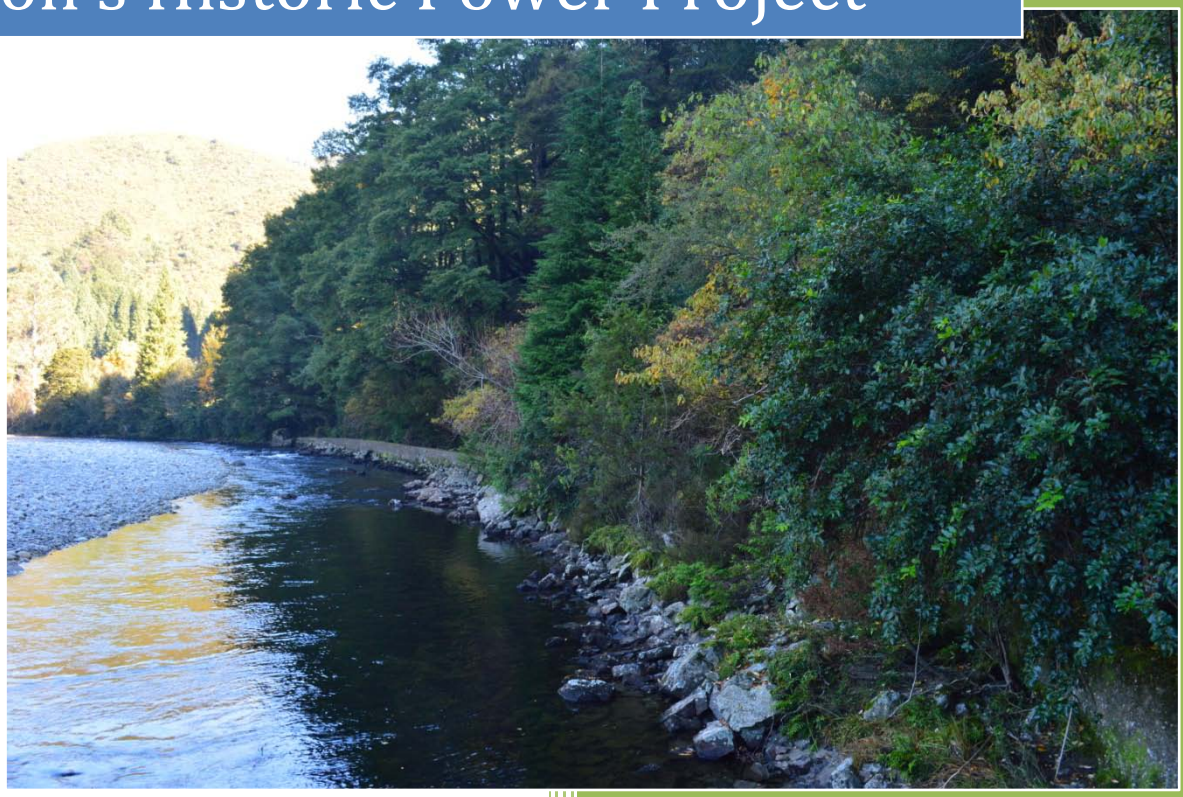
2013

Geotechnical Risk- Restoration & Rebuild of Reefton's Historic Power Project



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GEOTECH
GROUND ENGINEERING

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Geotech Ltd were approached by Rebecca Inwood and Allan Archer with regards to providing geotechnical design advice on the proposed community project to restore and rebuild Reefton's historic power scheme along the Inangahua River. A request was made to assess stability and geotechnical implications of the proposed work at two specific sites along the scheme; at site 1) the concrete canal slip, and site 2) the rock tunnel slip, as seen in Figure 1. The following is a brief summary of notes made on May 14th, 2013 when a site visit was carried out by Anthony Black and Sarah Smith of Geotech Ltd, and Rebecca Inwood.

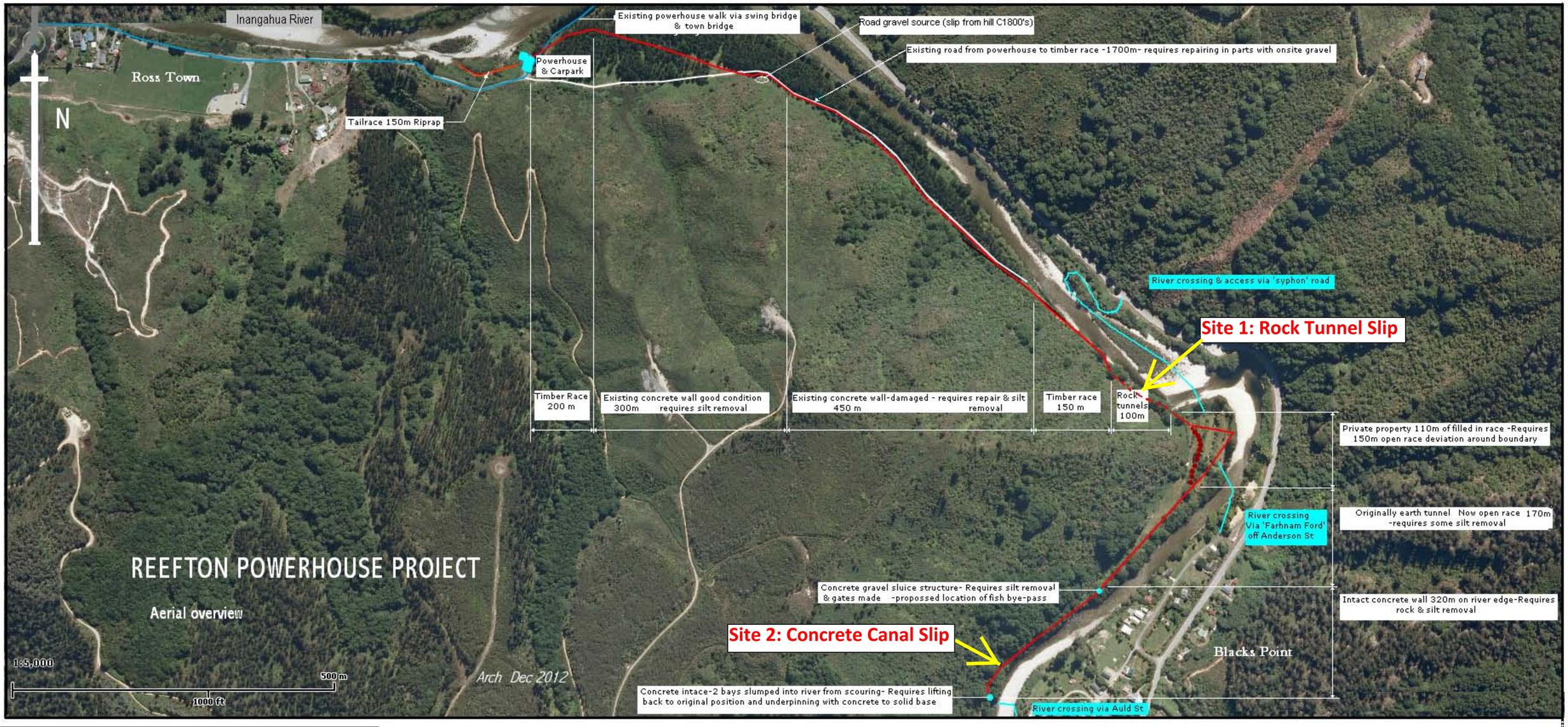

Figure 1. Aerial photograph of the Reefton powerhouse project with site 1 and 2 annotated (altered after Archer 2012).

SITE 1) THE CONCRETE CANAL SLIP

The concrete canal slip starts approximately 30 m downstream of the intake, and appears to be covering approximately 20 m in total length over the concrete canal (distances here are estimates only to discuss the general scale of the works). The proposed works discussed by Rebecca at this site is to excavate the slip from the canal before reinstatement can commence. A brief summary of what was seen on the site visit, along with several points for discussion are listed below.

- A colluvium slip (containing angular material from a close to source location), has come down from the bank above and deposited inside of the concrete canal. Vegetation is established on top of the slip and has stabilised the surface material for the time being.
- It is clear from bulging seen on the bank side of the concrete canal, at the downstream end of the slip that the canal has acted as a bunding to stabilise the toe of the slip at some stage. Bulging at the toe indicates pushing from behind, and may be a sign of that it was not simply an overtopping of material from above, but also of lateral spreading, which could indicate a larger unstable mass than what is evident at the surface. The nature of the concrete used looks to be low quality and unreinforced, this could have contributed to what is seen at the surface (essentially due to lack of structural strength).
- It is not known from the first pass review how far back into the bank until bedrock is intercepted, however there is competent bedrock outcropping in the stream.
- Based on the current proposal for the reinstatement of this section of canal, Geotech Ltd suggest that when works begin, a timeframe when low river flows are expected should be used, a ramp is constructed using river material on the outer (river) side of the canal to gain access to the site should be constructed (after excavation natural scour should remove this material). Excavation should be carried out by a 20 T hydraulic excavator. Assessing of the concrete walls should be carried out during excavation of the in filled section of the canal, under careful supervision of an engineer with suitable experience, along with some basic survey to monitor any movement that may occur on the slope. It is suggested that a structurally reinforced section of concrete replaces the bank side concrete wall to minimize any future bulging which may occur as a result of future bank failures in this section. Rip-rap should be placed on the bank above the concrete canal in an effort to put weight on the toe of the slip. *With this option Geotech Ltd stresses that excavation of the historic canal at site 1, may induce unforeseen geotechnical failure which will be difficult to budget for, and cannot back that the removal of this material will not adversely affect the current landscape above.*
- Geotech Ltd suggest that the a new straightened alignment around this slip is installed, which will have minimal impact on the existing canal structure; with the exception of a diversion upstream and downstream of the slip, and therefore the historic integrity of the scheme will remain intact, and there will be minimal risk of inducing failure of the slip above. Design of the proposed new alignment seen in Figure 2 should include the placing of rip rap above the new bank side of the canal to reduce the possibility of further natural failure of the slip. Costing for such a project will be simplified, as there will be less financial risk associated with the unknown ground conditions which may be encountered with the above proposal. Concerns have been raised with regards to the impact on the river that this might

cause for neighboring properties, but two points should be brought up here, since the scheme was abandoned the riverbed has lowered more than a meter according to Watson (2013), and that water will be essentially still travelling in the current location, but will be segregated (i.e. within the canal and in the natural river course). *It is recommended that this is peer reviewed by a hydrologist to provide support on rationality.*

Figure 2. Photograph of site 2, the intake can be seen in the background of the photograph, with the slip over concrete canal in the frontage of the photo. Note, new alignment is not drawn to scale.

SITE 2) THE ROCK TUNNEL SLIP

The rock tunnel slip is located approximately a third of the way down the scheme's waterway, and can be seen in Figure 1. The affected section of approximately 12m chainage has left 2 portals day-lighting at both sides, and a localised slip through the centre. Figure 3 shows an outline of the proposed remediation of this section from Allan Archer. A brief summary of what was seen on the site visit, along with several points for discussion are listed below.

- The tunnels daylight in blocky but competent greywacke (with the downstream side portal just covered from view due to a recent slip).
- There appears to be insitu bedrock approximately 1-2 meters horizontally back towards the scarp of the slip at the level of the tunnels, however this should be confirmed for the downstream portal from records.
- The slip material is angular and ranges in size from pebble to boulder size, there is little vegetation growing on the slip material, indicating that the surface is active.

- Under natural conditions unaffected by any anthropogenic influence, it is expected that the slip will continue to fail during heavy periods of rain saturating the colluvium above, and river flooding due to the undercutting of the toe which will induce localised land sliding at the site. It is therefore expected that the proposed activity will not adversely affect the current stability of the site more than what is already happening naturally. It is expected under careful management of the proposed works that the site will become more stable in the long term.
- When remedial works begin onsite it is recommended that a ford is built across the river course and this is used for access, there is already access from the main state highway down to the river on the other side. A 20 T hydraulic excavator will be suitable to carry out this work.
- There will be a period of exposure to failure during the excavation stage, however this can be minimized by choosing to carry out the work during a low rainfall period, and minimizing the amount of time that it takes to install the structure that will carry the water through.
- It is recommended that the structure that bridges the two portals is designed for a dead load of at least 16 T per lineal meter to allow for the weight of 3 to 4 vertical meters of material to sit on top of the structure.
- It is recommended for a quick installation that the bridging is pre-cast or already built prior to installation, so that it can be lifted and lowered directly into the excavation, minimizing the need for workers to be placed in any hazardous positions, attached is the NZ regulations for working in excavations.
- Large rip-rap should be placed at the toe of the slip to effectively buttress the slip in the final design, the rip-rap should be placed up to at least the level indicated in Figure 4, large rip-rap placed at the toe of the slip will reduce natural scour from flooding. Slip material should be landscaped above this level; the angle of the final landform should be approximately 38 degrees/ the angle of repose (or lower) for longevity of the slope.
- It is recommended that the large tree located just above the upstream portal seen in Figure 4, is removed due to the effects the roots will have on the tunnel entrance.

N

PLAN (NTS)

INANGAHUA RIVER

RACE

STEEP ROCK CLIFF

SLIP

ROCK

RACE

A

1800

200

600

50m

12 m APPROX

34m APPROX

A

LONGITUDINAL SECTION SCALE 1:100

200x50 'LATHS' - H5

200x200 H5 BAR

200x200 H5 LEGS

1800

2000

BASE

200x200 H5 BASE PLATE

INTERNAL FLOOR AND SIDES LAGGED FOR RACE

SECTION A-A SCALE 1:20

REEFTON POWER HOUSE PROJECT

ROCK TUNNEL SLIP 'BRIDGING'

Figure 3. Rock tunnel slip remediation design (Archer 2013).

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Figure 4. Photograph of the rock tunnel slip, taken from across the river, photo taken May 14th, 2013. Yellow dashed line indicates the level where rip rap should be placed up to (atleast), based on the scour level on the slip toe from high flow. The red arrow points to a tree that is recommended to be removed.

REFERENCES

Archer A 2012. Unpublished map of the Reefton powerhouse project.

Archer A 2013. Unpublished rock tunnel slip design.

Watson K 2013. Reefton Power Scheme: An Archaeological Assessment. Underground Overground Archaeology Ltd. Les Wright.