Memorandum

To:	Journeys - Gisborne District Council
From:	LDE
Copy:	
Subject:	Waihau Road RP 4.8
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1 Background

LDE was asked by Gisborne District Council (GDC) to undertake a geotechnical inspection of a slip at approximately RP 4.8 on Waihau Road on Tuesday 27th June 2023.

The site has been subject to a slip following a significant rain event in June, where approximately 5m of the road has been lost, and the southern portion of the road has suffered subsidence. Our brief was to inspect the slip and advise on remediation works to reopen Waihau Road.

At the time of the initial inspection, the weather was fine. However, the region had been subject to a significant rainfall event in the proceeding fortnight, where up to 366.6 mm of rainfall has been recorded at a Pouawa gauge (Figure 1).

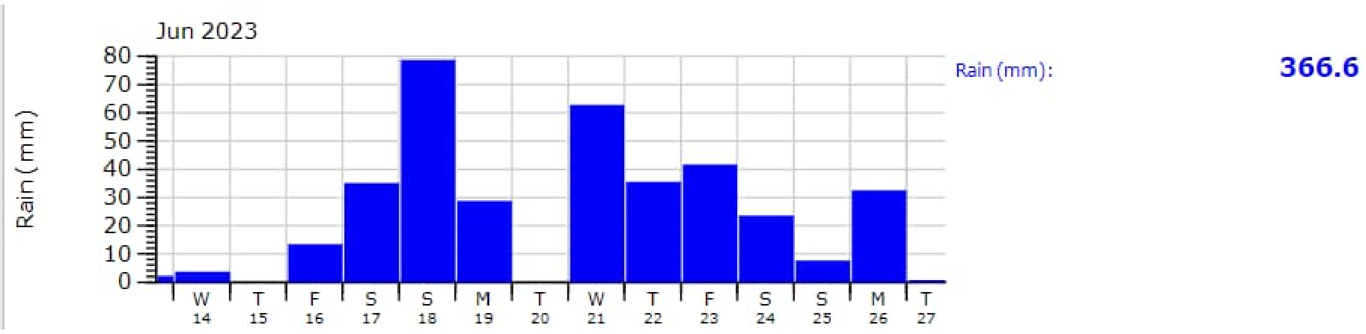

Figure 1: Pouawa Rural Fire Rain Gauge record (source: Harvest)

2 Geological Setting

The underlying geology is mapped as sandstone dominated Tolaga Group Rock, which is dipping into the slope (GNS Science, 2023). GDC's Tairāwhiti Maps (2023) shows several active faults are mapped in close proximity to the site (on the ridgeline above the road) which generally trend southwest to northeast (Active Faults Project 2022). Two additional faults are mapped in the area trending south to north.

From the superficial weathering appearance derived from drone footage it appears that the slopes below the road are mudstone and siltstone dominated in contrary to the upper slopes which appear to be sandstone dominated.

The geomorphology of this portion of the road is defined by steep bluffs, and colluvial slopes adjacent to the coastline.

3 Initial Site Visit

The initial site visit was undertaken by an LDE Senior Engineering Geologist on the 27th June 2023, alongside Downer.

The dropout is located between Tidal Waters Lodge and the settlement at Waihau Bay. The dropout was approximately 5m wide and has resulted in the road becoming impassable to vehicles. Temporary pedestrian access had been facilitated by locals using ladders and wooden planks. The road forms the only connection to the rural community of Waihau Bay. It is understood the dropout occurred over the weekend of the 24th- 25th June 2023.

During our inspection we observed:

- The dropout is the northern side scarp of a larger landslide feature.
- The landslide is approximately 110m wide.
- The southern side scarp is located at approximately RP 4.688.
- There appeared to be a scarp near the base of the bluff above the road.
- It is likely the deformation at the northern side scarp was exacerbated by:
    - Debris flow/ overland flow from the slope above,
    - Overland flow from the road,
    - Scour from the adjacent culvert.

Following the inspection, LDE recommended obtaining drone imagery of the entire landslide, due to the steep topography of the site, and largescale nature of the landslide.

4 Second Site Visit

A second site visit to capture drone imagery of the landslide was undertaken by two LDE staff consisting of a Senior Engineering Geologist and Engineering Geologist, on Wednesday 19th July 2023.

The imagery taken during this inspection has been reviewed. This imagery shows:

- A debris avalanche leading to a debris flow has occurred from an area above the bluff, and coincides with the northern sidescarp of the landslide, where significant scour has occurred.
- A headscarp has been confirmed along the toe of the bluff above the road.
- Debris flows along the (potential) side scarps of the wedge failure make it difficult to conclude on the failure mode.
- Significant debris appears to have dropped from the colluvial soil to rock interface and caused disturbance downslope obscuring any potential conclusive evidence of a global wedge failure.
- A wedge failure occurred in the bluffs below the site.

- It is possible the toe of the landslide is near to or at the base of the coastal cliff.
- Several sandstone features appear to be poorly supported within the upper bluff feature and without engineering measures pose a rockfall risk.
- Several defects (cracks) were observed subparallel to the upper bluff, which may lead to ‘slabbing’ failures and also pose a rockfall risk.
- From the drone imagery, there appears to be a significant tension crack behind the upper bluff.
- Arcuate features (scallops) are evident in the drone imagery along the edge of the bluff. Therefore, larger scale rock mass failures from the top of the bluff also pose a potential rockfall/ debris avalanche risk.

5 Interpretation

Based on our site observations our geotechnical interpretation is:

- The dropout which washed out access along Waihau Road is the northern side scarp of a much larger feature.
- There is not likely to be a viable solution to stabilise the 110m wide landslide.
- Any works within the landslide block to enable access are likely to only last for a short term unless the landslide movement arrests.
- There is significant risk of further movement of the landslide.
- Surface water is causing erosion and saturation at the northern side scarp.
- There is also a rockfall risk at the site.

The large global landslide feature is either a:

- Wedge failure within the rock which may extend down to the toe of the slope.
- Alternatively, the global movement (rotational/translational) may be occurring within the colluvial soils above the underlying rock which is estimated to vary between 10 to 20m below road level.
- If a wedge failure is occurring, that does not exclude the risk of additional failure mechanisms within the colluvium.

Additionally, the over steepened bluff above the road poses a rockfall risk, and the debris avalanche landslide also poses a potential debris flow risk in further significant rain events.

6 Initial Options Assessment

6.1 Short Term Remedial Options:

We consider the site to be at high risk of ongoing movement and cannot rule out a large rapid evacuation failure occurring. Any of the following works may not be able to be completed safely, until there is evidence of the slope movement arresting and soil moisture levels returning to a normal level.

We have considered the following options to enable emergency access:

- New culvert and backfill washout. Attach sock/flume or similar to culvert to protect outlet.
- Road retreat into colluvial slope above the road.
- Combination of retreat and culvert.

We consider the risk of traversing this slip to be significant, and if movement continues any remedial works are unlikely to withstand significant movement, which may prevent vehicle assess, especially emergency services.

Further assessment is recommended prior to any emergency works being carried out.

6.2 Long Term Remedial Options:

If a wedge type failure mechanism is confirmed, then the risk of evacuation would be considered too high to reestablish access over the current alignment even during dry conditions.

If the movement is determined to be within the upper colluvial soils only, then the risk of ongoing movement could be mitigated by limiting access to periods of favourable weather conditions. Road closures would be recommended during wet periods. There is unlikely to be an economic solution to prevent ongoing landslide movements, even though significant earthworks and drainage may reduce the frequency of movement.

The rockfall and debris flow risk could be mitigated with engineering measures.

7 Recommendations

We recommend another drone/ site walkover assessment following further movement on site. Having now assessed the site in detail, evidence for or against a wedge failure within the bluff could likely be gathered following a rainfall event which triggers slope movement. If no further movement occurs on site, then a reassessment in two months may be considered.

We don’t recommend that any other work is carried out and access for the public remains limited (complete closure during wet weather recommended) until further assessments can be completed.

If determined to be safe following the reassessment, other options could be considered further at the time.

In any case, we recommend an alternative route is investigated for long term access for the Waihau Bay community.

8 Limitations

This report should be read and reproduced in its entirety including the limitations to understand the context of the opinions and recommendations given.

This report has been prepared exclusively for Journeys Gisborne District Council in accordance with the brief given to us or the agreed scope and they will be deemed the exclusive owner on full and final payment of the invoice. Information, opinions, and recommendations contained within this report can only be used for the purposes with which it was intended. LDE accepts no liability or responsibility whatsoever for any use or reliance on the report by any party other than the owner or parties working for or on behalf of the owner, such as local authorities, and for purposes beyond those for which it was intended.

This report was prepared in general accordance with current standards, codes and best practice at the time of this report. These may be subject to change.

Opinions given in this report are based on visual methods only and conditions may be found to differ from those described in this report. No quantitative assessment has been carried out.

9 References

Gisborne District Council. (2023). *Tairāwhiti Maps*. Retrieved from https://maps.gdc.govt.nz/H5V2_12/

GNS Science. (2023). *Geology webmap*. Retrieved from https://data.gns.cri.nz/geology/

Appendix A

Initial Site Photographs

Photo 1: Northern side scarp.

Photo 2: Northern Side scarp, looking south. Culvert outlet visible

Photo 3: Northern side scarp, looking north.

Photo 4: Northern side scarp, showing where overland flow/ debris flow has occurred

Photo 5: Cracking in pavement. Subsidence of landslip block (foreground) relative to insitu road (background on other side of side scarp)

Photo 6: Southern side scarp, cracking is visible traversing upslope. Landslide block has dropped approx. 300mm.

Photo 7: South side scarp, view to south showing subsidence of landslide block and lateral movement.

Photo 8: Within landslide block, tension cracking within shoulder, fresh scarp approximately 1m from pavement edge, view to north

Photo 9: Within landslide block, boulders on both sides of the road are evidence of rockfall from upper slope escarpment.

APPENDIX B

DRONE IMAGERY

Drone Image 1: Oblique view of landslip, approximate extent outlined.

Drone Image 2: Aerial overview of landslip.

Drone Image 3: Oblique view of northern side scarp and drop out.

Drone Image 4: Oblique view showing debris avalanche slip and associated catchment above northern side scarp. Tension crack behind bluff circled (and enlarged image below).

Drone Image 5: Tension crack behind bluff.

Drone Image 6: Example under cut blocks within upper bluff.

Drone Image 7: Example of vertical defects subparallel to the bluff face within upper bluff.