Memorandum

09 April 2018

To	Banana Shire Council		
Copy to	Ray Geraghty (Chief Executive Officer - Banana Shire Council)		
From	Greg Penhaligon (Senior Civil Engineer - GHD)	Tel	(07) 4973 1600
Subject	Gibihi Road Alternative Access	Job no.	42/20370

1 Introduction

GHD has been engaged by the Banana Shire Council to assess the feasibility of an alternative alignment for Gibihi Road with respect to the failure of the current Gibihi Road formation through the Anglo American Dawson Mine. At Anglo American's public meeting on the 21st of February 2018, Anglo American stated that the existing Gibihi Road formation was to be closed for a substantial amount of time due to the significant movement of the underlying rock. At a later point in the meeting, Anglo American advised that it would continue to use its haul road to the south of the existing Gibihi Road formation under a regime of strict monitoring of ground movement in the area.

The alternative routes to be considered are to be within the current Gibihi Road reservation boundaries. If an alternative route can be found within the current Gibihi Road reservation, GHD will undertake a high level alignment and grading on the road.

1.1 Purpose of this report

The purpose of this report is to provide Banana Shire Council a high level assessment of the viability of an alternative route for Gibihi Road across the Anglo American Mine which has an acceptable factor of safety for use as a public roadway.

1.2 Scope and limitations

This report: has been prepared by GHD for Banana Shire Council and may only be used and relied on by Banana Shire Council for the purpose agreed between GHD and the Banana Shire Council.

GHD otherwise disclaims responsibility to any person other than Banana Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

2 Background

2.1 Existing Ground Conditions

The Dawson Mine produces coal from Permian-age reserves contained in five major seams that average 3.5–4.0m in thickness, and dip at 5°–12°.

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The land under the current Gibihi Road was previously subjected to mining activity which involved the extraction of coal from the seams in the more accessible region to a depth of 30m. The area mined was then backfilled with overburden to existing ground level and the current Gibihi Road formation was constructed upon this backfilled material.

2.2 Information received

GHD has prepared this report on the basis of information provided by Banana Shire Council, Anglo American and others who provided information to GHD. GHD received the following information from Anglo American as a basis to the assessment of this report:

- A report on the geotechnical analysis of the failure conducted by GEONET Consulting Group on behalf of Anglo American.
- Survey data of the site.
- A series of cross sections from the survey data of the area.
- A layout plan of the previous mining activity in the general vicinity of the failure area.

GHD has not independently verified or checked the above information received beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information. No independent base data was collected or geotechnical testing was undertaken by GHD.

GHD engineers undertook a field visit on the 13 November 2017 to investigate the geotechnical failure. GHD observed the major failure on and to the north of the existing road formation, and further tension cracking between the road formation and the barbed wire fence to the south.

A further field visit was undertaken on the 18 March 2018 to assess if any further cracking was apparent. The tension cracks inspected on the 13th of November 2017 had not progressed any further to the south of the wire fence.

Anglo American had installed a toe berm at the base of the failed embankment to shore up the road (as shaded green in Figure 1) and protect its own mining operations.

Figure 1 Newly Installed Toe Berm

2.2.1 GEONET Report

The GEONET report presents a geotechnical back-analysis of the large slope failure. This report includes modelling the pre and post failure slope in order to gain an understanding of the mechanism of failure. GEONET have used geological and geotechnical data provided by Anglo American for their analysis, including, but not limited to the following:

- Geology
- Stratigraphy
- Structural geology
- Mining history

The final modelling has generated a number of outputs, including factor of safety (FOS) charts. These charts indicate the propensity/tendency for the rockmass to fail at specific locations, which is discussed further in the report.

The GEONET report confirmed the mechanism of failure was a block failure caused by the failure of a weak coal seam. The coal seams under the site dip away 10 degrees below the horizontal towards the west of the site and are located approximately 80 m below the level of Gibihi Road. GEONET's modelling indicates that this lower coal seam forms the lower surface of the block failure, and the coal seam is persistent along the length of Gibihi Road failure.

2.3 Land Tenure

Gibihi Road is located in a road reserve crossing the Dawson Mine, the cadastral boundaries of which are indicated in the yellow lines in Figure 2. The Gibihi Road formation is located along the northern side of the reserve, as indicated by the white line. Council has limited rights to build own and operate a new road within the road reserve under the mining lease, but little or no rights outside of the reserve.

Figure 2 Cadastral Boundaries for the Gibihi Road (Source: Google Earth/Queensland Globe)

Mining leases are held by Anglo American Coal (Dawson) Pty Ltd over the area including the Gibihi Road reserve including:

- ML5599 (granted 1967, Expiring 31/03/2020)
- ML5611 (granted 1971, expiring 31/03/2020)
- ML 5603 (granted 1968, expiring 31/03/2020)

Figure 3 Production Mining Leases (Source: Google Earth/Queensland Globe)

Mining activities are already occurring as-of-right within the road reserve. Anglo American had allocated a section of land bounded by fencing for the provision of a road across the site. Land outside of the fenced road area is deemed to be within the mine and is operated under the Coal Mining Safety and Health Act 1999 (CMSH Act) and its associated regulation and the Mining and Quarrying Safety & Health Act 1999 (MQSHA).

For any public access to a mining area, the operator of the mine and the Senior Site Executive (SSE) would need to provide approval. The SSE is the most senior person employed at a mine and is responsible for that mine's operations. Their key responsibility is to ensure the risk to persons from operations, plant or substance is at an acceptable level.

The operation of any public road whether it be on the current or an alternative alignment within the mine lease area would require the approval of the Anglo American and the SSE.

3 Road Design Basis

In order to assess the viability of the construction of an alternative road alignment, GHD has identified the appropriate road construction standards. Banana Shire Council adopted the *Capricorn Municipal Design Guidelines* which covers the domestic road design, but does not cover earthworks specifically.

Given the potential size and scale of the earthworks required to remediate the road, GHD propose adopting Department of Transport and Main Roads' (TMR) documentation for guidance as to the requirements for the earthworks.

TMR's *Geotechnical Design Standard – Minimum Requirements* outlines the design philosophy for the design of major earthworks for public roads. A Factor of Safety of 1.5 (long term) is required for the stability of all road embankments and cuttings.

4 Road Embankment Safety

The mode of failure for the road embankment (pit wall) is a block failure where a large block of earth has moved horizontally up to six metres north of its previous location, failing along low strength coal seam. The horizontal movement of the material has left multiple deep fissures along the northern boundary of the fenced road potentially up to of 70-90m deep. The visible upper portion of these fissures are vertical, and it is feasible that this profile extends for most of the depth to the coal seam. All material to the north of these fissures is considered already failed and highly unstable, while the wedge of material defined by a line extending from the base of the fissures upwards at 1V:1H to the south is also considered highly unstable (FoS ≈ 1.0).

Any realigned road must be located sufficiently outside this zone of unstable material to achieve a Factor of Safety against failure appropriate for a public road (FoS > 1.5). For reference the overall batter slope of the failed pit wall was 1V to 1.5H, so adopting a slope flatter than this is not overly conservative.

GHD recommend adopting TMR *Geotechnical Design Standards* as a design guide. The road realignment will be treated as an embankment given the extensive volume of overburden fill material within the area. TMR's general requirements for road embankments to achieve an acceptable long term factor of safety (FoS > 1.5) are as follows:

1. Embankment batter slopes shall not be steeper than:
    i. 1 (vertical) to 2 (horizontal) for earth-fill, and
    ii. 1 (vertical) to 1.5 (horizontal) for rockfill
2. A minimum 4.0 m wide bench shall be provided at the top of any 10m high single continuous batter slope.
3. Embankments will not be susceptible to cracking due to seasonal moisture changes, tunnelling or rill erosion.

5 Assessment against provided data

The GEONET Report contains Factor of Safety (FOS) Charts which GHD have adopted as the basis for the assessment of reasonably viable alternative routes. Factor of safety charts were generated at locations as indicated on the following eastings:

- 200650E
- 200700E
- 200750E
- 200800E
- 200850E
- 200950E

The location of these sections are indicated in green lines on Figure 5.

The survey cross sections provided by Anglo American were superimposed over the FOS charts. In order to define an envelope for the alternate route, the appropriate FOS 1.5 colour was identified from the charts (mid green). Safe batter profiles defined from the lowest point with a factor of safety of 1.5 on the FOS chart, with batter slopes of 1V in 1.5H and 1H in 2V extended from this point to the surface. The area between these intercepts and the existing cracking forms a safety exclusion zone for the location for an alternative road alignment for Gibihi Road.

An example of the cross sections are indicated in Figure 4. The remaining cross sections are contained in Appendix A at the end of the Report.

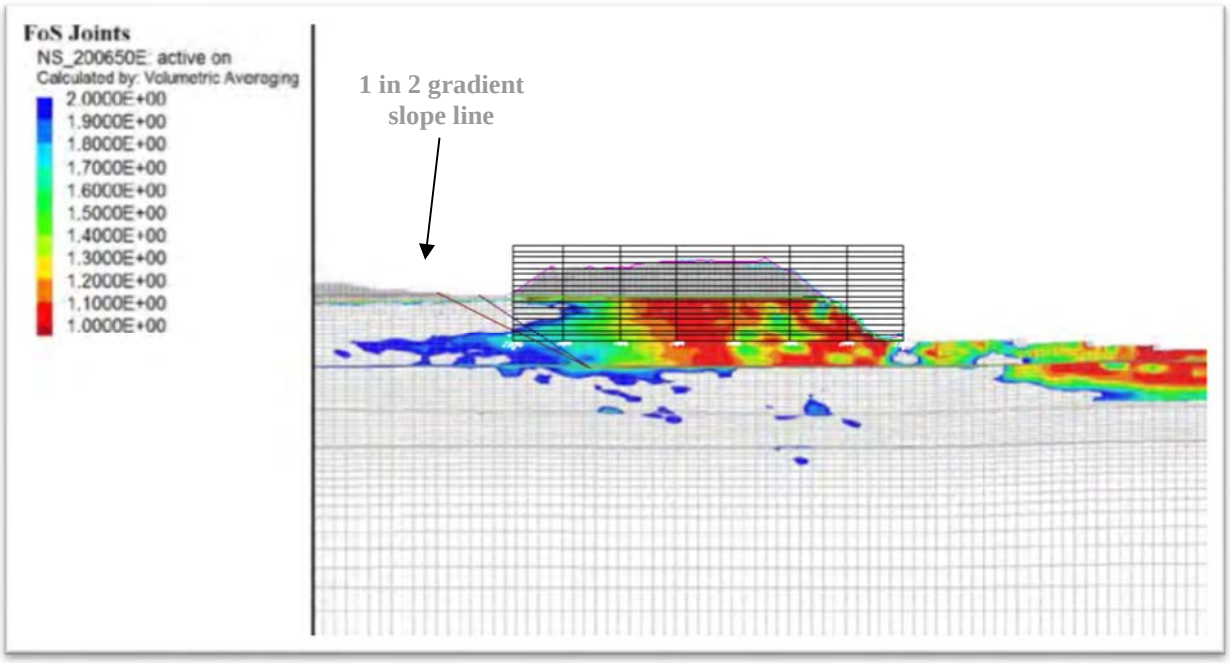

Figure 4: Factor of safety chart at 200650E with cross section and safe slopes shown

The results of the assessment of the safety exclusion zone a FOS below 1.5 using batter slopes of 1V:1.5H and 1V:2H is some 210m to 270m from the existing road formation. This places the alternate alignment outside of the road reserve.

5.1 Arbitrary High-level Assessment

A second arbitrary assessment of the safety exclusion zone was carried out, extending a projected batter slope from 70 metres below the surface cracks at 1V to 2H to the surface. The line where the slope meets the surface is also located outside of the existing road reserve.

5.2 Influence of Mining the Southern Pit on Alternate Alignment

The southern pit of the Dawson Mine has been excavated down to approximately RL40 m at the deepest point with the Gibihi Road formation at approximately RL150 m elevation. Using a safe batter slope of 1V: 2H from the base of the pit, the extent of the safety exclusion zone is approximately 10 metres north of the southern mine haul route. (as indicated by a blue dashed line). This estimated batter line does not include the 4 metres wide benches as required by TMR at every 10 metres of elevation which would extend the top batter line an additional 44 metres of area, taking the design safety exclusion zone right up to the current Gibihi road formation.

This would preclude any alternative road alignment to the south of the current roadway.

The planned mining activity on the site is to continue to the west of the current pit, which may also prevent the location of an alternate road alignment to the south of the existing Gibihi Road formation

5.3 Analysis of Results

Figure 5 presents the results of the above assessment.

The yellow line is an approximated property boundary line for the road reserve.

The safety limits plotted from the FOS diagram are indicated for 1V:1.5H and 1V:2H are indicated in black and red lines respectively on Figure 5. The estimation of these safety limits do not include the TMR requirement for a 4 metre wide bench for every 10m vertically of batter. The red shaded area on the figure indicates the safety exclusion zone with a FOS below 1.5 unsuitable for public road construction resulting from the block shift failure. These lines extend well past the road reserve boundary into the mine lease (approximately 250m to the south of the existing Gibihi Road formation). The area also covers the south mine haul route used by Anglo American.

The magenta line on Figure 5 indicates the arbitrary 1 in 2 line from the initial estimated base of the fissure resulting from the block shift. Given the depth of the fissure could as deep as 90 metres and there is no allowance for the four metre wide TMR benches, the safety exclusion line could easily be outside of the road reserve.

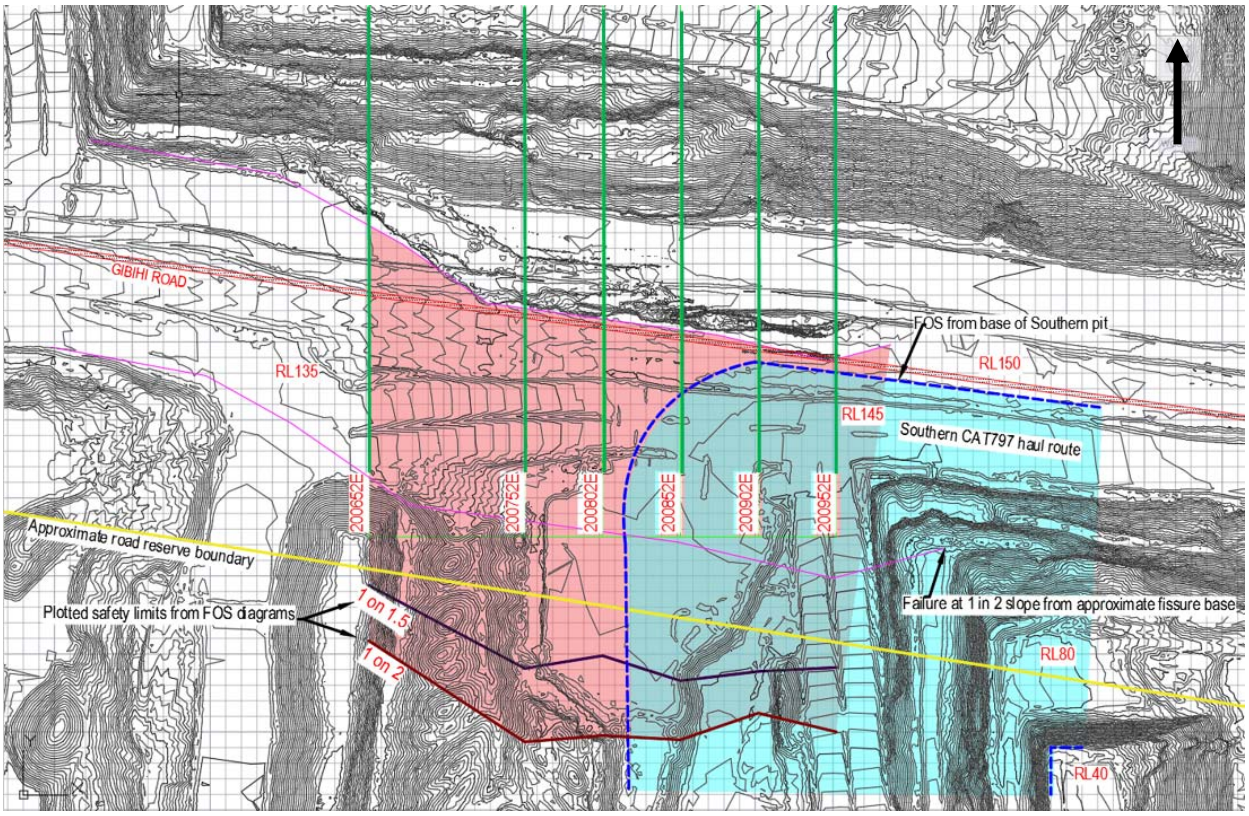

Figure 5 Plotted location of sections and Factor of Safety Lines (Base information from Anglo American).

The blue dashed line represents the potential influence of the existing mine excavation of the southern pit at a slope of 1V in 2H from the base of the pit at RL 40m (without 4m earthworks benches). The blue shaded area on Figure 5 indicates the safety exclusion area resulting from the mine excavation with a FOS below 1.5 unsuitable for public road construction.

From the above assessment of areas with a factor of safety suitable to construct a permanent alternative route for Gibihi Road, with the safety exclusion area from the existing southern pit excavation overlapping with the unsuitable FOS area from the block shift failure, an alternative route is precluded from being constructed between the existing Gibihi Road formation and the southern mine pit.

6 Conclusions

It can be concluded from the results of this memorandum that no alternative route can be found within the current Gibihi Road reserve with an adequate factor of safety for a public road. The reasons for this can be summarised by the following:

- The plotted safety exclusion zone for a Factor of Safety of 1.5 associated with the block shift failure extends some 250 metres south from the failure and is located within private property under the mining lease.
- The excavation of the southern pit excavation some 85m below the Gibihi Road formation pushes the safety exclusion zone just to the South of Gibihi Road formation.
- Planned future mining activity to the West of the current Southern pit excavation has the potential to influence any possible alternative routes in the Gibihi Road corridor
- The overlapping of the safety exclusion zones of the block shift failure and the mining operations precludes the construction of an alternate alignment for Gibihi Road.

7 Recommendation

Given the stability of the corridor between the block shift failure and the mining operations have a factor of safety less than 1.5, further investigation of an alternative road alignment is not recommended within the road reserve for Gibihi Road.

Appendix A – Factor of Safety Charts

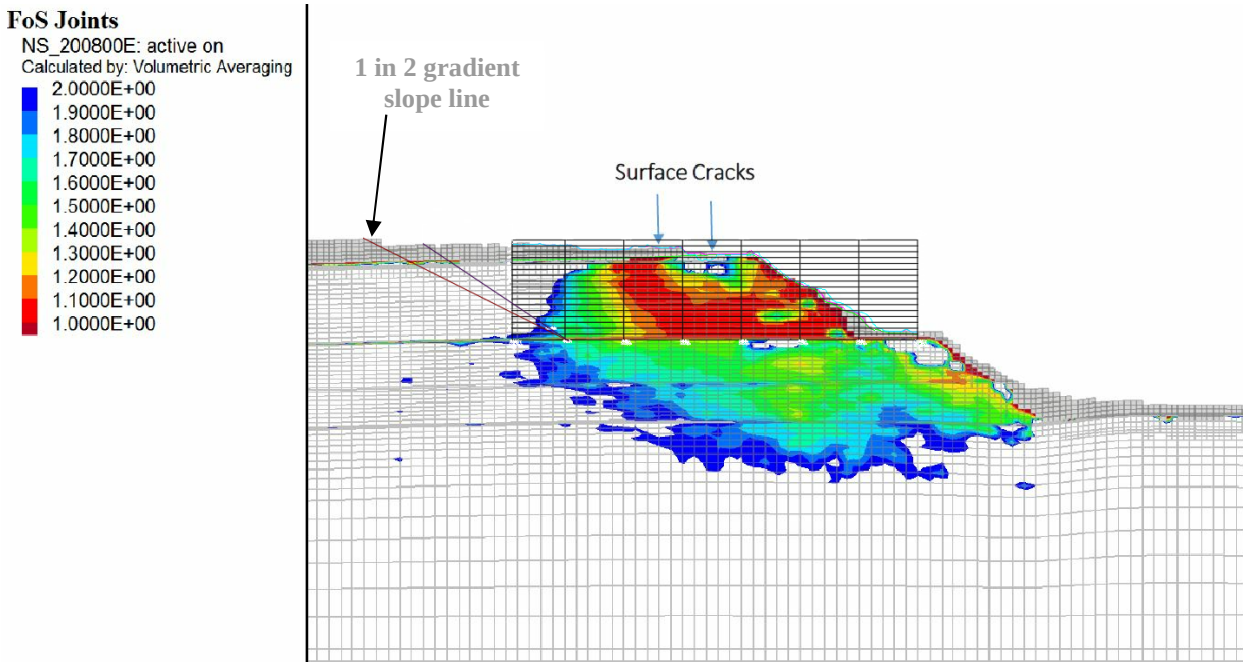

Figure 6: Factor of safety chart at 200800E with cross section and safe slopes shown

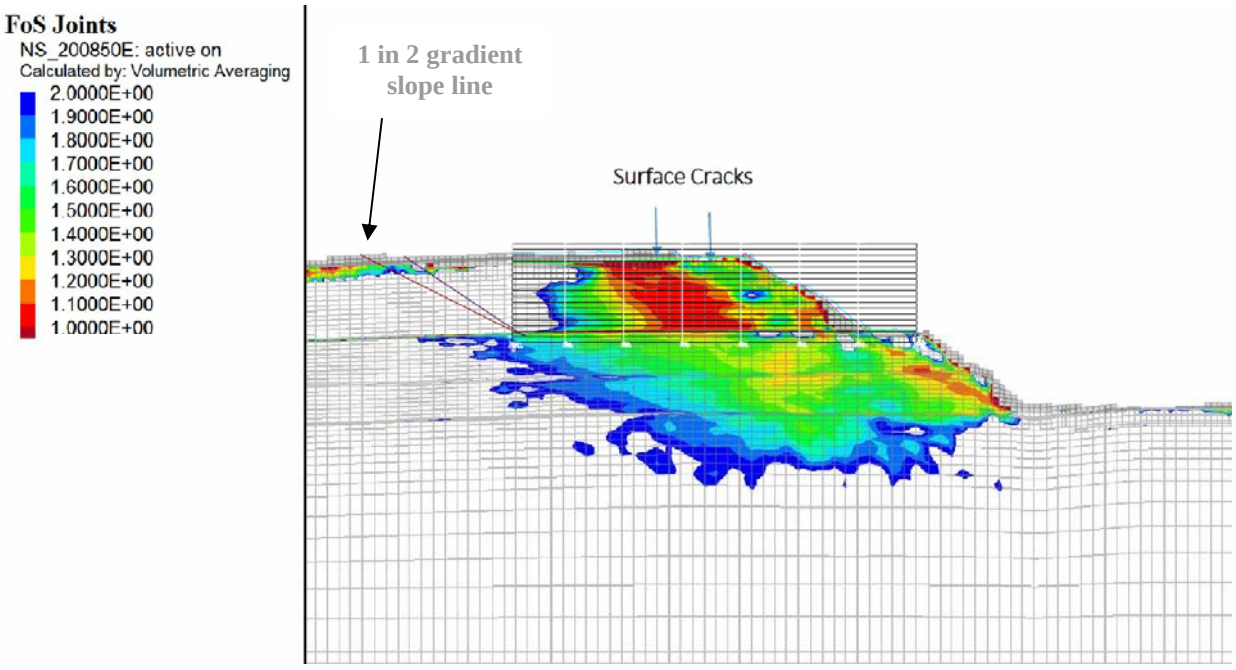

Figure 7: Factor of safety chart at 200850E with cross section and safe slopes shown

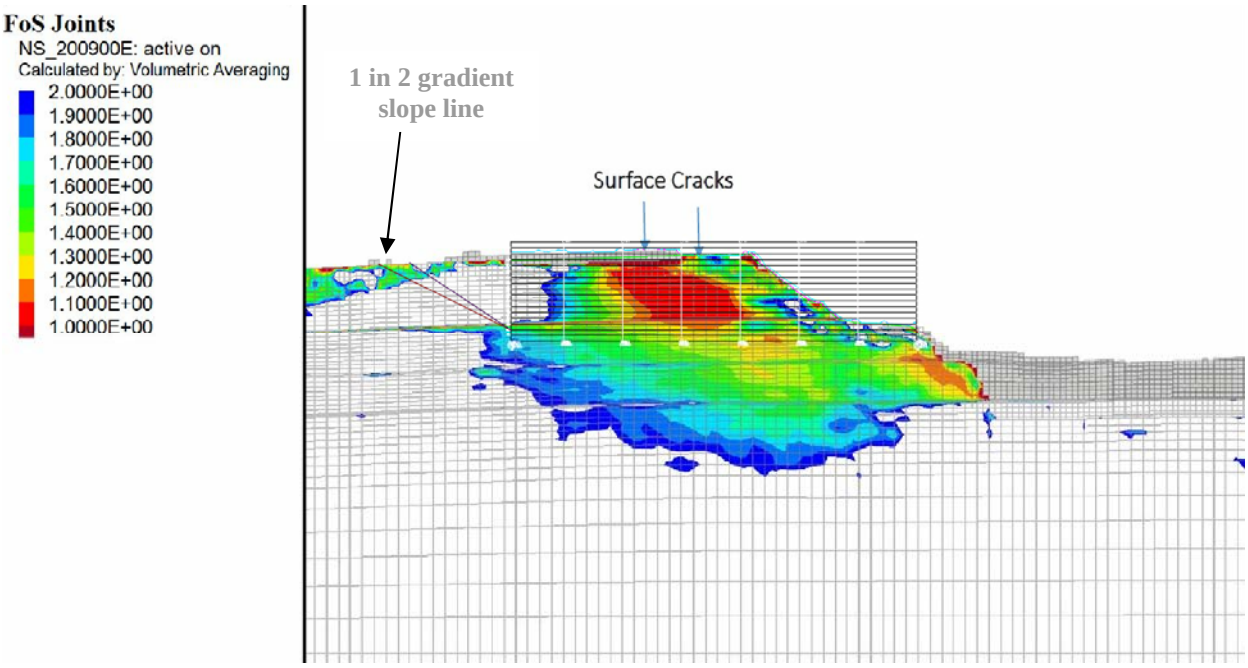

Figure 8: Factor of safety chart at 200900E with cross section and safe slopes shown