

## MIN-4265 Pūhoi to Warkworth land stability - follow up

21 July 2023

Provide a summary of the reports on land stability for Pūhoi to Warkworth.

- The reason detailed reports (such as the Geotechnical Review of Cut Slopes and Landslide Risks and N1A Remediation Options – Technical Review Comments reports) are commissioned is so that we can identify the potential risks, and more importantly so that the issues can be addressed and mitigated.
- The recent cyclone and heavy rain event presented a significant test and while there were some minor landscaping issues, no major slips occurred and the road demonstrated its resilience in contrast to existing roads in the region.
- When the motorway was opened last month, we signalled that there was still some work to do and that people using the road could expect to see work continuing around the motorway for several months, which includes earthworks at the N1A location. We worked hard to get the motorway open as soon as possible and we're confident that the road is safe, and people are already enjoying the benefits of the new motorway.

### Geotechnical Review of Cut Slopes and Landslide Risks

- Following several landslides during the construction of the project, NX2 engaged s 9(2)(ba)(i) to conduct an independent geotechnical landslide risk assessment for the Pūhoi to Warkworth project. The report is not a peer review of the design, construction and no independent analyses were undertaken s 9(2)(ba)(i) relied on a combination of site observations and design material.
- As part of this assessment, s 9(2)(ba)(i) reviewed all cut slopes along the Pūhoi to Warkworth motorway, including cuts where landslides have occurred and cuts where no failures were reported.
- The assessment covers 49 individual cut sections which were reviewed separately at both sides of the alignment. A total of 94 risk reviews have been undertaken.
- The report studies the chances of geotechnical issues and slope failures, along with their associated risks. It also predicts potential future landslides and their risks.
- The report looked at six possible failures for the slopes and reported the risk ratings shown in the table below (reproduced from the report).

Risk Rating	Revision E Assessment
Very low Risk	51
Low Risk	26
Low to moderate Risk	15
Moderate Risk	2
Moderate to high risk	0
High risk	0
Total	94

Very low risk:	Not expected to occur and very low consequences
Low risk:	Unlikely to occur and low consequences
Low to moderate risk:	Low possibility of occurrence and moderate consequences
Moderate risk:	Possible to occur and moderate consequences
Moderate to high risk:	Likely to occur and moderate to high consequences
High risk:	Expected to occur with potential high consequences

- The report included several recommendations, many of which were adopted by the Contractor's geological experts.
- s 9(2) (ba)(i) as been reviewing the slopes of the project over several years and construction seasons. The s of the latest report available showed a progressive reduction in the risk of most, if not all, the slopes of the project following the Construction Joint Venture's works.

#### **N1A cut slope landslide and remediation**

- The N1A cut slope is approximately 1.8km south of the Pukerito roundabout on the eastern side of the southbound lanes. N1A is the identifying code for this specific cut, which is located within the northern earthworks zone.
- During construction, several sites were stabilised following ground movements. This is typical for earthworks whereby designs need to be refined in response to the actual ground conditions encountered in construction, which can differ from the assumed conditions in the initial design. The assumed conditions are derived from the geotechnical investigations undertaken at the beginning of the project.
- In late 2022, a landslide was observed at the N1A cut slope, with the slope slowly moving towards the motorway.
- Slope monitoring found that a historic and deep-seated landslide had been reactivated.
- Observations also found cracks in concrete barriers in two separate places on the western (opposite) side of the motorway, opposite the cut slope, potentially indicating that the slip could be occurring across the full width of the motorway.
- Monitoring data shows that following the 2023 Auckland Anniversary storm, the cut slope above the road experienced periodic episodes of increased movement.
- The April 2023 N1A Remediation Options report advised:
  - based on similar slope failures experienced elsewhere during construction of the project, catastrophic failure (rapid slide onto the carriageway) was unlikely.
  - The risk (at that time) to the motorway (property only) was 'Moderate Risk'.
  - The risk (at that time) to the N1A cut slope and the shoulder of the motorway (property only) was considered 'High Risk'.
  - A risk assessment to persons (loss of life) was not carried out, as that is usually associated with high velocity landslides (e.g. avalanche) as opposed to slow moving slides such as this.
- The Contractor provided three preliminary options to stabilise the slope and stop the movement:
  1. Option 1 Earthworks solution – reprofiling the slope and adding a buttress
  2. Options 2 & 3 - Piling options (with either 1 or 2 platforms)
- The earthworks solution involves cutting the existing slope to a less steep angle and placing material to load the bottom of the slip to resist further movement.
- Piled solutions require significant excavations and concrete piles to be installed to resist further movement. This option would require closure of one or more motorway lanes for extended periods.

- A fourth option of rock anchors was proposed by the authors of the report, which would similarly require closure of motorway lanes.
- The N1A Remediation Options report was produced to review the options provided by the Contractor early in the design process.
- This allowed Waka Kotahi to fully assess the suitability of the options looking across a broad number of considerations, including safety risk and impact on ability to open the road.
- The preliminary nature of the options presented resulted in further clarification requests being recommended by the report.
- Following receipt of the report, numerous workshops were held between Waka Kotahi subject matter experts and the Contractor. These workshops resulted in a solution being agreed which is currently being implemented. The agreed solution also allowed the road to open and the works to be carried out safely behind concrete barriers.