Mark T Mitchell Ltd

Consulting Geotechnical Engineers

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Ref: T – 9036/1
19 October, 2006

Blance & Associates
Registered Surveyors
19 Manuaute Street
Taumaranui

Attention: Ian Blance

Dear Sirs,

Re: Site Assessment and Supplementary Geotechnical Engineering Appraisal
Proposed Whareroa North Residential Subdivision
Hauhungaroa No. 6, Whareroa Road North, West Lake Taupo

In accordance with your request, we have carried out a supplementary Geotechnical Assessment of the above referenced property. The purpose of our investigation and assessment was to determine the geomorphology and processes that formed the western side of the proposed subdivision area. We understand that the low-lying area has been allocated for future filling to bring it up to a level near that of the upper terraces.

This report is a supplement to our earlier report dated 4 August, 2006 that included site testing and recommendations for on-site disposal of stormwater for the proposed Whareroa North Residential Subdivision.

1. Introduction

The proposed residential subdivision is located within Whareroa Station farm, alongside the south-western shores of Lake Taupo, adjacent to Kuratau village. The property is bounded to the southwest and southeast by moderately steep to steep slopes that fall some 30 to 40 metres to Whareroa Stream and Lake Taupo respectively. (*ref.* Fig. 1).

The development site is presently accessed through Whareroa Station via farm tracks however, all lots will be accessed from a new road to be constructed from Kuratau. The road will course near parallel to Lake Taupo and then ascend the moderately steep to steep slope gaining access to the upper terraces being the proposed subdivision.

Fig. 1: View south towards the low-lying area with Lake Taupo in the distance. Test Pit No. 1 is in the foreground.

In the main, the site consists of a gently sloping terrace area. However, near the western edge of the subdivision, the land surface falls some 15 metres to a smaller, low-lying area. A steep slip-scarp is exposed along the south-western fenceline that drops to Whareroa Stream below. (*ref.* Fig. 2).

Fig. 2: Slip scarp along the south-western side of the subdivision displaying the distinct stratification of the volcanic soils.

An overall scheme plan showing the area investigated is re-presented on the attached Site Plan, Drawing No. 9036-01. The Plan includes the western part of the roading and section layout of the proposed subdivision, as prepared by Blance and Associates, Registered Surveyors. The development proposal involves the subdivision of the land to create some 150 separate titles.

The purpose of the Soils Investigation was to determine the subsurface conditions within an area of concern and to evaluate what special conditions, if any, would be required for the proposed filling within this area. The test pits were excavated to varying depths governed by the soils encountered.

2. Local Geology and Site Geomorphology

The underlying rock formation in the area consists of 'welded' rhyolitic Ignimbrite rock being the Whakamaru Ignimbrite. This was deposited during a volcanic episode from the Taupo Volcanic Zone during the Pleistocene period (New Zealand Castlecliffian Stage) approximately 300,000 years ago.

These rocks have been overlain by undifferentiated volcanic air-fall tephras (Ash) during various subsequent Taupo Volcanic Zone eruptions, creating the gently rolling country typical of the site under investigation.

The property sits above Lake Taupo and Whareroa Stream, the latter of which has cut down through the ashes and Ignimbrite bedrock to an equilibrium level at Lake Taupo. Apart from the cliff failure along the western fenceline, the site does not exhibit signs of significant historical landslips. Minor localised slumps were observed along the steepest section of the slope below the upper terrace. (*ref.* Fig. 3).

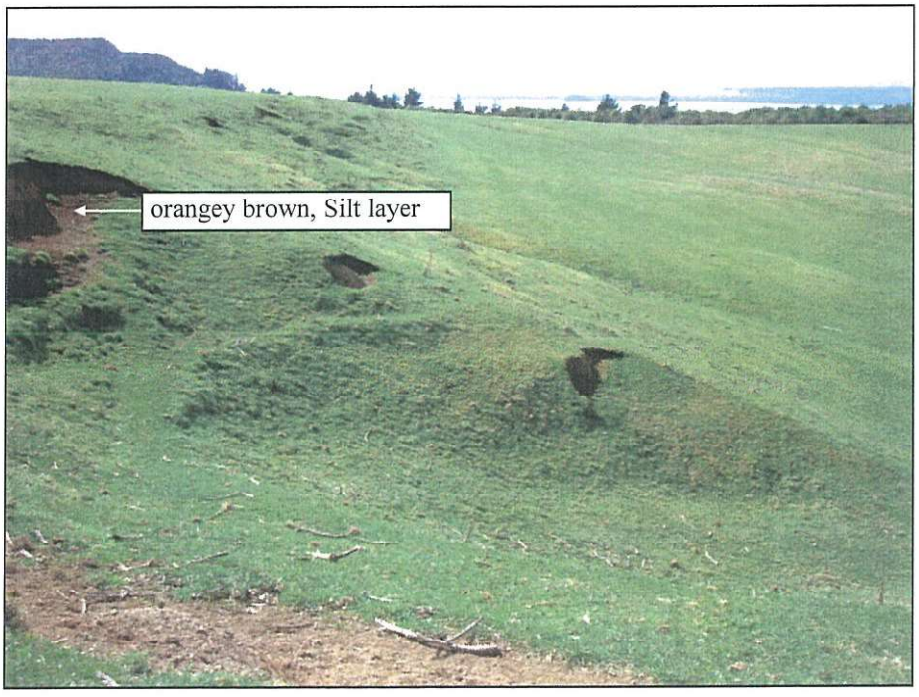


Fig. 3: Minor slumps along the east-west oriented slope that separates the upper terrace from the low area. Lake Taupo can be seen in the distance to the east.

The results of our investigation and assessment of the ground conditions are as follows:

3. Field Investigations and Soil Conditions

The subsurface conditions at the site were investigated by excavating seven Test Pits at the locations shown on the Site Plan, Drawing No. 9036-01. These Test Pits are designated Nos. 1 to 7 with the Test Pit Logs presented on Figs. A-1 to A-8 and are described below.

The purpose of the test pits was to provide guidance as to the general subsurface soil profile and variability of the soils within the proposed subdivision area. Actual ground conditions may vary across the proposed site however, and may differ slightly from those as described below due to the diverse nature of the volcanic soils in the area.

Soil conditions encountered below the site are also presented diagrammatically on the attached Ground Profiles, Drawing No. 9036-02. The profiles were surveyed through the site during the field investigations, by Blance and Associates staff, Registered Surveyors.

Test Pit Nos. 1 to 3, 6 and 7

These Test Pits were excavated along the east-west aligned, moderately steep slope (ref' Fig 3). The test pits revealed a deep Topsoil layer, some 200 to 500mm thick. Beneath the Topsoil, a layer of orangey brown, clayey, sandy SILT mantled the relict slope and was traced to varying depths in the test pits. (*ref'* Fig 4)

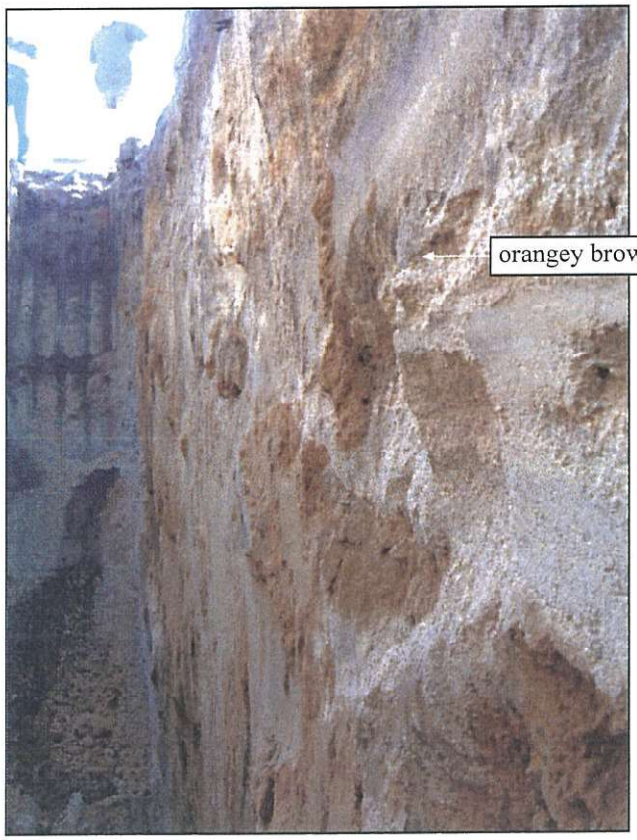


Fig. 4: Test Pit No. 1 revealed an orangey brown, clayey, sandy Silt layer below the Topsoil.

Just below the top and down the steeper part of the slope, the Silt layer was found directly beneath the Topsoil layer. However, on the upper terrace, near the toe of the slope and on the low-lying terrace area, various Sand layers overlie the Silt layer.

This displays a typical feature of the sandy Ash soils. These air-fall ashes and soils cannot maintain their position on moderately steep to steep slopes and will migrate downward to settle on less steep areas either during deposition, or soon afterwards.

Ground Profile AA displays the proposed stratification below the surface using information revealed by the test pits. The Silt layer can be seen to mantle the area and outcrops at the slip face some 1.5 metres below the surface as seen in Fig. 2.

Test Pit No. 5

This Test Pit was excavated to the east of the area of concern and encountered silty and gravelly pumiceous SANDS, but not the orangey brown, Silt layer. Ground Profile BB assumes that the Silt layer may indeed be present in this area however, probably at some depth below the Sand layers.

The test pits were terminated at varying depths from 3.1 to 4.8 metres below existing ground level.

Groundwater was not encountered in the Test Pits at the time of investigation.

4. Geotechnical Assessment

The purpose of carrying out the excavations along and down the depressed basin area of the site was to assess whether the bowl-shape feature was the remnants of a shallow landslide. If this were the case, the addition of filling over this feature could result in a further landslip feature.

As described in Section 3 above, the near-surface Silt-ash soils within the basin area do reveal that some downslope movement of these air-fall deposits has occurred, but it has likely been at a time soon after they were deposited. This movement has occurred over the top of the sand and gravel soils that were deposited some time before as alluvial or delta deposits when the lake level was considerably higher than it is today.

5. Site Preparation Recommendations

The test pits has revealed that the ash-soils that occur in the region of the steeper ground have been disturbed during their deposition and are therefore likely to be compressible.

On this account, it is recommended that at the time commencement of filling of this area, after the Topsoil has been removed, this steeper area is to be cut down to reveal the underlying sand and gravel soils. The excavated soils would be used as filling over the lower, near-level parts of the site, with some air-drying prior to their compaction.

This process would also enable benching of the underlying soils to be carried out over the steeper parts of the site.

Also, due to the extreme variability in material type present within the upper 2 to 3 metres in this area, and associated variations in compression, filling is to be carried out in the summer months under the supervision of a Chartered Engineer.

The steep and high slip-scarp at the south-western fenceline that runs down to the stream below will required remedial action to be taken as soon as possible as it appears that this erosion failure-feature is increasing in size.

5. Road Construction

Directly below the subject site and above the steep slopes that drop to the shores of Lake Taupo, a naturally occurring, 4-metre high relict bench exists along where the proposed access road is to be constructed. We understand that the road construction may follow alongside and below this high feature.

The high bench feature appears stable, however does not consist of welded Ignimbrites, but rather sandy ashes and Gravels. Therefore, the development of the road access to the development site will need to be carried out with caution as cut slopes in these materials will be prone to on-going slope instability unless they are cut back to less than the angle of repose of loose sand and gravel, which is about 33 degrees to the horizontal, or less than 1 in 1.5 slope gradient.

6. Conclusion

The results of this study indicate that based upon available information, the proposed subdivision area investigated is stable and suitable for filling. The Ash soils that mantle the site in their natural state and attitude have not caused significant slumping of the ground surface. The area under investigation is a natural bench feature created by welded Ignimbrite bedrock mantled by younger air-fall tephra material.

Yours faithfully

Mark T Mitchell Ltd

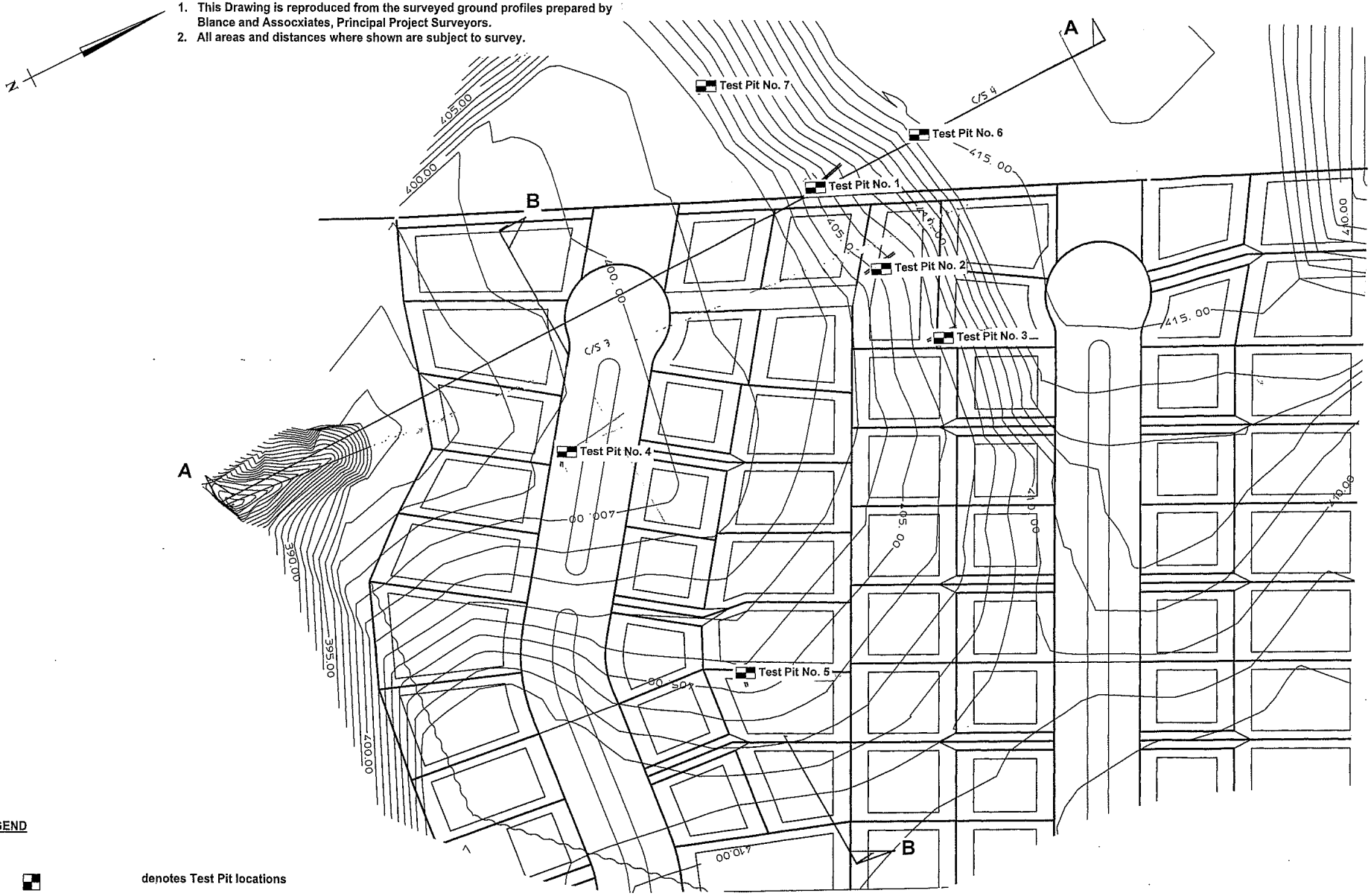
Mark T Mitchell
Director

References

Grindley, G.W., 1960: Geological Map of New Zealand, Sheet 8 – Taupo, 1:250,000. *New Zealand Geolocial Survey, Department of Scientific and Industrial research, Wellington, New Zealand.*

NOTES

1. This Drawing is reproduced from the surveyed ground profiles prepared by Blance and Assocxiates, Principal Project Surveyors.
2. All areas and distances where shown are subject to survey.



LEGEND

denotes Test Pit locations

" Ground Profile locations

SCALE 1: 1500

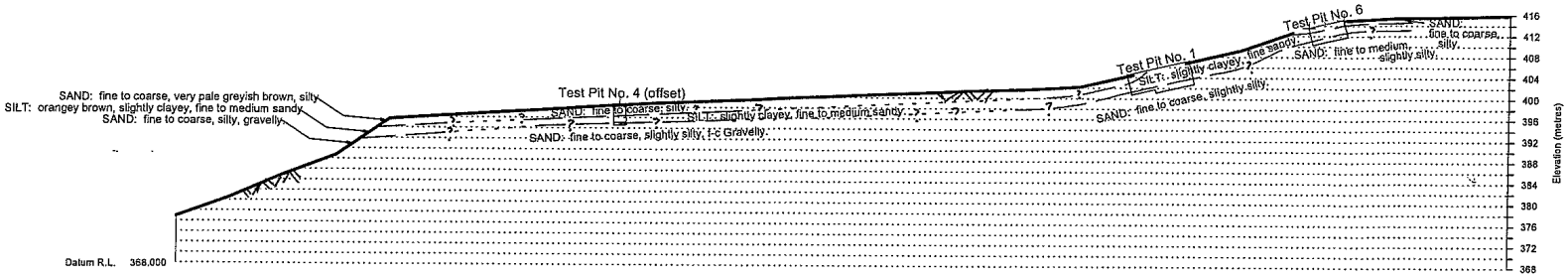
0 30 60 90 120 150 Metres

Mark T Mitchell Ltd Consulting Geotechnical Engineers 1150 Victoria Street, P.O. Box 9123, Hamilton	BLANCE & ASSOCIATES Investigation for Proposed Residential Subdivision Hauhungaroa No. 6, Whareroa North, Whareroa	**SITE PLAN**	DRAWING No. 9036-01 DATE October 2006 ISSUE One

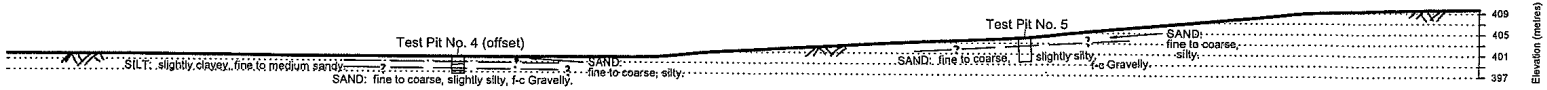
ptopelex\c\00Working Folder\9036_Whareroa Rd Kuratau BLANCE-draft profiles.VCD 9/30/2006

NOTES

1. This Drawing is reproduced from the surveyed ground profiles prepared by Blance and Associates, Principal Project Surveyors.
2. All areas and distances where shown are subject to survey.



GROUND PROFILE A - A



GROUND PROFILE B - B

SCALE 1: 1500

0 30 60 90 120 150 Metres

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BLANCE & ASSOCIATES

Investigation for Proposed Residential Subdivision
Hauhungaroa No. 6, Whareroa North, Whareroa

GROUND PROFILES

DRAWING No. 9036-02
DATE October 2006
ISSUE One

TEST PIT LOG No. 1

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.	0				
	SILT: orangey brown, moist, slightly clayey, fine sandy.	1				
		2				
		3				
	SAND: fine to coarse grained, light grey, moist, slightly silty.	4				
	Tets Pit Completed 07/09/06	5				
		6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
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BORE HOLE LOG

TEST PIT No. 1
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-1

TEST PIT LOG No. 1A

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, pale grey, moist, silty.	1				
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2				
	SAND: fine to coarse grained, light grey, moist, slightly silty containing fine Gravels.	3				
	Tets Pit Completed 07/09/06	4				
		5				
		6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
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BORE HOLE LOG

TEST PIT No. 1A
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-2

TEST PIT LOG No. 2

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)
	TOPSOIL.	
	SAND: fine to coarse grained, pale grey, moist, silty.	1
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2
	SAND: fine to coarse grained, moist, light grey, slightly silty containing fine Gravels.	3
	Tets Pit Completed 07/09/06	4
		5
		6

GEOLOGICAL FORMATION

VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)

SCALA PENETROMETER (blows/100mm)

1 2 3 4 5 6 7 8 9 10

PIEZOMETER / WATER LEVEL

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
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BORE HOLE LOG

TEST PIT No. 2
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-3

TEST PIT LOG No. 3

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)
	TOPSOIL.	
	SAND: fine to coarse grained, pale grey, moist, silty.	1
	SAND: fine to coarse grained, very pale greyish brown, moist, slightly silty containing fine to coarse Gravels.	2
	SAND: fine to coarse grained, pale grey, moist, silty.	
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	3 4
	SAND: fine to coarse grained, light grey, moist, silty.	
	Tets Pit Completed 07/09/06	5 6

GEOLOGICAL FORMATION

VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)

SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10

PIEZOMETER / WATER LEVEL

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

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BORE HOLE LOG

TEST PIT No. 3
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-4

TEST PIT LOG No. 4

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)
	TOPSOIL.	
	SAND: fine to coarse grained, very pale greyish brown, moist, silty.	1
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2
	SAND: fine to coarse grained, light grey, moist, slightly silty containing fine to coarse Gravels.	3
	Tets Pit Completed 07/09/06	4
		5
		6

GEOLOGICAL FORMATION

VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)

SCALA PENETROMETER (blows/100mm)

1 2 3 4 5 6 7 8 9 10

PIEZOMETER / WATER LEVEL

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES

JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa

JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator

RIG: 12T CAT

DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ

DATE: 07/09/06

CHECKED: KH

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1160 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 4

LOCATION: Refer Site Plan RL (m):

SHEET: 1 OF 1 Fig. No. A-5

TEST PIT LOG No. 5

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, greyish brown, moist, silty.	1				
	SAND: fine to coarse grained, pale grey, moist, slightly silty containing fine to coarse pumiceous Gravels.	2 3 4 5 6				
	Tets Pit Completed 07/09/06					

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
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BORE HOLE LOG

TEST PIT No. 5
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-6

TEST PIT LOG No. 6

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)
	TOPSOIL.	
	SAND: fine to coarse grained, pale grey, moist, silty.	1
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2
	SAND: fine to medium grained, pale brownish grey, moist, slightly silty.	3
	Tets Pit Completed 07/09/06	4
		5
		6

GEOLOGICAL FORMATION

VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)

SCALA PENETROMETER (blows/100mm)

1 2 3 4 5 6 7 8 9 10

PIEZOMETER / WATER LEVEL

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
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DRILLER: Dave Porritt

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BORE HOLE LOG

TEST PIT No. 6
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-7

TEST PIT LOG No. 7

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.	0				
	SAND: fine to coarse grained, light brownish grey, moist, silty containing fine pumice Gravels.	1				
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	3				
	SAND: fine to coarse grained, light brownish grey, moist, slightly silty.	4				
	Tets Pit Completed 07/09/06	5				
		6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

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JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

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BORE HOLE LOG

TEST PIT No. 7
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-8