

Geotechnical Assessment (2008)

Preliminary Geotechnical
Assessment
(Coffey, 2008)



The following document was prepared in 2008 by Coffey Geotechnics Pty Ltd for Coopers Gap Wind Farm Pty Ltd. It is important to note that this document was prepared for a client separate to AGL and for a wind farm layout and specification that is different to that which is currently proposed as a part of this Community Infrastructure Designation. This document has been included as a reference document to this IAR purely for the purposes of providing further detail behind some aspects of the study previously undertaken on the site, and is intended to be read only where referenced within the IAR Volume One document.

PRELIMINARY GEOTECHNICAL ASSESSMENT

Coopers Gap Windfarm

GEOTKPAR01416AA-AB
7 April 2008

Investec Bank (Australia) Limited

7 April 2008

Investec Bank (AUSTRALIA) Limited
300 Gilles St
Adelaide SA 5000

Attention: Mr Jim Trenery

Dear Jim

**RE: Preliminary Geotechnical Assessment
Coopers Gap Windfarm**

Please find following our preliminary geotechnical assessment for Coopers Gap Windfarm. We trust that this report will satisfy your requirements for the time being. We would be pleased to work with you to develop a scope of work for a more detailed geotechnical assessment.

Should you require further information or assistance, please contact the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd



Ian Shipway

Principal

Distribution: 3 copies Investec Bank (Australia) Limited
1 Copy Coffey Brisbane Library

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important information about your coffey report

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1 INTRODUCTION

Coffey Geotechnics has conducted a preliminary geotechnical assessment of the proposed site for the Coopers Gap Windfarm in south east Queensland. The assessment was conducted on behalf of Investec Bank (Australia) Limited with the following intentions:

- Identify and generally characterise the different geological units within the extents of the project;
- Make a generalised preliminary assessment as to the likely founding depths for Wind Turbine Generator (WTG) footings in the different geological units; and,
- Make a preliminary assessment of geotechnical constraints that could affect the construction of access roads and other infrastructure.

This report presents the results of our assessment, addresses the items above, and provides information on some other geotechnical aspects discussed on site with Mr Jim Trenery of Investec Bank. Also included are design parameters for guy anchor blocks which we understand are necessary for the construction of wind monitoring towers.

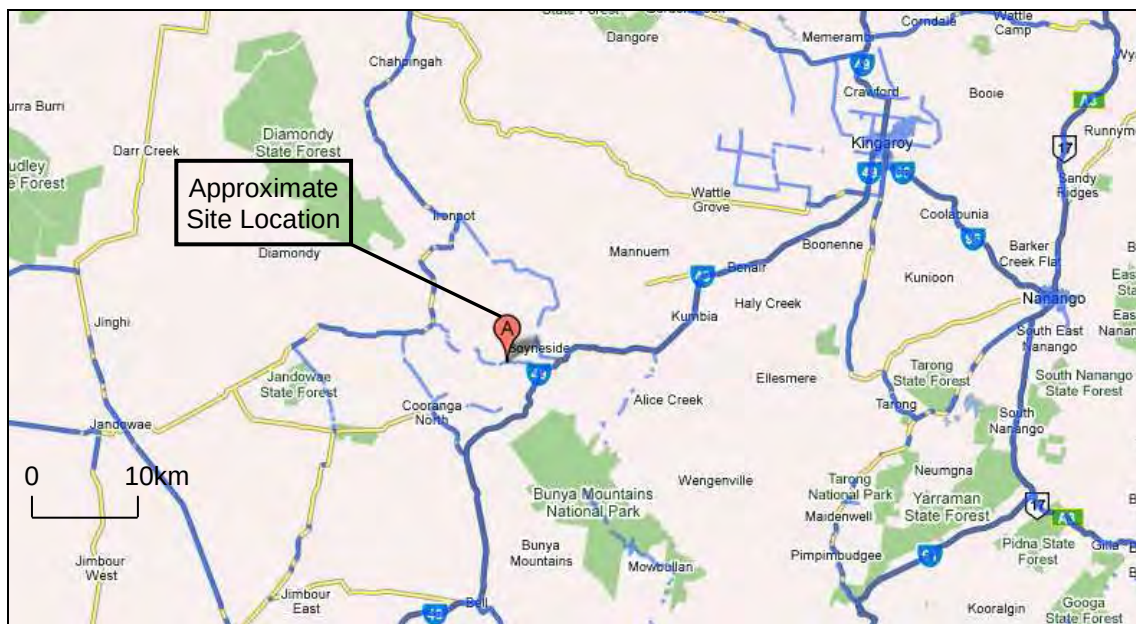


Figure 1.1. General Site Location

2 PROJECT DESCRIPTION

The site for the proposed windfarm is located off Niagara Road in Boyneside which is about 70 km south west of Kingaroy as indicated on Figure 1.1. Topographically, this vicinity is characterised by a series of north west to westerly trending ridgelines along which up to 147 wind turbine generators are to be distributed. Drawing 1 shows the general layout of wind turbines at the time of the assessment.

The turbines will be founded through steel reinforced concrete footings which generally found at up to 3m below surface level. Footings may be either of the gravity variety, that is, possessing sufficient weight to resist the overturning moments developed by the mass and operation of the turbine, or may be smaller footings that provide resistance to the forces through ground anchors.

Roads connecting the wind turbine sites to the surrounding public road system will be required to allow construction, and also to provide access for maintenance vehicles for the design life of the wind turbines. Construction traffic will include large, heavily laden trucks. Experience indicates that although such vehicles are generally limited to grades of less than 10%, they can often traverse short distances with grades up to 20% in good weather conditions with assistance.

In addition to the access roads, the WTGs will need to be linked by a series of electrical cables which are generally layed in trenches with a depth of at least 1m below ground surface level.

3 WORK CONDUCTED FOR THIS ASSESSMENT

The work conducted for this assessment comprised the following:

- o A desktop review of available geological information.
- o A site visit by a Principal Engineering Geologist on 21 and 22 May 2008. During this site visit, twenty two test pits (designated CG1 to CG22) were excavated using a rubber tyred backhoe to allow assessment of typical subsurface features and limited geotechnical assessment.

The test pits were distributed over several of the ridge lines upon which the windfarm will be developed. These ridge lines have been designated A to I on Drawing 1 to assist with referencing in this report. The intent behind excavation of the test pits was to provide general characterisation of the range of ground conditions within the different ridge lines, rather than to investigate the specific sites of wind turbines.

The test pits were excavated to refusal or in several cases were terminated at depths below 2m depth where it was considered that no further useful information would be gained by proceeding further. The backhoe that excavated the test pits was a modern Case machine fitted with a 600mm wide bucket with tiger teeth in near new condition.

Some parts of the site, particularly those areas to the north west, could not be assessed due to access restrictions as discussions between the developer and land holders were still ongoing at the time of the site visit.

In addition to the main site area, a visit was made to a location which could be a potential source for construction materials, and two cuttings on Niagara Road where subsurface conditions were exposed over a depth of about 6m. Drawing 1 shows these locations.

4 GEOLOGICAL FRAMEWORK & SURFACE OBSERVATIONS

4.1 Geology

Published geological information shows that the vicinity of the proposed windfarm is mainly underlain by basalt bedrock of Tertiary age. Basalt is a dark, fine grained, volcanic rock that was deposited as distinct layers of lava which could vary in thickness from a few metres to nearly a hundred metres. Although basalt is usually very strong in its fresh state, it weathers relatively quickly (in geological time scales) to form dark brown and red clay soils. The pattern of basalt weathering often leaves "corestones" or boulders of strong rock within a soil matrix. This rapid weathering, coupled with the mode of deposition in successive layers can often lead to a situation where one layer weathers to a soil and then is overlain by a new lava flow, which is itself weathered and partially eroded. The result of this is that terrain formed in basalt can often have relatively weak material underneath strong rock, a situation that is relatively uncommon outside of basalt terrains.

There are areas of the site to the north east that are underlain by older sedimentary rocks. These materials are not discussed in this report as those areas could not be visited during field work due to the access constraints outlined previously.

4.2 Surface Conditions

The development area comprises a series of west to north west trending ridge lines which rise to as high as 850m above sea level. The area has generally been cleared, with only scattered trees remaining. Grazing is the predominant land use along the ridge lines and slopes. Ground cover is mainly long grass with some prickly pear and small shrubs. Clay soils are generally evident at the surface, with zones of scattered rock fragments and rare areas of rock outcrop. Where outcrop is visible at the surface it usually comprises fractured basalt which would break into large fragments on excavation.

Slopes vary greatly in steepness from very shallow to angles steeper than 20°. The density of contour lines on Drawing 1 provide a reasonable comparison of the steepness of different areas. The current access to Ridges F and G required us to traverse slopes of up to 10° (about 17%). Access to Ridge H uphill of test pit CG21 would require a long section of slope of 15° (27%) to be traversed. Current access to most of the other ridges assessed involves traversing slopes of not more than 7° (12%).

5 SUB-SURFACE CONDITIONS

5.1 Observations in test pits

The test pits revealed a profile comprising variably weathered basalt which formed a profile as outlined in Table 1. More detailed descriptions of materials are provided on the Engineering Logs included in Appendix A, which also includes sheets explaining the meaning of the terms used in the descriptions.

TABLE 1. SUMMARY OF MATERIALS OBSERVED IN TEST PITS

Depth Range	Generalised Material Description
Not present at many locations. Generally around 0.5m thickness but over 3.3m in CG21 on Ridge H	Unit 1 Very stiff and hard, brown and red brown clay. Clay is generally of high plasticity with some medium plasticity materials.
Not present at some locations. Generally about 0.5m thick, but varies.	Unit 2 Very stiff and hard gravelly clay or very dense clayey gravel usually with some large rock fragments over 100mm in size. Generally medium or high plasticity clay.
Present only at a few locations.	Unit 3 Basalt fragments in a soil matrix. Rock fragments varying in size from 100mm to 500mm in size in a matrix of stiff to hard clay. In some locations fragments are much smaller than others.
Found in nearly all test pits.	Unit 4 Weathered basalt bedrock. Varies in degree of weathering. Generally high to very high strength but with numerous soils strength zones between sections of rock. In most cases the backhoe bucket refused after penetrating about 0.5m, but in some cases penetrated over 1m into predominantly rock strength material. The spoil size of the excavated material varied significantly from about 100mm to as large as 600mm.

Figure 5.1 shows the profile from test pit CG8 on Ridge C.



Figure 5.2 Profile in test pit CG8 showing clay over basalt.

The difference between Unit 3 and Unit 4 relates to the assessed quantity of rock strength material, with Unit 4 comprising mainly rock with some soil zones. Figure 5.1 shows a comparison of spoil between two of the test pits to give some idea of the range of sizes of excavated spoil observed.



Figure 5.1. Comparison of Spoil from Two Test Pits

5.2 Observations in Cuttings

The two cuttings revealed highly complex, variable conditions over short distances. Some parts of the cutting face exhibited deep soil strength zones, whilst other areas were rock from near the surface. The materials were generally weathered such that the block size in disturbance was generally up to 100mm, but with some blocks to about 600mm in size. These conditions are generally consistent with those revealed in the test pits. Figure 5.3 shows a typical cutting face. Note the spoil forming at the base which is a mixture of soil and rock strength material.



Figure 5.3. View of South Western Side of Road Cutting

5.3 Observations at Quarry Site

Conditions at the potential quarry site are quite different to those on the surrounding hillsides. In this location the near surface materials comprise variably sized fragments of fresh, very high strength basalt as shown on Figure 5.4. These conditions have formed through the collapse of large, joint defined “columns” of basalt which make up the adjacent hillside. Lava flows from which the basalt was formed often develop such continuous near vertical joints as they cool. At this location the adjacent creek appears to have undercut the base of the slope, exposing the columns and allowing collapse.



Figure 5.4. Part of potential borrow area, with source of material upslope

6 PRELIMINARY GEOTECHNICAL ASSESSMENT

6.1 Founding of Wind Turbine Generators

The WTGs will be founded on either “gravity” type near surface footings or reinforced concrete footings restrained by ground anchors.

For the anchored footing design to be appropriate for a specific WTG site the near surface materials must have appropriate strength and stiffness and there must be suitable rock at depth over the bond length of the anchors which would be at depths greater than 10m below the base of the footing.

Basalt provides specific challenges for an anchored footing system because of the potential for less strong materials underlying strong near surface materials. At this stage, the near surface investigations conducted so far have not revealed such conditions but they may still present undetected.

The main parameters pertinent to design of footings of both kinds are elastic modulus, serviceability bearing pressure and ultimate bearing capacity of the near surface materials. A key parameter governing design of an anchored footing is the allowable bond stress of the ground to grout bond at depth.

Based on the available information and our experience of the design requirements at other sites, we consider that at least some of the WTG sites would be able to satisfy the near surface criteria for an anchored footing. Deeper drilling to provide a greater understanding of the geology of the successive

lava flows comprising the ridge lines would be needed to make an assessment of the anchor bond zones. The quantity (and therefore the cost) of such investigation may be greater than usual for non basalt sites.

Based on the information available, we are of the opinion that suitable founding strata would be present at most locations between 0.7m and 1.5m depth and that an economic gravity footing could be designed for these ground conditions with the possible exception of the deep clay soils intersected by test pit CG21 on Ridge H. Note that these conditions have been found in only a single test pit, and that this pit was excavated on the flanks of the slope rather than the ridge line because of access constraints.

6.2 Excavation Conditions

6.2.1 General Excavations for Footings and Roads

The test pits have demonstrated that the majority of materials on site can be excavated down to about 1m depth or a bit less using a backhoe. Note that this was achieved using good equipment (detailed previously) in a confined trench. Large hydraulic excavators (ie, 30 tonne or greater) should be able to penetrate further, particularly in a larger bulk excavation. However, the variably weathered nature of the bedrock and the presence of rock outcrop in some locations suggests that there will be some zones where excavation using excavators would not be practical or economic. Large bulldozers or even blasting could be required if such zones cannot be avoided.

6.2.2 Excavation of Cable Trenches

During past assessments with respect to cable trenches and the like, we have developed a table of excavation classes as shown on Table 2.

TABLE 2: EXCAVATION CLASS DEFINITIONS

Class	Typical Material Descriptions	Likely Type of Machine to be Used
I	Soil; soil & "very weak rock" (i.e. typical Unconfined Compressive Strength (UCS) < 2 MPa)	Cleveland Bucket Wheel Excavator
II	"Weak rock" (i.e. typical UCS<40MPa), open closely jointed "strong" rock.	Vermeer Chain Trencher
III	Tight jointed "strong rock"; variable rocky ground.	Tracked Excavators & Hammers
IV	Massive "strong" rock.	Blasting or Heavy Use of Rock Hammers

The conditions revealed by the test pits (and inferred by surface observation) generally fall into either Class II or Class III with the majority being "variable rocky ground" (Class III). Whilst a Vermeer trencher may be successful in some parts of the development, a particular challenge is posed by the large, high strength boulders within the soils which allow the trencher to get up to speed before bringing it to a rapid halt, often resulting in broken teeth and slow repairs. Taking this into account, we consider

that large excavators would be a more economical alternative for excavating cable trenches. Note that even using such equipment it may be necessary to divert trenches around some zones of stronger material or alternatively resort to blasting or heavy rock hammers for short sections.

6.3 Road Construction Issues

6.3.1 Geometrics and General Issues

The philosophy behind road construction should be carefully considered prior to embarking on the project. Our understanding is that the roads are required to be serviceable during construction under relatively heavy traffic and for the in-service period under infrequent light traffic. An all weather, easily maintained, unsealed road is usually adopted. Our experience suggests that as the majority of traffic will be experienced during the construction period there is little point in trying to construct the final pavement surface at the outset. It will often be more practical for the contractor to form the road and maintain/resurface during the construction period as required by very short term traffic requirements. The finished surface would be trimmed etc on completion of construction of the turbines and other infrastructure.

In previous projects we have been advised that the maximum grade trafficable by the required construction traffic is 10%, however we are also aware that in practice short sections of road at up to 20% grade have been used. Larger trucks may require assistance to get through these steeper sections and they may not be passable during wet weather.

As noted previously, the current access to several of the ridge lines (F, G and H) involves traversing slopes significantly steeper than 10% and at some places steeper than 20% grade. It is likely that there are other unobserved locations that will be similarly steep. However it is possible that there are other practical routes to access many of these sites where grades would not be as steep. These will need to be carefully assessed, and it may be worth considering accessibility in detail when finalising turbine locations.

If large tracked cranes are required for construction, as is the case in many wind farms it may be necessary to construct access roads over 10m wide with tight tolerances on the maximum side slopes. Under these circumstances the steep terrain of the development area may provide an even greater challenge. Routes for roads will need to be carefully selected to limit the amount of cut required to meet the specification for cross fall.

6.3.2 Materials for Road Construction

Construction materials for a serviceable road as outlined above would generally comprise a mixture of gravel, sand and clay/silt binders. Usually the maximum size of these materials would be about 80mm except for the case of certain weak rocks that break down under a grid roller. For unsealed roads such materials generally require slightly more plastic fines than a typical road base will usually possess. The less processing a material requires, the cheaper it will be. Therefore preference would be given to materials that can be excavated and used immediately, rather than those that require crushing and complex screening. An intermediate step would be basic screening to remove oversize particles.

In our opinion it may be practical to use some of the materials won during excavation of footings and small cuts for roads in construction of road pavements. The challenges posed by basaltic materials in this regard are the high plasticity of the clay component and the large blocks of strong rock that are likely to be won from some locations as shown in Figure 5.1. This material would certainly require

screening to remove larger blocks. These could be crushed by mobile on site crushing plant if greater volumes of material are required than can be provided by screening alone. In some areas (ie, Ridges A and C) there is a high proportion of clay which may make the materials unusable unless the materials can be selectively won to remove the more clayey components.

6.3.3 The Potential Quarry Site

Economics will dictate that carting material for road construction from off site would only be contemplated if insufficient suitable material can be won on site during construction. Materials observed near the surface of the proposed quarry site comprised fragments of very high strength basalt (varying from gravel to over 0.5m in size) that appeared to be suitable for crushing to make good quality road material. Whilst the material appears generally suitable there are a number of issues which may affect the practicality of this source. Firstly, the mode of collapse of the basalt columns has formed very steep slopes adjacent to the hillside which may be readily subject to instability during extraction of resource. The extraction plan would need to be carefully considered to maintain the safety of those working on site.

Another aspect is the access road to the quarry site, a small section of which is shown on Figure 6.1. As shown this is an unsealed road in poor condition with many twists and low overhead clearance in several locations. It is likely that the road would need to be upgraded if significant truck traffic was considered. It is possible that the road may not be trafficable by larger semi-tippers even after upgrading.



Figure 6.1. Small section of proposed quarry access road

6.4 Founding of Guy Anchor Block

Test pits CG8 and CG9 were excavated at the location of a proposed wind monitoring tower to provide information on the founding of the guy anchor blocks. The profile revealed by the test pits is that shown in Figure 5.1 and comprises clay and gravelly clay to about 0.6m (Unit 1/2) overlying moderately weathered basalt (Unit 4). Based on our observations in the test pits and experience with similar materials we consider that the design parameters given in Table 3 may be adopted.

TABLE 3. DESIGN PARAMETERS FOR GUY ANCHOR BLOCKS

Parameter	Unit 1/2 (Down to ~0.6m)	Unit 4
Bulk Unit Weight	19 kN/m ³	22 kN/m ³
Allowable Bearing pressure at 0.8 m depth	NA	1000kPa
Effective cohesion	5 kPa	20 kPa
Effective angle of friction	32°	40°

We understand that these parameters will be used to calculate the resistance provided by anchor blocks founded at about 1m depth. Note that during excavation of the test pits the pit walls were loosened during excavation as larger rocks were “plucked” from the sides leaving an irregular shaped excavation. The parameters above assume that the anchor blocks can be constructed with a good contact between the undisturbed ground on the side of the blocks and the concrete. If such contact cannot be effected in practice some parameters may need to be down graded. Further advice should be sort from a geotechnical consultant under these circumstances.

For and on behalf of Coffey Geotechnics Pty Ltd



Ian Shipway

Principal

Drawings

Appendix A

Field Investigation Data

Excavation No. **CG1**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346041 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044000 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations	unit geology
BH	1	2	3	N					CH	CLAY: High plasticity, dark brown & red brown; trace of fine to medium basalt gravel.	D-M	H	100 200 300 400		Residual Soil
							0.5		CH/CL	CLAY & GRAVELLY CLAY: High plasticity clay (red brown) & low plasticity, gravelly clay (pale brown) with fine to coarse basalt gravel; with a trace to some angular basalt fragments to 150mm in size.					RS-XW Basalt
							1.0			HW BASALT: Dark brown and red brown; medium to high strength; numerous XW seams and zones of hard, red brown, high plasticity clay; breaks into fragments up to 150mm (but mainly <50mm) on excavation.					HW Basalt
							1.5			Near refusal at 1.3m Test pit CG1 terminated at 1.3m					
							2.0								
							2.5								

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Engineering Log - Excavation

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Principal:

Project: **COOPERS GAP WINDFARM**

Test pit location: **See Figure 1**

Excavation No. **CG10**

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Date started: **22.5.2008**

Date completed: **22.5.2008**

Logged by: **IS**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346041 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044000 m datum: AHD

excavation information						material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations			unit geology
BH	1 2 3	N	None Observed		0.5		CH	GRAVELLY CLAY: High plasticity, red brown & grey; approx 35% fine to coarse angular basalt fragments to 150mm in size.	D-M	H	100 200 300 400				RS/XW BASALT
					1.0			MW BASALT: Dark brown stained pale brown; high to very high strength; numerous XW zones comprising hard, red brown, high plasticity clay; breaks into fragments from 20mm to 200mm in size on excavation.							MW BASALT
					1.5			Near refusal at 1.4m Test pit CG10 terminated at 1.4m							
					2.0										
					2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4  no resistance ranging to refusal water  water level on date shown  water inflow  water outflow	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	based on unified classification system moisture D dry M moist W wet W _p plastic limit W _L liquid limit	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

Excavation No. **CG11**

Engineering Log - Excavation

Sheet 1 of 1
Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345940 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7041944 m datum: AHD

excavation information					material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- kPa	meter	structure and additional observations	unit geology
BH	1 2 3	N		None Observed	0.5		D-M	MIXTURE OF SOIL (30%) AND ROCK (70%): Soil is gravelly clay; medium to high plasticity, dark brown; fine to coarse angular basalt gravel; rock comprises basalt fragments to 400mm in size (angular).	D-M		100 200 300 400		Corestones in a soil matrix	RS/HW BASALT
					1.0			HW BASALT: Dark brown and red brown (stained); medium to high strength; numerous XW zones comprising hard, red brown, high plasticity clay; breaks into fragments up to 100mm in size (but mainly up to 50mm) on excavation.						MW BASALT
					1.5			Near refusal at 1.0m						
					2.0			Test pit CG11 terminated at 1m						
					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 W _p 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
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Excavation No. **CG12**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345568 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7042010 m datum: AHD

excavation information						material substance										
method	penetration			support	water	notes samples, tests, etc	depth		graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter	structure and additional observations	unit geology
BH	1	2	3	N			RL	metres			soil type: plasticity or particle characteristics, colour, secondary and minor components.			100 200 300 400		
								0.5		CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 150mm in size.	D-M	H			RS/XW BASALT
											HW BASALT: Dark brown and red brown (stained); medium to high strength; numerous XW zones comprising hard, red brown, high plasticity clay; breaks into fragments up to 100mm in size (but mainly up to 50mm) on excavation.					MW BASALT
								1.0			Near refusal at 0.9m Test pit CG12 terminated at 0.9m					
								1.5								
								2.0								
								2.5								

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet W _p plastic limit W _L liquid limit	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

Excavation No. **CG13**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 340360 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7040874 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations	unit geology
BH	1	2	3	N					CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 150mm in size.	D-M	VS/ H	100 200 300 400		RS/XW BASALT
					None Observed		0.5 								

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet W _p plastic limit W _L liquid limit	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

Excavation No. **CG14**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

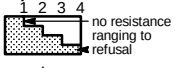
Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346525 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7040826 m datum: AHD

excavation information						material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations			unit geology
BH	1 2 3	N	None Observed		0.5		CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 150mm in size; some pockets and zones of (CH) CL, high plasticity, dark brown; up to 0.5mm in size.	D-M	H	100 200 300 400				RS/XW BASALT
								HW BASALT: Dark brown and red brown (stained); medium to high strength; numerous XW zones comprising hard, red brown, high plasticity clay; breaks into fragments up to 100mm in size (but mainly up to 50mm) on excavation; near refusal at 0.90m,							HW BASALT
					1.0			Near Refusal at 0.9m Test pit CG14 terminated at 0.9m							
					1.5										
					2.0										
					2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4  no resistance ranging to refusal water  water level on date shown  water inflow  water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG15**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345657 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7039508 m datum: AHD

excavation information						material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations			unit geology
BH	1 2 3				0.5		CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 150mm in size; some pockets of (CH) clay, red brown and orange brown; to 1mm in size.	D-M	H	100 200 300 400				RS/XW BASALT
			None Observed		1.0			HW BASALT: Dark brown and red brown (stained); medium to high strength; numerous XW zones comprising hard, red brown, high plasticity clay; mainly fragments to 150mm, but some to 300mm in size.							MW BASALT
					1.5			Near refusal at 1.40m Test pit CG15 terminated at 1.4m							
					2.0										
					2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Engineering Log - Excavation

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345459 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7039554 m datum: AHD

excavation information						material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations			unit geology
BH	1 2 3	N					CL/CH	SILTY CLAY: Medium to high plasticity, dark brown	D-M	Fb/VH	100 200 300 400				RS
					0.5		CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 150mm in size; some pockets of dark brown CH							XW BASALT
			None Observed		1.0			HW BASALT: Dark brown and red brown (stained); medium to high strength; numerous XW zones comprising hard, red brown, high plasticity clay; most fragments to 100mm in size some to 300mm; platy fragments with orientation down slope.							HW BASALT
					1.5			Refusal at 1.3m Test pit CG16 terminated at 1.3m							
					2.0										
					2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG17**

Engineering Log - Excavation

Sheet 1 of 1
Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345354 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7039572 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	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	structure and additional observations	unit geology
BH	1	2	3	N			0.5			MIXTURE OF SOIL (25%) and ROCK (75%): Soil is gravelly clay; medium plasticity, dark brown; rock comprises rock fragments to 600mm in size; angular basalt.	D-M				HW-MW BASALT
							1.0			Near refusal at 0.7m Test pit CG17 terminated at 0.7m					
							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 W _p 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
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Engineering Log - Excavation

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345216 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7039561 m datum: AHD

excavation information					material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations		unit geology
BH	1 2 3	N					CH	CLAY: High plasticity, dark brown; some fine to coarse basalt gravel; some zones medium plasticity clay; trace of boulders to 300mm in size	D-M	H				RESIDUAL SOIL
					0.5		CH	CLAY: High plasticity, red brown.	M	H				
					1.0		CL	SILTY CLAY: Low to medium plasticity, orange brown and pale brown; trace of fine to coarse basalt gravel.	D	Fb/H				XW BASALT
					1.5		GC	CLAYEY GRAVEL: Fine to coarse, angular, orange brown and pale brown; ~40% low plasticity fines; some angular basalt fragments to 150mm in size.	D	VD				XW-HW BASALT
					2.0									
					2.5			Test pit CG18 terminated at 2.1m						

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 W _p 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
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Excavation No. **CG19**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

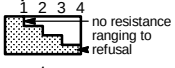
Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 3450222 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7039564 m datum: AHD

excavation information						material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations			unit geology
BH	1 2 3	N	None Observed		0.5		CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 30mm in size.	D-M	H	100 200 300 400				XW BASALT
					1.0			HW BASALT: Dark brown and red brown (stained); medium to high strength; numerous XW zones comprising hard, red brown, high plasticity clay; breaks into fragments up to 400mm in size (but mainly up to 50mm) on excavation.							NW BASALT
					1.5			Refusal on basalt at 1.00m Test pit CG19 terminated at 0.95m							
					2.0										
					2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4  no resistance ranging to refusal water  water level on date shown  water inflow  water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG2**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 345880 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044046 m datum: AHD

excavation information						material substance										
method	penetration			support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations	unit	geology
BH	1	2	3	N					CH	CLAY: High plasticity, dark brown/ red brown; trace fine to medium basalt gravel; Numerous fissures; breaks into fragments 10mm-50mm in size under hand pressure.	D-M	H	100 200 300 400			
							0.5		CL/CH	SILTY CLAY/ CLAY: Medium plasticity/ high plasticity, pale brown/ dark brown; with some fine to coarse basalt gravel.						RESIDUAL SOIL
							1.0		GC	CLAYEY GRAVEL: Fine to coarse, pale grey; approximately 30% low plasticity fines; trace of basalt fragments to 100mm in size.		VD				RS/XW BASALT
										HW-MW BASALT: Dark brown and red brown; medium to very high strength; with some XW zones of dark brown low plasticity clay; breaks into fragments from 10mm - 150mm in size on excavation.						XW BASALT
							1.5			Test pit CG2 terminated at 1.4m						HW-MW
							2.0									
							2.5									

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG20**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

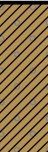
Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346086 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7040163 m datum: AHD

excavation information						material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter	structure and additional observations			unit geology
BH	1 2 3	N		None Observed	0.5		CL	GRAVELLY CLAY: Medium plasticity, dark brown and grey; 40% fine to coarse gravel; trace of angular basalt fragments to 150mm in size.	D-M	H	100 200 300 400				XW BASALT
					1.0		MW	MW BASALT: Dark grey and pale brown; high strength to very high strength; breaks into fragments of 40mm to 300mm on excavation; numerous clay seams and zone of variable thickness							MW BASALT
					1.5			Refusal at 1.1m Test pit CG20 terminated at 1.1m							
					2.0										
					2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG21**

Engineering Log - Excavation

Sheet 1 of 2

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 340255 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044976 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	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	structure and additional observations	unit geology
BH	1	2	3	N					CH	GRAVELLY CLAY: High plasticity, dark brown and red brown; approximately 40% fine to coarse subangular gravel; some cobbles and boulders to 300mm.	D-M	H	100 200 300 400		
							0.5		CH	CLAY: High plasticity, red brown; some fine to coarse gravel.	D-M				COLLUVIUM
							1.0		CH	CLAY: High plasticity, yellow brown and pale grey, banded in part; trace of fine to coarse gravel; some pockets of white silt.	M				RESIDUAL SOIL
							1.5								
							2.0								
							2.5								XW BASALT

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 W _p 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
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Excavation No. **CG21**

Engineering Log - Excavation

Sheet 2 of 2

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 340255 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044976 m datum: AHD

excavation information						material substance										
method	penetration			support	water	notes samples, tests, etc	depth		graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter	structure and additional observations	unit geology
BH	1	2	3	N			RL	metres			soil type: plasticity or particle characteristics, colour, secondary and minor components.			100 200 300 400 kPa		
								3.0			CLAY: High plasticity, yellow brown and pale grey, banded in part; trace of fine to coarse gravel; some pockets of white silt. (continued)	M	H			
										GC	GRAVELLY CLAY: Medium plasticity with numerous fragments of basalt.					
								3.5			Test pit CG21 terminated at 3.3m					
								4.0								
								4.5								
								5.0								

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 W _p 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
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Excavation No. **CG22**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **22.5.2008**

Principal:

Date completed: **22.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 341870 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7046404 m datum: AHD

excavation information						material substance													
method	penetration			support	water	notes samples, tests, etc	depth metres		graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa				structure and additional observations	unit geology
BH	1	2	3	N						CL	SILTY CLAY: Medium plasticity, dark brown.	D-M	Fb/VSt	100	200	300	400		
							0.5			CH	CLAY: High plasticity, red brown; trace of fine to coarse angular basalt gravel.	M	H						RESIDUAL SOIL
							1.0			CH	GRAVELLY CLAY: High plasticity, red brown; 25% fine to coarse angular gravel.								XW BASALT
							1.5			GC	GRAVELLY CLAY: Fine to coarse; red brown and grey; with some cobbles and boulders of vesicular basalt to 300mm in size; resistance increasing with depth.		VD						
							2.0				HW BASALT: Low to medium strength, dark brown and red brown; some clayey zones.								HW BASALT
							2.5				Test pit CG22 terminated at 2.1m								

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG3**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346131 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044909 m datum: AHD

excavation information					material substance									
method	penetration	support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations		unit geology
BH	1 2 3	N					CH	CLAY: High plasticity, dark brown; trace of fine to coarse basalt gravel; numerous fissures; breaks into 10mm to 50mm in size fragments under hand pressure.	D-M	H	100 200 300 400			RESIDUAL SOIL
					0.5			HW BASALT: Pale grey brown and grey; very low strength; fragmented; some zones residual soil and some zones MW rock of medium to high strength.						HW BASALT
					1.0			HW-MH BASALT: Greg and pale grey red; medium to very high strength; breaks along defects to form fragments; 20mm to 100mm in size. Block size increasing to 50mm - 200mm.						HW/MW BASALT
					1.5			Near refusal at 1.35m Test pit CG3 terminated at 1.3m						
					2.0									
					2.5									

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet W _p plastic limit W _L liquid limit	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

Excavation No. **CG4**

Engineering Log - Excavation

Sheet 1 of 2

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346080 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044945 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	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	structure and additional observations	unit geology
	1	2	3												
BH				N					CH	CLAY: High plasticity, red brown; traces of fine basalt gravel, moist.	M	VSt			RESIDUAL SOIL
							0.5		CL/CH	CLAY: Medium to high plasticity, pale brown and brown; trace of firm basalt;hard; moist; trace of cobbles and boulders.	D-M	H			
							1.0								
							1.5		CL	GRAVELLY CLAY: Medium plasticity, dark grey with some pale grey; some fine to coarse basalt gravel; traces of cobbles and boulders to 250mm.					XW BASALT
							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 W _p 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
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Engineering Log - Excavation

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Principal:

Project: **COOPERS GAP WINDFARM**

Test pit location: **See Figure 1**

Excavation No. **CG4**

Sheet 2 of 2

Project No: **GEOTKPAR01416AA**

Date started: **21.5.2008**

Date completed: **21.5.2008**

Logged by: **IS**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346080 m R.L. Surface:

excavation dimensions: 3.5m long 0.7m wide Northing: 7044945 m datum: AHD

excavation information							material substance												
method	penetration			support	water	notes samples, tests, etc	depth		graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro- meter				structure and additional observations	unit geology
	1	2	3				RL	metres						100 200 300 400 kPa					
BH				N							D-M	H							
										Test pit CG4 terminated at 2.6m									

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 W _p 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
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Excavation No. **CG5**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346020 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044967 m datum: AHD

excavation information					material substance													
method	penetration			support	water	notes samples, tests, etc	depth metres		graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa			structure and additional observations	unit geology
BH	1	2	3	N			RL				soil type: plasticity or particle characteristics, colour, secondary and minor components.				100 200 300 400			
					None Observed			0.5			MIXTURE OF SOIL AND ROCK: Basalt fragments from 60mm to 300mm in size of high strength to very high strength (70%); in a matrix of very stiff, gravelly clay (CH) of medium platicity.	D-M				Weathered in-situ core stones (sub angular to subrounded)	XW/MW BASALT	
											MW BASALT: Dark grey, stained pale brown; VHS; broken into blocks to 400mm on excavation.						MW BASALT	
								1.0			Test pit CG5 terminated at 0.9m							
								1.5										
								2.0										
								2.5										

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG6**

Engineering Log - Excavation

Sheet 1 of 1
Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346014 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7044978 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter	structure and additional observations	unit geology
BH	1	2	3	N						MIXTURE OF SOIL AND ROCK: Basalt fragments from 60mm to 300mm in size of high strength to very high strength (70%); in a matrix of very stiff, gravelly clay (CH) of medium platicity.	D-M		100 200 300 400		XW-MW BASALT
					None Observed		0.5			MW BASALT: Dark grey, stained pale brown; very high strength; broken into blocks to 400mm in size on excavation.				Weathered in-situ core stones (sub angular to subrounded)	MW BASALT
							1.0			Test pit CG6 terminated at 0.9m					
							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 W _p 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
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Excavation No. **CG7**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 346847 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7045798 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations	unit geology
BH	1	2	3	N					CH	CLAY: High plasticity, red brown; fine to coarse angular basalt gravel; moist; some zones of clayey gravel; trace of cobbles and boulders		Fb/VSt			RESIDUAL SOIL
						0.5					VSt/H				
						1.0		MW	MW BASALT: Dark grey and pale brown; high strength to very high strength; breaks into fragments of 40mm to 300mm on excavation; numerous clay seams and zone of variable thickness						
							1.5			Test pit CG7 terminated at 1.1m					
							2.0								
							2.5								

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG8**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 347826 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7045896 m datum: AHD

excavation information						material substance									
method	penetration			support	water	notes samples, tests, etc	depth metres	graphic log	classification symbol	material	moisture condition	consistency/ density index	pocket penetro- meter kPa	structure and additional observations	unit geology
BH	1	2	3	N			0.5		CH	CLAY: High plasticity, red brown; fine to coarse angular basalt gravel; some zones of clayey gravel; trace of cobbles and boulders	M	Fb/VSt			RESIDUAL SOIL
									MW	MW BASALT: Dark grey and pale brown; high strength to very high strength; breaks into fragments of 40mm to 300mm on excavation; numerous clay seams and zones of variable thickness		VSt/H			MW BASALT
							1.0			Test pit CG8 terminated at 0.9m					
							1.5								
							2.0								
							2.5								

Sketch

method	support	notes, samples, tests	classification symbols and soil description	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water level on date shown water inflow water outflow	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	based on unified classification system moisture D dry M moist W wet Wp plastic limit WL liquid limit	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

Excavation No. **CG9**

Engineering Log - Excavation

Sheet 1 of 1

Project No: **GEOTKPAR01416AA**

Client: **INVESTEC BANK (AUSTRALIA) LIMITED**

Date started: **21.5.2008**

Principal:

Date completed: **21.5.2008**

Project: **COOPERS GAP WINDFARM**

Logged by: **IS**

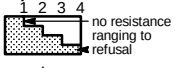
Test pit location: **See Figure 1**

Checked by:

equipment type and model: CASE - 450mm Bucket Pit Orientation: Easting: 847441 m R.L. Surface:
excavation dimensions: 3.5m long 0.7m wide Northing: 7045968 m datum: AHD

excavation information						material substance										
method	penetration			support	water	notes samples, tests, etc	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	structure and additional observations	unit geology
BH	1	2	3	N			RL			CH	CLAY: High plasticity, red brown; fine to coarse angular basalt gravel; moist; some zones of clayey gravel; trace of cobbles and boulders	D-M	Fb/VSt	100 200 300 400		
							0.5			MW	MW BASALT: Dark grey and pale brown; high strength to very high strength; breaks into fragments of 40mm to 300mm on excavation; numerous clay seams and zones of variable thickness Test pit CG9 terminated at 0.85m					
							1.0									
							1.5									
							2.0									
							2.5									

Sketch

method	support	notes, samples, tests	classification symbols and soil description based on unified classification system	consistency/density index
N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	S shoring N nil penetration 1 2 3 4  no resistance ranging to refusal water  water level on date shown  water inflow  water outflow	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	moisture D dry M moist W wet Wp plastic limit WL liquid limit	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