



s 7(2)(f)(ii)

Tauranga City Council
Private Bag 12022
TAURANGA

17 December 2007

Our Ref: 3203964/100
T1:71117-ST57DL02.DOC

Dear s 7(2)(f)(ii)

Mt Maunganui Beachside Holiday Park Slip Assessment

1 Introduction

Beca Infrastructure Ltd (Beca) has been engaged by Tauranga City Council (TCC) to undertake a review and assessment of a slip within the Mt Maunganui Beachside Holiday Park. This slip is in close proximity to a camp site.

Included within this letter are the findings of the geotechnical investigation undertaken and recommendations for short-term and long-term remedial options. The geotechnical assessment undertaken for this stage is at a preliminary level only. Most of the recommendations are derived from observations of the site and a review of the field testing undertaken. No geotechnical analysis has been performed for this stage.

2 Site Description

The slip has occurred within a slope that has a camping site at the top and an access way at the base (see attached photographs). The slip has occurred within the upper section of the slope, which is approximately 10 m high with a batter slope of between 23° and 40°. Above the slope is a relatively level area that is used as a camping site, at the back of the camp site there is an approximately 1.7 m high 50° batter and beyond that is a moderate slope. At the toe of the failure slope there is a 7 m wide sealed access way. Beyond the access way there is an approximately 2.5 m high 33° slope which flattens off at the base.

The upper section of the slope has slumped with a vertical headscarp forming along the top of the slope. No evidence of movement has been noted within the lower section of the slope.

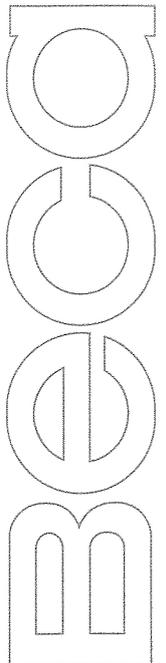
3 Site Investigations

A field investigation was conducted by a Beca geotechnical engineer on 3 December 2007, comprising three hand augers with shear vanes and Scala penetrometers. Disturbed samples were collected at 0.5 m intervals. The hand augers were advanced to refusal at between 2.0 m and 2.7 m below existing ground level, while the Scala penetrometers were terminated at 2.1 m and 3.0 m below existing ground level.

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4 Geology

The site is underlain by the Mt Maunganui Formation, which is part of the Minden Rhyolite (Briggs et al, 1996). The Minden Rhyolite varies widely, it may be light to dark grey, or cream or pink with flow banding and commonly spherulitic. It consists of phenocrysts of plagioclase, hypersthene, hornblende, augite and minor quartz and ranges in age between Late Miocene and Pliocene. The lower flanks of Mt Maunganui are covered with a layer of redeposited weathered and reworked material consisting of large boulders within a matrix of silt and clay.

5 Geotechnical Assessments

5.1 Site Observations

An inspection of the site was undertaken as part of the site visit. The following was observed:

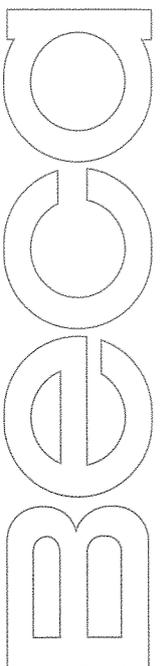
- The observed instability appears to be confined to the upper slope area, and to have caused the crest of the slope to recede by around 0.5 m.
- There is evidence of near surface instability, ie localised small slumps and soil creep, within the surrounding steeply sloped areas.
- A scarp was observed along the top of this slope, indicating around 50 mm to 100 mm of vertical movement.
- The slope surface is mantled in variable fill materials. Assorted debris, including concrete blocks and plastic, plus topsoil was noted within this fill.
- The remainder of the slope area is variably covered in grass, bushes and small trees.

A discussion with the holiday park staff has indicated the following:

- Following the removal of the caravan and permanent structure, the site was re-levelled and additional topsoil placed on it and possibly on the upper part of the failed slope.
- Substantial water flows over the area during heavy/prolong rainfall events, with water flowing from the upper flanks of Mt Maunganui.
- The camping site had been occupied by a caravan and permanent structure for a number of years; following the removal of the permanent structure it had been noted that a shower within the structure had been discharging waste water down the slope to the west of the failure.

5.2 Soil profile

The soil profile encountered with the hand augers consisted of silty clay that overlays weathered rhyolite (see attached cross-section). The hand augers show that the upper 1 m of the upper section of the slope consist of fill material (silty clay with organic material),



while the upper 0.7 m of the lower section consists of cohesive fill materials containing plastic, glass and charcoal and other debris.

The in situ materials encountered had shear strengths in the range of 50kPa to over 150kPa. No groundwater was encountered within the hand auger holes.

5.3 Slope Instability Mechanism

The observed instability appears to be confined to the fill materials that overlay the stiff in situ soils encountered on this slope. These materials have likely been placed as a part of localised earthworks to form a platform for a caravan site, and appear to have been compacted poorly and with unsuitable materials used.

Instability of a similar type to that observed is likely to continue in the future. These future episodes will continue to cause the crest of the slope to retreat, potentially by an additional 1 m to 2 m. A large scale and deep seated movement appears unlikely given the stiff in situ soils encountered below the fill.

The trigger for future instability is likely elevated groundwater levels, either by heavy or persistent rainfall, particularly if surface water run-off concentrates in the area, or potentially by water discharges from camp site occupiers.

6 Recommendations

The recommendations made consider immediate requirements to allow some use of the camp site if possible over this summer and for longer term remedial options.

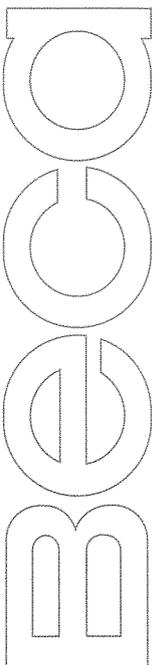
6.1 Short term

The recommended immediate action is to restrict access to the crest of the slope in the short term and until a remedial option has been selected, keeping campers and vehicles clear of the slope crest.

A suitable set back is around 2 m, though this may restrict the use of the adjoining camp site. This set back has some allowance for future localised slumping to occur over the summer. Periodic inspections should also be undertaken, particularly after heavy rainfall. The adjacent camp site should be closed should any further instability occur.

A suitable measure to restrict access includes placing large painted rocks or installing posts a minimum of 2 m from the crest of the slope.

No uncontrolled water discharges near the crest of the slope should be permitted from occupiers (ie showers and other domestic uses) of the adjoining camp site.



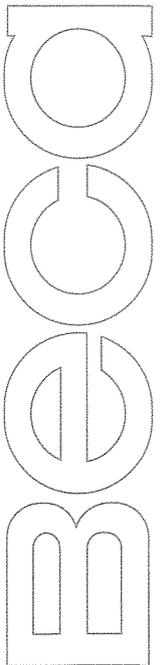
Long-term

There are several options for the long-term remediation of the slope. All options require the fill materials encountered within the upper portion of the slope to be either replaced or retained. All options would require access onto and above the slope and could not be undertaken while occupied.

Potential options include the following:

- Construct a timber pole retaining wall:
Locally retain the upper section of the slope with a timber pole retaining wall founded within the underlying stiff soils. Constructing the wall on this steep slope would be challenging.
- Reconstruct the upper slope:
Excavate the uncontrolled and poorly compacted fill and backfill with compacted engineered fill. This fill would be keyed into the in situ soils and may include drainage measures.
- Abandon use of the adjoining camp site:
The adjoining camp site may need to be abandoned if the cost of the slope remedial measures are too high or the risk of future instability remains despite remedial measures being constructed. Should this be selected, some localise earthworks is recommended to flatten off the upper slope plus revegetation to reduce erosion.

Additional assessment and design would be required to assess the feasibility of these and other potential options.



If you have any questions regarding the content of this letter, please do not hesitate to contact the undersigned.

Yours sincerely

[Redacted signature block]
s 7(2)(a) ... Privacy

on behalf of

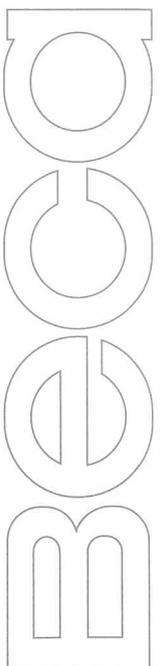
Beca Infrastructure Ltd

[Redacted contact information]
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References

Briggs, R. M., Hall, G. J., Harmsworth, G. R., Hollis, A. G., Houghton, B. F., Hughes, G. R., Morgan, M. D., and Whitbread-Edwards, A. R. (1996) 'Geology of the Tauranga Area' sheet U14, Scale 1:50 000, occasional report No. 22, Department of Earth Sciences, University of Waikato, 1996, 57p + map.



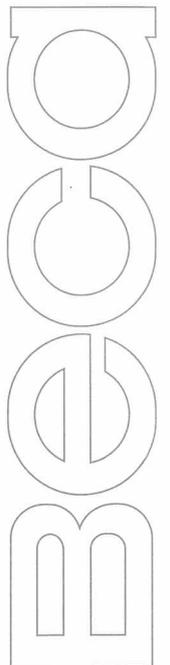
Site Photographs



Photo 1: Looking across the slope from the eastern side.



Photo 1: Looking along the top of the failure slope from the western side, recent movement indicated by the near vertical scarp.







HAND AUGER LOG

PROJECT: Mauao Slip JOB NUMBER: 3203964/100
 SITE LOCATION: Mount Maunganui Campground CLIENT:

BOREHOLE LOCATION:
 COORDINATES: N m R L: 11.9 m
 E m DATUM:

| GEOLOGICAL UNIT | R L (m) | DEPTH (m) | WATER LEVEL | GRAPHIC LOG | CLASSIFICATION | MOISTURE | CONSISTENCY | SOIL DESCRIPTION | SAMPLES | Scala (Blows/150mm) | SV (kPa) | τ (kPa) |
|---------------------------|---------|-----------|-------------|-------------|----------------|----------|-------------|---|---------|---------------------|----------|---------|
| | | | | | | | | | | | | |
| Topsoil and Fill | | | | | ML | D | F | Firm dark brown clayey silt TOPSOIL; dry, trace seashells. | | 1 | | |
| | | | | | OL | M | F | Firm black ORGANIC SILTY CLAY; moist, plastic, amorphous. Trace inclusions of non-decomposed timber. | | 9 | | |
| Tephra | 11 | 1 | | | CH | M | VSt | Very stiff brownish orange CLAY, trace gravel, trace sand; moist, high plasticity. Gravel is fine grained, sub-angular. Sand is fine grained. Contains pockets of cemented brownish white and grey silt. Pockets to 8 mm in diameter. | | 4 | 100/12 | 150/17 |
| | | | | | | | | | | 6 | | |
| Weathered Minden Rhyolite | 10 | 2 | | | CL | M | VSt | Very stiff brown mottled bluish red and reddish brown SILTY CLAY, trace sand; moist, moderate plasticity. Bluish red and reddish brown patches are silt. Sand is fine grained. Trace pockets of grey silt. Pockets to 5 mm in diameter. | | 6 | 110/12 | 171/17 |
| | | | | | | | | | | 10 | | |
| | | | | | MH | M | VSt | Very stiff brown with pockets of grey CLAYEY SILT; moist, low plasticity, friable. | | 10 | 110/12 | 171/17 |
| End of Hand Auger 2.7 m. | | | | | | | | | | 6 | | |
| | | | | | | | | | | 9 | | |
| | | | | | | | | | | 3 | | |
| | | | | | | | | | | 5 | | |
| | | | | | | | | | | 4 | | |
| | | | | | | | | | | 8 | | |
| | | | | | | | | | | 4 | | |
| | | | | | | | | | | 7 | | |
| | | | | | | | | | | 5 | | |
| | | | | | | | | | | 6 | | |

DATE DRILLED: 3/12/07 EXCAVATION METHOD:
 LOGGED BY: s 7(2)(a) - F COMMENTS: Refusal at c. 2.7 m.
 PILCON VANE No: DR 4494 REVIEWED BY: s 7(2)(a)

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

BIL HA P:\3201320000\F00TE\3203964\100\MAUAO SLIP.GPJ BCHFMB2.GDT 17/12/07

Mauao Slip

0.00m to 2.00m



2.00m to 2.70m



HA01



PROJECT: Mauao Slip JOB NUMBER: 3203964/100
 SITE LOCATION: Mount Maunganui Campground CLIENT:

BOREHOLE LOCATION:
 COORDINATES: N m R L: 7.2 m
 E m DATUM:

| GEOLOGICAL UNIT | R L (m) | DEPTH (m) | WATER LEVEL | GRAPHIC LOG | CLASSIFICATION | MOISTURE | CONSISTENCY | SOIL DESCRIPTION | SAMPLES | Scala (Blows/150mm) | SV (kPa) | τ (kPa) |
|-----------------|---------|-----------|-------------|-------------|----------------|----------|--------------------------|---|---------|---------------------|----------|--------------|
| Topsoil | | 0 | | | OL | D | F | Firm dark brown clayey silt TOPSOIL; dry becomes moist | | | | |
| Tephra | | 0.7 | | | CL | M | St | Stiff brown CLAY, some sand, trace organics (rootlets); moist, moderate plasticity. Sand is fine to medium grained, sub-rounded to sub-angular. | | | 78/10 | 110/15 |
| | | 1.6 | | | SC | M | MD | "Medium dense" light brown CLAYEY SAND; moist, low plasticity, pumiceous. | | | 65/20 | 93/28 |
| | | 2.0 | | | CL | M | St | Stiff brown CLAY, some sand, trace organics (rootlets); moist, moderate plasticity. Sand is fine to medium grained, sub-rounded to sub-angular. | | | | |
| | | 2.1 | | | | | VSt | At c. 2.0 m. becomes very stiff. | | | 140/16 | 215/23 |
| | | 5.0 | | | | | End of Hand Auger 2.1 m. | | | | | |

DATE DRILLED: 3/12/07 EXCAVATION METHOD:
 LOGGED BY: § 7(2)(a) - COMMENTS: Refusal at c. 2.1 m.
 PILCON VANE No: DR 4494 REVIEWED BY: § 7(2)(a)

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

BIL HA P:\320132000\OFF\00TE\3203964\100\MAUAO SLIP.GPJ_BCH\FMB2.GDT 17/12/07





Beca

HAND AUGER No: HA03

HAND AUGER LOG

SHEET 1 of 1

PROJECT: Mauao Slip JOB NUMBER: 3203964/100
 SITE LOCATION: Mount Maunganui Campground CLIENT:

BOREHOLE LOCATION:
 COORDINATES: N m R L: 5.1 m
 E m DATUM:

| GEOLOGICAL UNIT | R L (m) | DEPTH (m) | WATER LEVEL | GRAPHIC LOG | CLASSIFICATION | MOISTURE | CONSISTENCY | SOIL DESCRIPTION | SAMPLES | Scala (Blows/150mm) | SV (kPa) | τ (kPa) |
|---------------------------|---------|-----------|-------------|-------------|----------------|----------|-------------|--|---------|---------------------|------------|--------------|
| Topsoil and Fill | 5 | | | | OL CL | D D | F St | Firm brown clayey silt TOPSOIL; dry. Stiff dark brown ORGANIC SILT, trace organics (rootlets); dry, trace rubbish (plastic, glass, charcoal). | | 6 7 9 | 47/14 | 69/20 |
| Tephra | 4 | 1 | | | CL | M | St | Stiff brown SILTY CLAY; some sand, trace organics (rootlets); moist, moderate plasticity. Sand is fine grained. | | 6 8 | 60/10 | 86/15 |
| Weathered Minden Rhyolite | 3 | 2 | | | ML | M | VSt H | Very stiff dark brown SILTY CLAY, some sand, trace gravel; moist, moderate plasticity, pumiceous, friable. Sand is fine to coarse grained, subrounded to angular. Gravel is fine grained, sub-rounded to angular, appears weathered. Trace pockets of bluish red cemented silt. Trace mottling of non-welded pink, white and brown silt. At c. 1.9 m, becomes hard. | | 5 20 24 11 | UTP UTP | |
| End of Hand Auger 2 m. | | | | | | | | | | | | |

DATE DRILLED: 3/12/07 EXCAVATION METHOD:
 LOGGED BY: s 7(2)(a) COMMENTS: Refusal at c. 2.0 m.
 PILCON VANE No: DR 4494 REVIEWED BY: s 7(2)(a)
 FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

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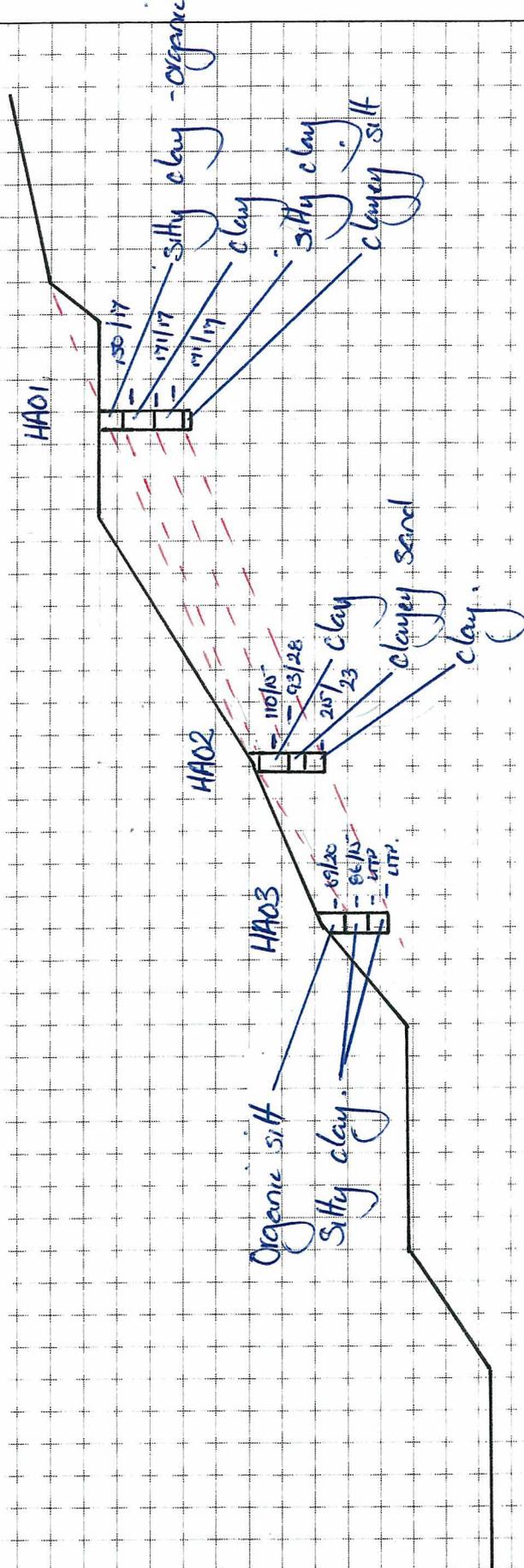


Calculation Sheet

Job name: *Mauvo Slip*
Subject: *Geological cross-section*
By: *s 7(2)(a)*

Job No: *3203964*
Page No: *1 of 1*
Date: *07/12/2007*

Scale 1:200



Legend:
69/20 Shear Vans