Kawakawa Bay
(Turei Hill)
Slip Stabilisation

Presented by Matt Hebden of Opus International Consultants
Presentation Overview

- Initial Slip of August 2008
- Further investigation
- Effects on Community
- Permanent Design
  - Bulk Earthworks
  - Buttress Construction
  - Anchor Installation
- Questions
Initial slip of August 2008

• Approximately 500m$^3$ fell onto and over road.

• Manukau City Council Road Maintenance Contractors co-ordinated clean up.
Second slip of August 2008

• A further 200m³ slipped onto the road.

• Sluicing was carried out by helicopter to dislodge additional material.

• Further investigations were required to identify whether a larger problem existed.

• Road temporarily closed to protect the community.
Further Investigation...
Further Investigation...
Effects on Community

- Kawakawa Bay Road closed on 24\textsuperscript{th} August 2008 due to extreme risk of total failure of the slip surface.
- Kawakawa Bay effectively sealed off from rest of Auckland.
- The 5 houses at the base of the slip were evacuated on 28\textsuperscript{th} August 2008 in fear of catastrophic failure predicted, by some, to be within days.
- Local businesses suffered severe financial pressure.
Effects on Community

- Local schools had temporary class rooms added for additional pupils.
- Ferries provided by Manukau City Council to deliver residents to Pine Harbour.
- Buses also provided for shopping runs to Thames and Papakura townships twice a week.
- A 4x4 track was created to transfer residents to the top of the hill where a temporary car park was created (along with lighting and security cameras).
Effects on Community

- Vector installed a temporary transmission line behind the slip to ensure constant supply.
Effects on Community

- The only alternative route to the rest of Auckland was via a 100km trip.
Permanent Design

- Used a combination of:
  - Large volumes of earth moving;
  - One third of which was used to construct the Toe Buttress;
  - Installation of 46 rock anchors; and
  - Installation of 4km of horizontal bored drains to lower the pore water pressure in the slip zone.
Bulk Earthworks

- Comprised of the following:
  - 100,000 m³ of material removed from the slip surface;
  - 30,000 m³ used in Buttress construction;
  - 70,000 m³ transported via haul roads to the tip site 800 m away; and
  - Removal of an existing stock water storage pond.

- Remaining material contoured into 5 benched levels from RL80 to RL12.
Bulk Earthworks

- Earthworks progress late January 2009.

Location of House
Bulk Earthworks

- Earthworks progress March 2009.
Bulk Earthworks

- Earthworks progress April 2009.
Bulk Earthworks

- Earthworks progress May 2009.
Buttress Construction

• Comprised of the following:
  • 30,000 m³ of material used;
  • Constructed in 1 m lifts and compacted to 140 kpa;
  • Strengthened using multiple 15 m lengths of geogrid at 1 m lifts to increase shear strength and load capacity;
  • Biostrike matting installed on the outer face to facilitate grass strike.
• Several different grades of Geogrid were used depending on location and spacing required.
  • Miragrid 160/50
  • Miragrid 80/30
  • Miragrid 40/40.
Buttress Construction

- Installation of Geogrids
Buttress Construction

- Lower Buttress face.
Anchor Installation

- Comprised of the following:
  - 150 mm dia hole drilled between 46-52 m in length.
  - Anchors design called for a 12 m bond/fixed length.
  - Two test anchors with a 6 m bond length proof tested to a load of 320 tonnes to confirm design.
  - All 46 production anchors proof tested to 280 tonnes with a working load of 180 tonnes.
  - Anchors pull against a 0.6 m x 0.6 m x 80 mm solid steel plate on top of a 2.4 m x 2.4 m x 0.6 m steel reinforced solid concrete face plate.
  - Steel plate required to counter punching shear.
Anchor Installation

- Anchor head details

Anchor Faceplate

Steel Bearing Plate

Anchor Head
Anchor Installation

- Test Anchor 2 during final testing.

350 tonne Jack

Hydraulic Power Pack

Monitoring Equipment
Anchor Installation

Steel bearing Plate

Anchor Head

Anchor strands
Anchor Installation

- Design drawing showing location of each anchor.

AH 1
AH 25
AH 50
AH 70
Anchor Installation

- Design drawing showing confliction zones.
Anchor Installation

- Final location of anchors and completed earth works.
Questions??