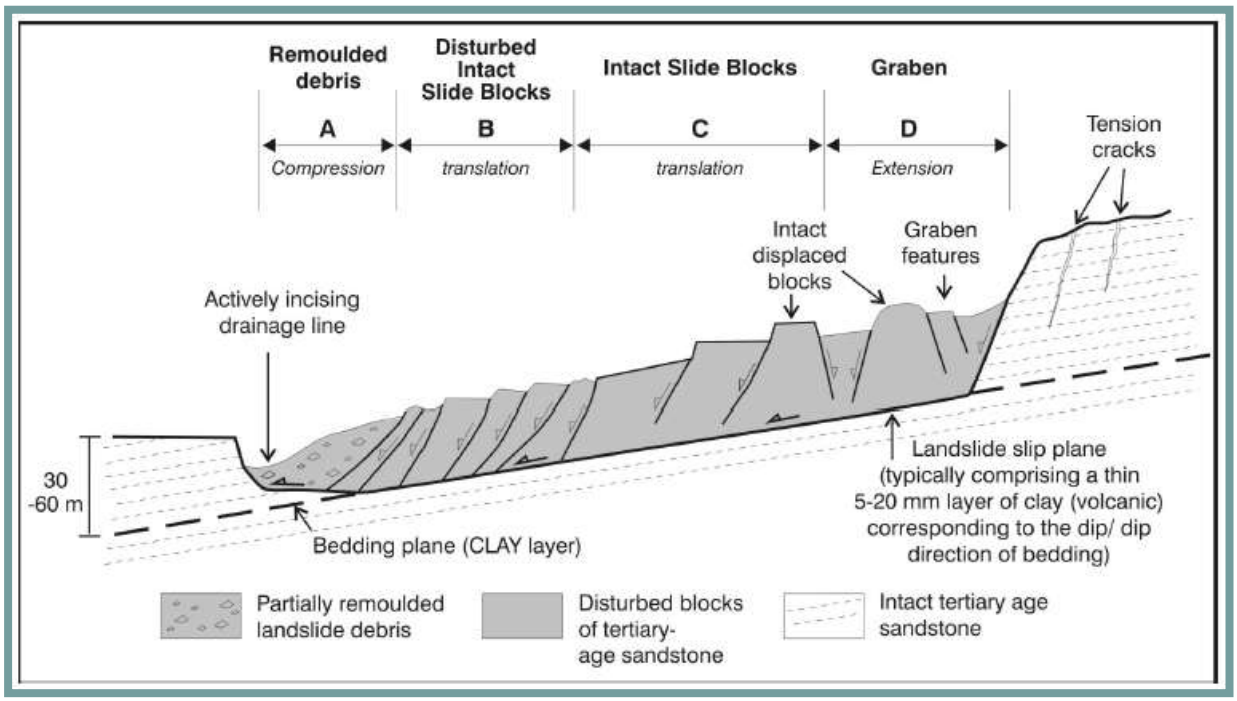
Large Deep Seated Landslide Training Day

This training day will focus on three large deep-seated landslides in the Taihape area and discuss the interaction between factors contributing to movement and effective actions for mitigating damage.

Geomorphology & Background

The Utiku, Taihape and Bird Slide are part of 7000 deep seated translational landslides mapped within New Zealand that that have geomorphically altered our landscape. Landslides in soft rock such as Tertiary aged sandstone and mudstone occasionally accelerate rapidly or reactivate, however the depth of knowledge in relation to reactivation phases and triggering mechanisms is relatively limited.



Translational landslide (Massey, 2010).

Preconditioning Factors

- Factors naturally encompassed by a landscape that predispose it to landsliding.
- E.g: Geology (weakly lithofied geology and clay rich strata/ development of failure surfaces), bedding orientation (dipping down slope). Within the Taihape area bedding is dipping approximately 3°– 7°SSE (Thompson, 1982).

Preparatory Factors

- Factors that change/reduce the stability of a slope from a stable state to a marginally stable.
- E.g: Tectonic activity, weathering (progressively weakens rock mass), climate (incision & undercutting), anthropogenic activity (deforestation & excavation).

Triggering Factors

- Shifts a slope from a stable or marginally stable to active failure.
- Eg: Hydrological processes (saturation, pore water pressures, accelerated incision), seismic interaction.

Utiku Slide

Site History

- Set within the Tarare Sandstone and Tangahoe Mudstone also known as Taihape Mudstone (Massey, 2010).
- Similar age to the Taihape Slide (80,000 years).
- First recorded accelerated movement noted in 1964.
- Since 1964 activity has fluctuated.
- Covers an area of 80 ha with 26 ha of the total still currently active (Massey, 2010).

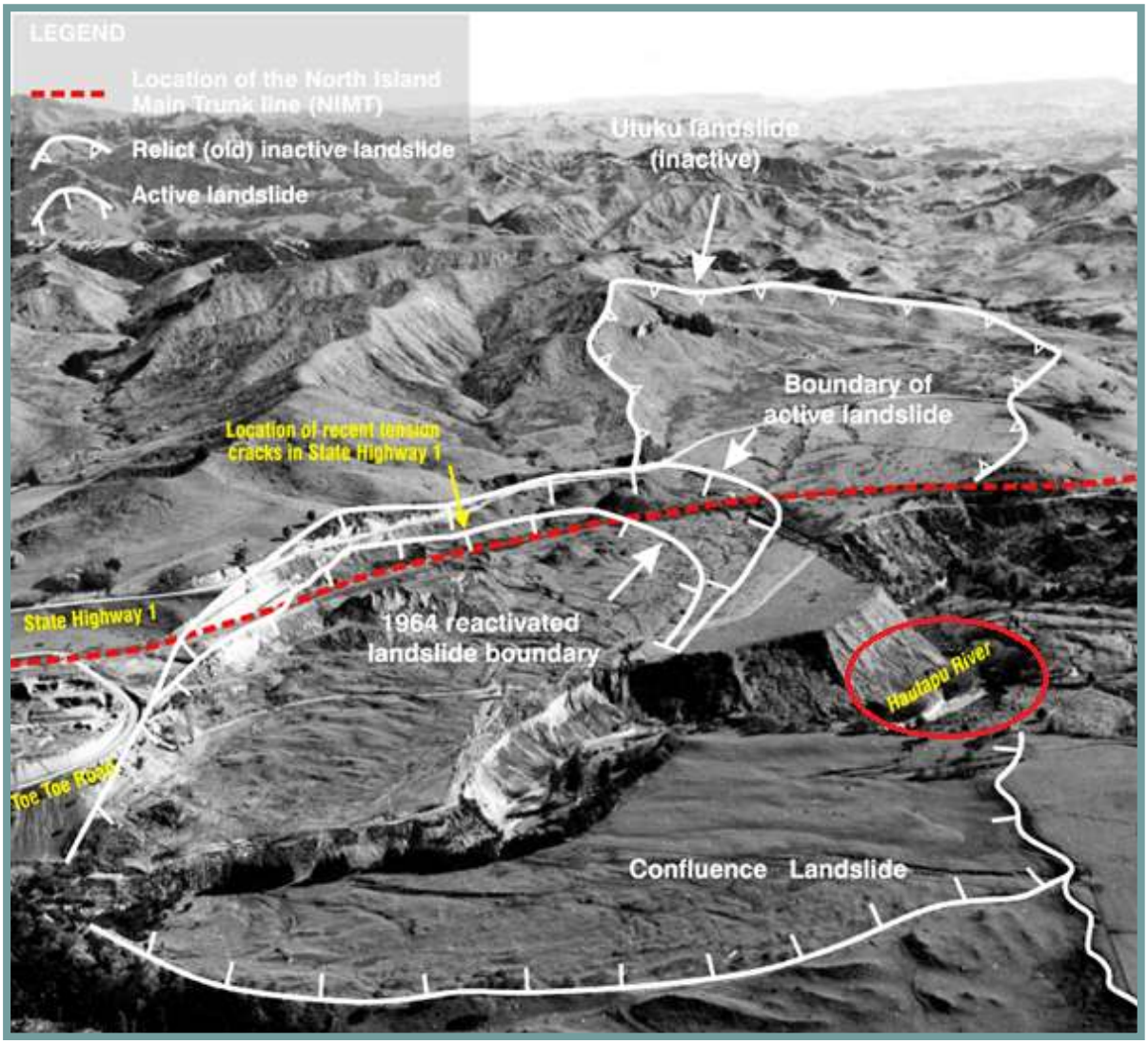
Preconditioning, Preparatory and Triggering Factors

- Incision-driven landslide.
- At the toe of the Utiku landslide, the Hautapu River has exposed potential failure surfaces that dip downslope towards the river, initiating movement (Massey, 2010).
- Continual erosion by the river maintains a creep-style of movement, which occasionally increases during more rapid incision phases.

Effect on Landscape / Infrastructure & Historical Management

- Damage to State Highway One (SH1) and railway lines.
- Caused by the slow, incremental movements of the Utiku Slide.
- The diversion of SH1 above the landslide was implemented in the 1980s to try to mitigate the effects of slumping (Ker, 1970, Read et al., 1998; Massey, 2010). However, movement of the Utiku landslide has since retrogressed upslope towards the new road. Realignment and damage to the road continues.

Monitoring Chris Massey (GNS):
- Surface and subsurface movement
- Pore-water pressure
- Rainfall
- Transient ground accelerations (earthquakes)
- River stage.



Utiku landslide, highlighting incision at the toe by the Hautapu River (Masey, 2010).

Taihape Slide

Site History

- Covers approximately 67 hectares.
- Set within a sandy layer of the Tangahoe Mudstone (Massey, 2010).
- Historically it is said to have originally activated 11,000-1,800 years ago (Thomson, 1982), however (Massey, 2010) estimated an age of 80,000 years based on geomorphology and historical movement.
- Landslide reactivation was first recorded in 1971, with accelerated movement concentrated at the toe.

Preconditioning, Preparatory and Triggering Factors

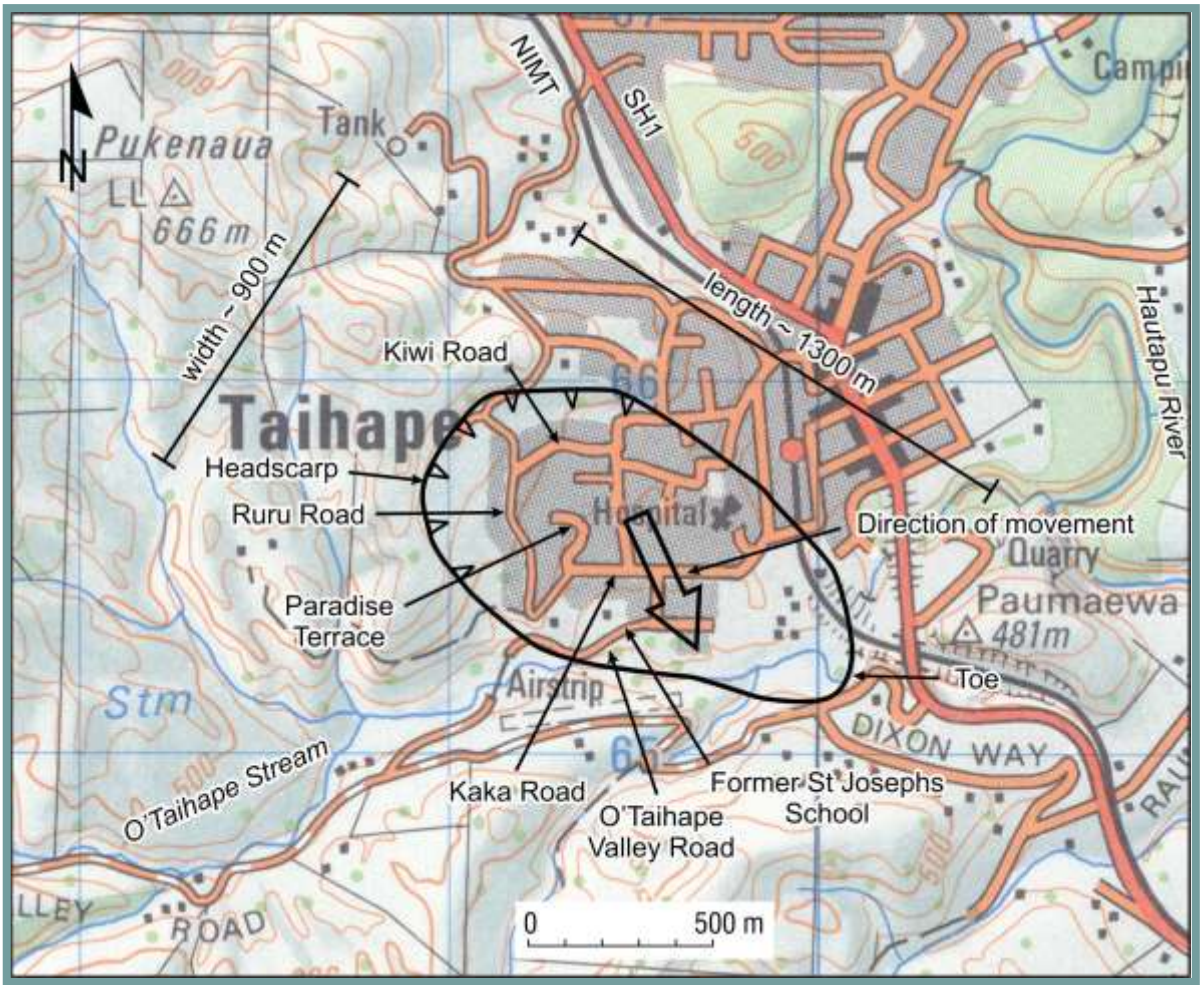
- Toe incised by the Otaihape Stream.
- Incision is thought to be the dominant preparatory and triggering factor in addition to preconditioning factors including mudstone unfavourable strata and bedding dipping down slope.

Effect on Landscape / Infrastructure

- St Josephs Primary School grounds were continually damaged due to landslide movement and closed down in April 2007.
- The Slide is a huge risk to a large proportion (200 homes) of Taihape if movement rapidly accelerated.

Historical Management

- Monitoring Chris Massey GNS;
  - Surface and subsurface movement
  - Pore-water pressure
  - Rainfall
  - Transient ground accelerations (earthquakes)
  - River stage.
- Surveys were conducted every two to five years between 1983 and 2006. No major changes in movement rate were observed until May 2005.



Taihape Landslide (Massey, 2010)

Bird Slide

Site history

- Bird Slide has remained relatively stable, with movement going mostly undetected.
- However, accelerated movement was noted in 1973 (B. Bird, personal communication, March 2013).
- Movement then slowed to previous rates.
- However, M. Bird (Personal communication, 2013) noted the progressive rise in elevation of land at the toe of the landslide during 2012.
- The slow growth of cracks across the slide also pre-empted the sudden reactivation event in September 2012.

Preconditioning, preparatory and triggering factors

- Lithologies within the Bird Slide include unfavorable clay rich strata within the Tangahoe Mudstone that is dipping down slope.
- Compression of material at the toe has continually blocked the main stream at the toe of the slide. Dredging of the stream has occurred until the redirection and excavation of a new drainage path. Compression has also created hummocks which have over steepened farm tracks. Subsequently these hummocks were excavated and flattened. Excavation could have contributed to the unloading of the toe.
- Saturation of the toe through flooding and the presence of a reservoir about the 2012 headscarp (prior to the 2012 event) may have reduced / is reducing the shear strength of the failure surface.
- No clear triggering mechanism such as high magnitude rainfall events or seismic activity.

Effect on landscape/ Infrastructure

- Features such as scarps, antiscarps, tension cracks, shear features, graben formations, rolls/ripples and hummocky terrain are all present.
- Such geomorphology has caused significant damage to fences and roads on the Maryknoll Station for many years.
- The 2012 movement episode caused structural damage to buildings in addition to flooding of land and buildings and the complete drainage of an artificially dammed reservoir above the headscarp.

Historical management

- The toe and head scarp zones of the Bird Slide have undergone earthwork and drainage modifications including;
  - Diverting tributaries at the toe.
  - Implementing nova flow drainage within the headscarp zone.
  - Excavation of hummock material (soil and rock) at the toe.