



12 November 2019

s 7(2)(f)(ii)

Tauranga City Council
Private Bag 12022, Tauranga 3143, New Zealand

2-9B463.00

Mauao Base Track Repair Options Assessment

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

1 Introduction

Further to your request, we present below a summary of our recent field investigation findings and a comparison of various options that have been discussed relating to the repair of the underslip affecting the Mauao Base Track on the southern side of Mauao.

2 Investigation and Findings

2.1 General

As you are aware we have carried out a recent field assessment of the subsoil conditions and surrounding geomorphology of the site. We have also carried out a recent topographical survey of the damaged track and surrounding area.

2.2 Site observations

- The total width of the slip at its lateral margins is approximately 23m across.
- The slip face ranges in height from 12.5 to 13m from the toe of the slope to the track with a slope of 61 to 68 degrees.
- There is a large Pohutukawa tree located to the west of the slip face and two large Pohutukawa located on the slope above the track which is standing at a slope angle of approximately 45 degrees.
- During our walkover we did not note any direct overland flow path leading towards the slip, however there may be sheet flows from the flat grassed area above the slip site.
- During our site investigations we noted seepages from the slip face.
- No tension cracks were observed above the slip face, or within the crest of the slope above the track.
- The slip face has shown little regression since the event occurred in April 2017.

2.3 Subsoil Conditions

WSP undertook the drilling of 5 hand augered boreholes to depths of up to 5m on 5 November 2019. Hand auger boreholes 1 and 4 were drilled on the flat area above the track and generally encountered stiff silt underlain by a silty sand layer and very stiff to hard clay to a depth of 5m.

The two boreholes drilled at the damaged track level comprised very stiff to hard clay underlain by stiff silt and sandy silt layers. During the drilling of these holes we noted some sensitive silt layers and groundwater seepage from sand and silt layers at a depth of 3m. Based on our observation of the slip face, the soils exposed in the scarp comprised interbedded light orange and brown sandy silt layers which transitioned to an orange very stiff clay from about 3 to 5m and which extended to the toe of the slope down to beach level.

The static ground water level was not encountered in any boreholes with the exception of hand auger 5 which was drilled through the slip debris at beach level. The groundwater was measured at 1.8m below the existing ground surface. However, we noted saturated sandy silt layers in the boreholes drilled at track level which may be water bearing layers confined by more impermeable clays. We also noted water seepage from the bank at the eastern end of the slip at approximately 3m down the face from the crest of the slip.

3 Options for Consideration

Based on our initial meetings with Tauranga City Council, and site assessments we have developed several options for the remediation of the track. The various options are presented on our appended preliminary design drawings C01 to C31. These options are discussed below:

3.1 Option 1 – Minor earthworks and slope stabilisation with soil nails and erosion protection matting.

This option involves cutting a steep batter into the slope above the track at a batter angle of approximately 76 degrees. To achieve the required track width, the excavation would be cut into the existing slope above the track over a horizontal distance of approximately 1.5m. The amount of excavated material required would be approximately 40m³.

Based on our preliminary slope stability analyses, the slope above the track would likely be detrimentally affected by this due to loss of toe support with a cut slope height of up to 3.8m below the large Pohutukawa trees. Therefore, the cut slope would require stabilisation such as soil nails to maintain long term stability of the cut batter.

Soil nails can be installed by drilling a 100 to 150mm borehole into the slope and then grouting a steel anchor into the hole. The anchors can then be attached to an erosion protection mat with small bearing plates which secure an erosion protection mat. The erosion mat is then filled with topsoil and hydroseeded to establish a green face which will blend into the surrounding environment. In addition to soil nails, horizontally bored drains can be drilled into the known seepage zones to prevent pore pressures building up in these zones and causing instability.

Although, observations suggest that the current slip face has been stable, under adverse weather conditions the risk of further underslips at the slip location remains high. Our stability analyses also indicate that the current slip face is marginally stable under normal conditions. Therefore, slope stabilisation such as soil nails would also be required on the slip face to maintain the long-term stability of the slope under adverse weather conditions or changes in groundwater conditions which could result in increased pore pressures.

This option would provide a long term stable option as the soil nails and erosion mat would protect the face from erosion and landslips. The toe of the slope appears to be above the mean high tide level however it may still be susceptible to coastal erosion during king tides or during

storm events so would require on going monitoring to assess if there is any toe erosion over time which could potentially undermine the slope. Although it is difficult to quantify, we anticipate an estimated design life of 10 to 15 years for this option but may be susceptible to coastal erosion and would require placement of rip rap at the toe if aggressive coastal erosion was experienced. This estimated design life can be further refined at the detailed design stage.

3.2 Option 2 – Reinstate the track in the existing location by constructing a footbridge to span the failed area.

This option would involve creating a footbridge that spans the slipped area. Based on our concept design, the bridge would be supported by a retaining wall or piles. Due to the marginal stability of the slip face the piles would need to be long and designed to resist the lateral movements of future slips. Conversely the existing slope could be stabilised prior to installing the foot bridge through the installation of soil nails or ground anchors.

With this option there is still the risk of overslips coming from the slope above the track which could potentially damage such a structure and require maintenance such as clearing slip debris from the track. On this basis we anticipate an estimated design life of 2 to 5 years for this option which could be extended if soil nails were incorporated into the upslope. This option would also be susceptible to coastal erosion from the same mechanisms stated above. Due to the susceptibility of damage from slips, we anticipate this option would not provide a long-term solution.

3.3 Option 3 – Realign the existing track at the existing level by excavating into the slope above the track.

This option would involve earthworks to retreat the current track away from the slip face. The new edge of the track would be situated approximately two metres away from the edge of the slip face with a large 45-degree batter cut into the slope above the track. Earthworks cut quantities would be approximately 400m³ based on our current concept design.

Our initial slope stability analyses indicate that the removal of the soil would improve overall slope stability conditions of the slope and provide greater resilience from regression of the slip face due to erosion or landslips.

A great benefit of this option is that construction of the track could be undertaken with conventional plant such as a hydraulic excavator which could be carried out relatively quickly although this option would require the removal of the two large Pohutukawa trees on the slope above the track, which will likely be strongly opposed by the trustees.

Based on our estimated regression rates due to landslips, we anticipate that widening the track at the existing level would provide an estimated life of 5 to 10 years, however this may be extended by protecting the existing slip face with erosion matting and protecting the toe from coastal erosion. Horizontally bored drains can also be installed within seepage zones to enhance stability or again soil nails could be incorporated within the face of the existing slip. This option would also require regular inspections to check for erosion or small slips following heavy rain events. The track would also require clearing of slip material from above if required.

3.4 Option 4 – Create a higher-level track above the existing Pohutukawa Trees

This option would involve cutting a new track into the slope above the existing track. This option would involve earthworks cut volumes of approximately 600m³. The advantages over option 3 would be that the two Pohutukawa trees could potentially be left in place with the track passing above and around. The other advantage being that the track will be positioned a greater distance from the slip face and will have greater resilience against coastal erosion and small landslips. We anticipate a design life of 10 to 15 years could be achieved with this option. This option would also require regular inspections to check for erosion or small slips following heavy rain events. The track would also require clearing of slip material from above if required.

4 Resource Consents & Archaeological Authority

A full assessment of resource consent and archaeological authority requirements is contained in the WSP Memo entitled “Mauao Base Track Repairs - Planning Assessment” dated 12 November 2019. Key points from this assessment are summarised below:

4.1 Tauranga City Council

Earthworks within the existing areas of cut and fill (including modified slopes immediately above the existing track) and pruning and trimming of the pohutukawa trees to remove weight and improve stability would be a permitted activity under the Tauranga City Plan.

However, resource consent would be triggered by the removal of the pohutukawa trees, or undertaking earthworks outside of the existing areas of cut and fill associated with the track.

Therefore, Options 1 and 2 would not trigger resource consent, while Options 3 and 4 would trigger resource consent. Note that even where consent is not required, reinstatement and restoration of disturbed areas is required under the City Plan within 6 months of completion.

4.2 Bay of Plenty Regional Council

The definition of “earthworks” under the Regional Natural Resources Plan explicitly excludes “maintenance of roads and tracks”, “the formation of walking tracks”, and “maintenance (including minor realignment) of existing foot tracks within public reserves”. As a result, earthworks associated with all options under consideration would be a permitted activity.

Note that any works would still be required to meet permitted activity conditions in relation to management of earthworks (including erosion and sediment control measures) and stormwater discharge during and after construction.

As no works are proposed on the foreshore in the Coastal Marine Area (CMA), no resource consents are triggered under the Proposed Regional Coastal Environment Plan.

4.3 Heritage New Zealand

Heritage New Zealand have advised Council (email from [REDACTED] s 7(2)(a) ... Privacy dated 12 November 2019) that Option 1 could be undertaken under the existing archaeological authority (2017/944) which is held by Council to undertake various activities associated with ongoing maintenance at Mauao. Options 2-4 are yet to be presented to Heritage New Zealand for consideration.

5 Option Comparison

The following table compares the advantages and disadvantages of the options presented above.

Option	Advantages	Disadvantages
<p>Option 1 - Minor earthworks and slope stabilisation with soil nails and erosion protection matting.</p>	<ul style="list-style-type: none"> • Small earthworks volume • Does not require resource consent from TCC or BOPRC. • Can use existing archaeological authority. • Pohutukawa trees do not require removal. • Stability of the slip face is enhanced. • Finished slip face and cut slope above the track will blend into the surrounding environment once vegetated. • Less chance of disruption to archaeologically significant areas. • Less cut material to dispose of onsite than options 3 and 4. 	<ul style="list-style-type: none"> • Procurement of materials may take time, e.g. Anchor rods, erosion mat. • May cost more than options 3 & 4. • Requires specialist machinery to achieve.
<p>Option 2 - Reinstate the track in the existing location by constructing a footbridge to span the failed area.</p>	<ul style="list-style-type: none"> • Would result in the least disturbance to archaeologically significant areas. • Does not require resource consent from TCC or BOPRC. 	<ul style="list-style-type: none"> • High risk of damage from future landslips. • Bridge abutments would require piled foundations and would need large piles to resist lateral forces of future landslips. • The bridge would be sensitive to damage from future slips from above including damage from failed trees if they were incorporated into the landslide debris.
<p>Option 3 - Reinstate the track at the existing level by excavating into the slope above the track.</p>	<ul style="list-style-type: none"> • Physical works can be undertaken with conventional earth moving equipment. • Once plant is established on site the work will be quick to undertake. 	<ul style="list-style-type: none"> • Will require removal of Pohutukawa trees to facilitate excavation. • Requires resource consent from TCC for tree removal and earthworks. • Will generate up to 400m³ of soil which will

	<ul style="list-style-type: none"> • Likely to be a cost-effective solution. • Does not require resource consent from BOPRC. 	need to be disposed of on site.
Option 4 - Create a higher-level track above the existing Pohutukawa Trees.	<ul style="list-style-type: none"> • Pohutukawa trees do not require removal. • Track is less susceptible to coastal erosion and landslips. • Resilient long-term option. • Physical works can be undertaken with conventional earth moving equipment. • Does not require resource consent from BOPRC. 	<ul style="list-style-type: none"> • Requires excavation into archaeologically significant areas • Requires resource consent from TCC for earthworks. • Has the largest earthworks volume and footprint and potential to disturb culturally significant areas. • Will generate up to 600m³ of soil which will be required to be disposed of on site.

5.1 Alternative Option

An alternative option would be to undertake a lower cost version of Option 1 by excluding soil nails on the slip face and installing a small number of nails to support the undercut slope above the track. Horizontal drains could be installed within seepage zones on the face of the existing slips along with erosion protection matting. This option would have a lower factor of safety than the options discussed above, and we anticipate the design life would be less, however the risk of instability would be similar to the land immediately adjacent to the slip site.

Further, if a future slip occurred at the same location, it may be very difficult to reinstate the track at the same location as there would be very limited access for machinery.

5.2 Maintenance Programme

The following table summarises the suggested maintenance inspection requirements and frequency for each option.

Option	Maintenance Requirements	Suggested frequency
Option 1 & 2	<ul style="list-style-type: none"> • Inspect base of slip face for signs of coastal erosion. • Inspect track integrity and width or signs of instability or erosion above and below track. 	<ul style="list-style-type: none"> • 0 to 2 months following construction - weekly monitoring suggested. • 2 to 4 months following construction - fortnightly inspections. • 4 to 12 months - monthly inspections. • After a 12 month period consider reducing to ongoing regular inspections every 2 months. • Inspection required after each major rain or seismic event.
Option 3 & 4	<ul style="list-style-type: none"> • Inspect base of slip face for signs of coastal erosion. 	<ul style="list-style-type: none"> • 0 to 2 months following construction - weekly monitoring suggested.

	<ul style="list-style-type: none"> • Inspect track integrity and width or signs of instability or erosion above and below track. 	<ul style="list-style-type: none"> • 2 to 4 months - fortnightly monitoring • After a 4 month period consider reducing to ongoing regular inspections every 2 months. • Inspection required after each major rain or seismic event.
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5.3 Further Actions

Once Council has determined the preferred option, then detailed design will be required. WSP will be on hand to provide detailed design services of the selected preferred option once instructions are given to proceed.

Letter prepared by:

Letter reviewed by:

