Site Clearance

The subdivision layout should be such that all residential lots have potential driveway access at a grade of 4H:1V or less. Any required slope modifications should comply with the above recommendations.

4.2.8 Drainage and Sewerage Disposal

Stormwater should be prevented from ponding adjacent to structures. All collected stormwater runoff should be piped into a street or inter-allotment drainage system that discharges into existing watercourses in a controlled manner that limits erosion.

Domestic effluent should be connected to a reticulated sewerage system or to a pump-out septic system. There should be no on-site disposal of domestic effluent.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation, or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership; or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts.Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

about the potential for hazardous materials existing at the site. The equipment, techniques, and personnel used to perform a geoenvironmental exploration differ substantially from those applied in geotechnical engineering. Contamination can create major risks. If you have no information about the potential for your site being contaminated, you are advised to speak with your geotechnical consultant for information relating to geoenvironmental issues.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid misinterpretations, retain your geotechnical engineer to work with other project design professionals who are affected by the geotechnical report. Have your geotechnical engineer explain report implications to design professionals affected by them, and then review those design professionals' plans and specifications to see how they have incorporated geotechnical factors. Although certain other design professionals may be familiar with geotechnical concerns, none knows as much about them as a competent geotechnical engineer.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE REPORT *

Geotechnical engineers develop final boring logs based upon their interpretation of the field logs (assembled by site personnel) and laboratory evaluation of field samples. Geotechnical engineers customarily include only final boring logs in their reports. Final boring logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes, and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use. (If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared and that developing construction cost estimates was not one of the specific purposes for which it was prepared. In other words, while a contractor may gain important knowledge from a report prepared for another party, the contractor would be well-advised to discuss the report with your geotechnical engineer and to perform the additional or alternative work that the contractor believes may be needed to obtain the data specifically appropriate for construction cost estimating purposes.) Some clients believe that it is unwise or unnecessary to give contractors access to their geotechnical engineering reports because they hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems. It also helps reduce the adversarial attitudes that can aggravate problems to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical engineers. To help prevent this problem, geotechnical engineers have developed a number of clauses for use in their contracts, reports, and other documents. Responsibility clauses are not exculpatory clauses designed to transfer geotechnical engineers' liabilities to other parties. Instead, they are definitive clauses that identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report. Read them closely. Your geotechnical engineer will be pleased to give full and frank answers to any questions.

RELY ON THE GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE

Most ASFE-member consulting geotechnical engineering firms are familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a construction project, from design through construction. Speak with your geotechnical engineer not only about geotechnical issues, but others as well, to learn about approaches that may be of genuine benefit. You may also wish to obtain certain ASFE publications. Contact a member of ASFE of ASFE for a complimentary directory of ASFE publications.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987.

ASFE THE ASSOCIATION OF ENGINEERING FIRMS PRACTICING IN THE GEOSCIENCES
8811 COLESVILLE ROAD/SUITE G106/SILVER SPRING, MD 20910
TELEPHONE: 301/565-2733 FACSIMILE: 301/589-2017

DEC0592/3 5M

descriptive terms soil and rock

Explanation Sheet 1

SOIL DESCRIPTIONS

Classification of Material based on Unified Classification System (refer SAA Site Investigation Code AS1726–1975 Add. No. 1 Table D1).

Moisture Condition based on appearance of soil

dry	Looks and feels dry; cohesive soils usually hard, powdery or friable, granular soils run freely through hands.
moist	Soil feels cool, darkened in colour; cohesive soils usually weakened by moisture, granular soils tend to cohere, but one gets no free water on hands on remoulding.
wet	Soil feels cool, darkened in colour; cohesive soils weakened, granular soils tend to cohere, free water collects on hands when remoulding.

Consistency based on unconfined compressive strength (Qu) (generally estimated or measured by hand penetrometer).

term	very soft	soft	firm	stiff	very stiff	hard
Qu kPa	25	50	100	200	400	

If soil crumbles on test without meaningful result, it is described as **friable.**

Density Index (generally estimated or based on penetrometer results).

term	very loose	loose	medium dense	dense	very dense
density index I_D %	15	35	65	85	

ROCK DESCRIPTIONS

Weathering based on visual assessment

term	criterion
Fresh:	Rock substance unaffected by weathering.
Slightly Weathered:	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Moderately Weathered:	Rock substance affected by weathering to the extent that staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Highly Weathered:	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and signs of chemical or physical decomposition of individual minerals are usually evident. Porosity and strength may be increased or decreased when compared to the fresh rock substance, usually as a result of the leaching or deposition of iron. The colour and strength of the original fresh rock substance is no longer recognisable.
Extremely Weathered:	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.

Strength based on point load strength index, corrected to 50 mm diameter - $I_S(50)$ (refer I.S.R.M., Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1). (Generally estimated: x indicates test result).

classification	extremely low	very low	low	medium	high	very high	extremely high
I_S (50) MPa	0.03	0.1	0.3	1	3	10	

The unconfined compressive strength is typically about 20 x I_{S50} but the multiplier may range, for different rock types, from as low as 4 to as high as 30.

Defect Spacing

classification	extremely close	very close	close	medium	wide	very wide	extremely wide
spacing m	0.03	0.1	0.3	1	3	10	

Defect description uses terms contained on AS1726 table D2 to describe nature of defect (fault, joint, crushed zone, clay seam (etc.) and character (roughness, extant, coating etc.):

Coffey Partners International Pty Ltd
Incorporated in NSW

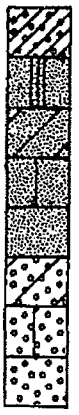
graphic symbols soil and rock

COFFEY

Explanation
Sheet 2

SOIL

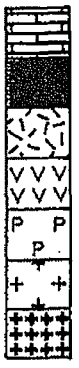
Asphaltic Concrete or Hotmix
Concrete
Topsoil
Fill
Peat, Organic Clays and Silts (Pt, OL, OH)
Clay (CL, CH)
Silt (ML, MH)
Sandy Clay (CL, CH)
Silty Clay (CL, CH)



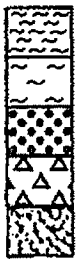
Gravelly Clay (CL, CH)
Sandy Silt (ML)
Clayey Sand (SC)
Silty Sand (SM)
Sand (SP, SW)
Clayey Gravel (GC)
Silty Gravel (GM)
Gravel (GP, GW)

ROCK

Claystone (massive)
Siltstone (massive)
Shale (laminated)
Sandstone (undifferentiated)
Sandstone, fine grained
Sandstone, coarse grained
Conglomerate



Limestone
Coal
Dolerite, Basalt
Tuff
Porphyry
Granite
Pegmatite



Schist
Gneiss
Quartzite
Talus
Alluvium

SEAMS

Seam >0.1 m thick
(on a scale 1:50)
Seam 0.01 m to 0.1 m thick
(on a scale 1:50)

INCLUSIONS (Special purposes only)

Rock Fragments
Swamp

Ironstone Gravel, Laterite
Shale Breccia in Sandstone

Water Level

Surfaces ——— Known Boundary — — — Probable Boundary ——— ? ———? Possible Boundary

APPENDIX A
results of field investigation

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP1
sheet 1 of 1

office job no: 20652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH							SP	Silty SAND, fine to medium grained light grey to grey, some roots	D	(MD)		TOPSOIL
							SC	Clayey SAND, fine to medium grained, light orange brown, some sandstone floaters in matrix				SLOPEWASH/ALLUVIUM
					1.0		CL	CLAY, medium plasticity, red brown, orange brown & grey brown some gravel	M	VSt		RESIDUAL
					2.0			SANDSTONE, fine to coarse grained extremely to highly weathered, orange brown & red brown				BEDROCK
								END TEST PIT TP1 AT 2.4m				
					3.0							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

pit no: TP2
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
R.L. surface: m
excavation dimensions: 3 m long, 0.8 m wide
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		N	NONE OBSERVED				SP	Silty SAND, fine grained, light grey, some roots	D			TOPSOIL
							SP	Silty SAND, fine to medium grained, light grey, some orange brown, trace clay				SLOPEWASH
					1.0		SC/CL	Clayey SAND/Sandy CLAY, fine to medium grained, medium plasticity orange brown & red brown	M <Wp	MD/D H		ALLUVIUM
					2.0		CL	CLAY, medium plasticity, mottled red brown, orange brown & light grey	M <Wp	H		RESIDUAL
					3.0			Becoming EW Sandstone near bottom of pit				
								END TEST PIT TP2 AT 3.3m				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

pit no: TP3
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH								Silty Clayey SAND, fine to medium grained, light grey, some rounded gravel				TOPSOIL/SLOPEWASH
								CLAY, medium plasticity, orange brown & red brown				RESIDUAL
					1.0			Silty CLAY, medium to high plasticity, light grey				EW SILTSTONE
					2.0			Siltstone, extremely to highly weathered, light grey & orange brown				BEDROCK
								END TEST PIT TP3 AT 2.3m				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support: T timbering, N nil
penetration: 1 2 3 — no resistance ranging to refusal
water: 10 Jan 78 water level on date shown; water inflow; water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP4
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	100 200 300 400 kPa hand penetrometer	structure and additional observations
BH		N	NONE OBSERVED				SP	Silty SAND, fine to medium, grey some sandstone cobbles to 100mm	D	MD		TOPSOIL/SLOPEWASH
					1.0			SANDSTONE, fine to coarse grained extremely to highly weathered				BEDROCK
								END TEST PIT TP4 AT 1.6m REFUSAL ON SANDSTONE				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP5
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	100 200 300 400 kPa hand penetrometer	structure and additional observations
BH		N	NONE OBSERVED				SP	Silty SAND, fine to coarse grained light grey & grey, some gravel	D			TOPSOIL
					1.0		CH	CLAY, medium to high plasticity, orange brown and red brown	M <Wp	H		RESIDUAL/SLOPEWASH
					2.0			CLAY, medium to high plasticity, light grey, some orange brown				
								some gravel content at depth				EW Siltstone
								END TEST PIT TP5 AT 2.8m				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP6
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	100 kPa hand 200 kPa 300 kPa penetrometer 400	structure and additional observations
BH		N	NONE OBSERVED					Silty Clayey SAND, fine to medium grained, grey, some roots	D			TOPSOIL/SLOPEWASH
					1.0			Silty CLAY, medium to high plasticity orange brown & red brown	M	H	x x x	RESIDUAL
								SANDSTONE, fine to coarse grained highly weathered, orange brown	M			BEDROCK
								END TEST PIT TP6 AT 1.7m REFUSAL ON SANDSTONE				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
US0 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP7
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		N	NONE OBSERVED					Silty Clayey SAND, fine to medium grained, grey, brown				TOPSOIL
								Silty CLAY, medium to high plasticity, orange brown & red brown				RESIDUAL
					1.0			Gravel fragments near base of unit				
								SANDSTONE, fine to coarse grained extremely to highly weathered, light grey & orange brown				BEDROCK
								END TEST PIT TP7 AT 1.7m REFUSAL ON SANDSTONE				
					2.0							
					3.0							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP8
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	NONE OBSERVED				SP	Silty SAND, fine to medium grained, grey brown				TOPSOIL
							CL	CLAY, medium plasticity, grey, orange brown & red brown				RESIDUAL
					1.0			SANDSTONE, fine to coarse grained light grey, orange brown & red brown				BEDROCK
								END TEST PIT TP8 AT 1.1m REFUSAL ON SANDSTONE				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP9
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH							SP	Silty SAND, fine to medium grained	D			TOPSOIL/SLOPEWASH
								SANDSTONE, fine to coarse, orange brown, light grey	D			BEDROCK
					1.0			REFUSAL ON SANDSTONE. END TEST PIT TP9 AT 0.6m				
					2.0							
					3.0							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil
penetration 1 2 3 — no resistance ranging to refusal
water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

.003

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP10
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		N						Silty SAND, fine to medium grained, dark grey	M			TOPSOIL
			NONE OBSERVED					CLAY, medium plasticity, orange brown, some gravel	M <Wp			RESIDUAL
					1.0			SANDSTONE, fine to med grnd, org brown	D			BEDROCK
								END TEST PIT TP10 AT 1.0m REFUSAL ON SANDSTONE				

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil

penetration 1 2 3 — no resistance ranging to refusal

water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP11
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 400 kPa	structure and additional observations
BH		N	NONE OBSERVED					Silty Sandy CLAY, low plasticity brown, some roots				TOPSOIL
								CLAY, high plasticity, red brown and orange brown	M	H		× RESIDUAL × >500 kPa
					1.0			Siltstone, extremely to highly weathered, light grey & orange brown, some interbedded sandstone to 200mm				BEDROCK
					2.0			END TEST PIT TP11 AT 2.5m				
					3.0							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support: T timbering, N nil
penetration: 1 2 3 — no resistance ranging to refusal
water: 10 Jan 78 water level on date shown; water inflow; water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

79_003

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP12
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		N	NONE OBSERVED					Silty Clayey SAND, fine grained grey, some roots	M			TOPSOIL
								Silty CLAY, medium plasticity, orange brown and light grey	M <Wp	H		RESIDUAL
					1.0			SANDSTONE, fine to medium grained, extremely to highly weathered, orange brown & light grey	M			BEDROCK
					2.0			END TEST PIT TP12 AT 2.0m SLOW RATE OF PROGRESS				
					3.0							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support: T timbering, N nil
penetration: 1 2 3 — no resistance ranging to refusal
water: 10 Jan 78 water level on date shown; water inflow; water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log
excavation

COFFEY

pit no: TP13
sheet 1 of 1

office job no: G0652/1

client:	CRIGHTON PROPERTIES	pit commenced:	4.5.93
principal:		pit completed:	4.5.93
project:	PROPOSED RESIDENTIAL SUBDIVISION	logged by:	BAS
pit location:	LOT 2 BELAR AVENUE, TERRIGAL	checked by:	PJNP
equipment type and model:	CASE 580E BACKHOE	R.L. surface:	m
excavation dimensions:	3 m long, 0.8 m wide	datum:	

method	penetration 1 2 3	support	water	notes samples, tests,etc.	R.L. / depth in metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH		N	NONE OBSERVED				SP	Silty SAND, fine to medium grained grey, trace clay, some roots	M			TOPSOIL
							CL	Silty CLAY, medium plasticity, mottled red brown & orange brown some gravel	M >Wp	H		RESIDUAL
					1.0			Gravel content increasing with depth				
								SANDSTONE, fine to coarse grained red & orange brown	M			BEDROCK
								END TEST PIT TP13 AT 1.7m REFUSAL ON SANDSTONE				
					2.0							
					3.0							

Key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support: T timbering; N nil
penetration: 1 2 3 — no resistance ranging to refusal
water: 10 Jan 78 water level on date shown; water inflow; water outflow

notes: samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

003

Coffey Partners International Pty Ltd
ACN 003 692 019

engineering log excavation

COFFEY

pit no: TP14
sheet 1 of 1

office job no: G0652/1

client: CRIGHTON PROPERTIES
principal:
project: PROPOSED RESIDENTIAL SUBDIVISION
pit location: LOT 2 BELAR AVENUE, TERRIGAL

pit commenced: 4.5.93
pit completed: 4.5.93
logged by: BAS
checked by: PJNP

equipment type and model: CASE 580E BACKHOE
excavation dimensions: 3 m long, 0.8 m wide

R.L. surface: m
datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency, density index	hand penetrometer 100 200 300 400 kPa	structure and additional observations
BH			NONE ORSERVED					Silty CLAY, low plasticity	D			TOPSOIL
								CLAY, medium plasticity, mottled orange brown & grey brown	M	H		RESIDUAL
					1.0			SANDSTONE, fine to coarse grained highly weathered, orange brown	D			BEDROCK
								END TEST PIT TP14 AT 1.1m REFUSAL ON SANDSTONE				
					2.0							
					3.0							

key
N natural exposure
X existing excavation
BH Backhoe bucket
B bulldozer blade
R ripper
E excavator
HA hand auger
DT diatube

support
T timbering N nil

penetration 1 2 3 — no resistance ranging to refusal

water
10 Jan 78 water level on date shown
water inflow
water outflow

notes samples and tests
U50 undisturbed sample 50mm diameter
D disturbed sample
N standard penetration tests:
N* SPT + sample recovered
Nc SPT with solid cone
V vane shear
P pressuremeter
Bs 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
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

TABLE 1

CLASSIFICATION OF RISK OF SLOPE INSTABILITY

RISK OF INSTABILITY	EXPLANATION	IMPLICATIONS FOR DEVELOPMENT
VERY HIGH	EVIDENCE OF ACTIVE OR PAST LANDSLIPS OR ROCKFACE FAILURE; EXTENSIVE INSTABILITY MAY OCCUR	UNSUITABLE FOR DEVELOPMENT UNLESS MAJOR GEOTECHNICAL WORK CAN SATISFACTORILY IMPROVE THE STABILITY. EXTENSIVE GEOTECHNICAL INVESTIGATION NECESSARY. RISK AFTER DEVELOPMENT MAY BE HIGHER THAN USUALLY ACCEPTED.
HIGH	EVIDENCE OF ACTIVE SOIL CREEP OR MINOR SLIPS OR ROCKFACE INSTABILITY; SIGNIFICANT INSTABILITY MAY OCCUR DURING AND AFTER EXTREME CLIMATE CONDITIONS	DEVELOPMENT RESTRICTIONS AND/OR GEOTECHNICAL WORKS REQUIRED. GEOTECHNICAL INVESTIGATION NECESSARY. RISK AFTER DEVELOPMENT MAY BE HIGHER THAN USUALLY ACCEPTED.
MEDIUM	EVIDENCE OF POSSIBLE SOIL CREEP OR A STEEP SOIL COVERED SLOPE; SIGNIFICANT INSTABILITY CAN BE EXPECTED IF THE DEVELOPMENT DOES NOT HAVE DUE REGARD FOR THE SITE CONDITIONS.	DEVELOPMENT RESTRICTIONS MAY BE REQUIRED. ENGINEERING PRACTICES SUITABLE TO HILLSIDE CONSTRUCTION NECESSARY. GEOTECHNICAL INVESTIGATION MAY BE NEEDED. RISK AFTER DEVELOPMENT GENERALLY NO HIGEER THAN USUALLY ACCEPTED.
LOW	NO EVIDENCE OF INSTABILITY OBSERVED; INSTABILITY NOT EXPECTED UNLESS MAJOR SITE CHANGES OCCUR.	GOOD ENGINEERING PRACTICES SUITABLE FOR HILLSIDE CONSTRUCTION REQUIRED. RISK AFTER DEVELOPMENT NORMALLY ACCEPTABLE.
VERY LOW	TYPICALLY SHALLOW SOIL COVER WITH FLAT TO GENTLY SLOPING TOPOGRAPHY.	GOOD ENGINEERING PRACTICES SHOULD BE FOLLOWED.

THIS TABLE IS AN EXTRACT FROM 'GEOTECHNICAL RISKS ASSOCIATED WITH HILLSIDE DEVELOPMENT' AS PRESENTED IN 'AUSTRALIAN GEOMECHANICS NEWS', NUMBER 10, DECEMBER, 1985, WHICH DISCUSSES THE MATTER MORE FULLY.

TABLE 1. CLASSIFICATION OF RISK OF SLOPE INSTABILITY

ASSESSMENT OF RISK

A landslip (or landslide) is a downslope movement of a soil or rock mass as a result of shear failure at the boundaries of the moving mass. The dominant movement is lateral and failure takes place over a relatively short period. Soil creep, which is slow and occurs without a well defined failure surface, is not included as a landslip.

Natural hill slopes are formed by processes which reflect the site geology, environment and climate. These processes include downslope movement of the near surface soil and rocks; in geological time all slopes are unstable. The area of influence of these downslope movements may range from local to regional and are rarely related to property boundaries. The natural processes may be affected by human intervention in the form of construction and related activities.

It is not technically feasible to assess the stability of a particular site in absolute terms such as stable or unstable. However the degree of risk of slope movement can be assessed by the recognition of surface features supplemented by limited information on the regional and local subsurface profile and with the benefit of experience gained in similar geological environments. The degree of risk is categorised below.

CLASSIFICATION OF RISK OF LANDSLIP WITHOUT DEVELOPMENT

CLASS	EXPLANATION
LOW	A landslip is very unlikely
MODERATE	A landslip is unlikely
HIGH	There is some risk of a landslip

CONSEQUENCES OF HILLSIDE CONSTRUCTION

It must be accepted that the risks associated with hillside construction are greater than construction on level ground in the same geological environment. The impact of development may be adverse and imprudent construction techniques can increase the potential for movement.

Australian Standard AS 2870 - 1986 provides a damage classification that relates to essentially vertical movements of masonry walls and is thus not directly applicable to hillside movements. In the absence of a suitable classification for hillside movements the range of damage categories from negligible to very severe can be used as a general guide for damage potential related solely to landslip.

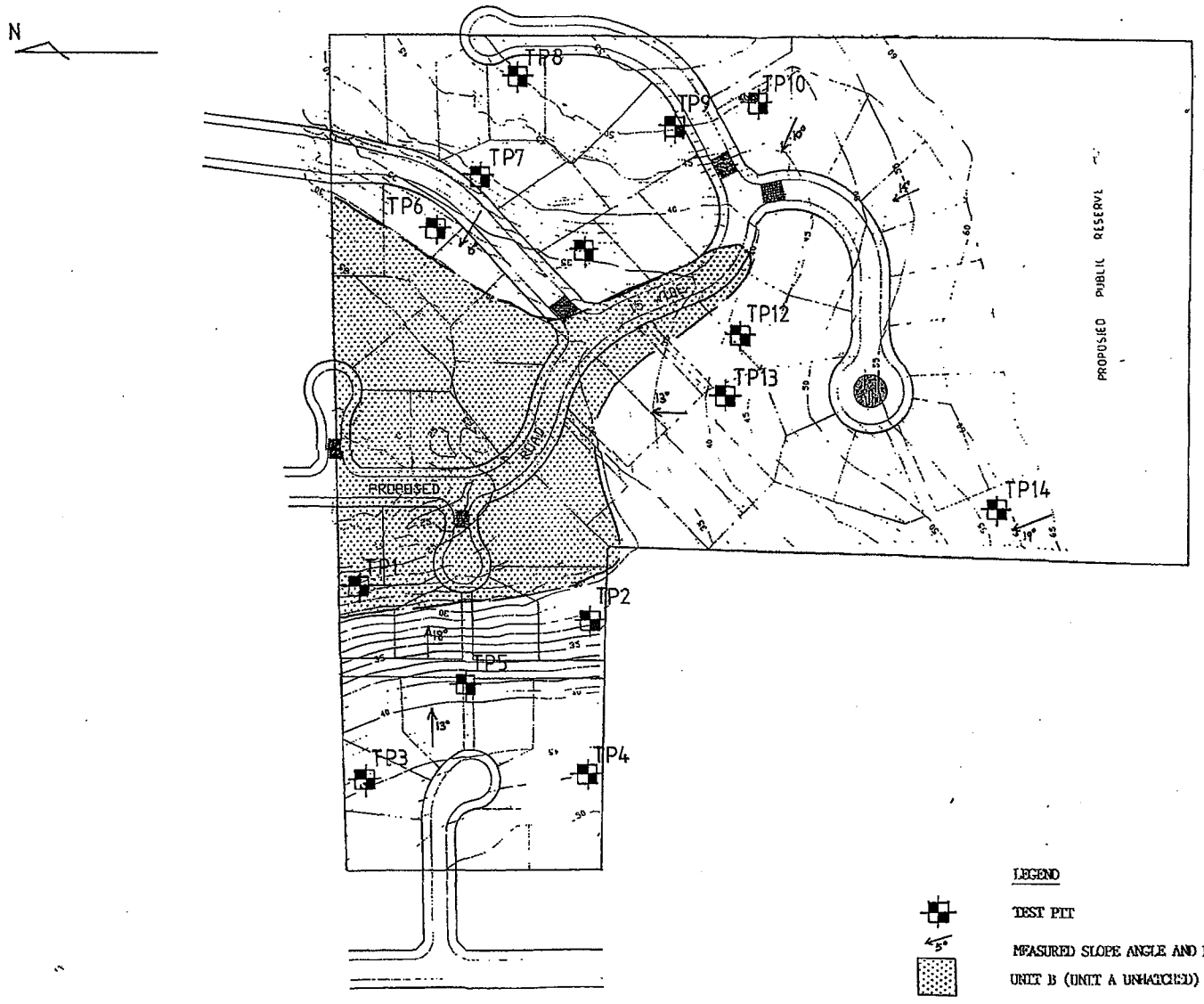
CLASS	DEVELOPMENT CONSTRAINTS	DAMAGE POTENTIAL EXTENT	DAMAGE POTENTIAL PROBABILITY
LOW	Good Hillside Practice	Slight	Very Low
MODERATE	Good Hillside Practice and site specific restrictions	Slight Moderate	Low Very Low
HIGH	No development unless major engineering remedial works	Moderate Severe	High Moderate

Damage to structures may occur due to a number of causes additional to that attributable to landslip. In the absence of a landslip slight damage might be expected even for good construction. If a landslip occurs damage would probably reach at least a moderate level.

TABLE 2 SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	POOR ENGINEERING PRACTICE
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the Risk of Instability and Implications for Development in mind.	Plan development without regard for the Risk of Instability.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements.
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use and compact clean fill materials. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may become unstable. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOUNDATIONS	Support on or within rock where practicable. Use rows of piers or strip foundations oriented up and down slope. Design for lateral creep pressures. Backfill foundation excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide generous falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to disipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer system; absorption trenches may be possible in some low risk areas. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant.	
SITE VISITS	Site Visits by consultant may be appropriate during construction.	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident seek advice. If seepage observed, determine cause or seek advice on consequences.	

This table is an extract from GEOTECHNICAL RISKS ASSOCIATED WITH HILLSIDE DEVELOPMENT as presented in Australian Geomechanics News, Number 10, 1985 which discusses the matter more fully.



Coffey Partners International Pty Ltd Consulting Engineers in the geotechnical sciences
Incorporated in NSW

scale (metres)

revision	description	drawn	approved	date

drawn	BAS
checked	
date	6.5.93

CRIGHTON PROPERTIES
PROPOSED RESIDENTIAL SUBDIVISION
LOT 2 BELAR AVENUE, TERRIGAL
SITE PLAN

COFFEY

drawing no. G0652/1 - 1

job no. G0652/1