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Report on
Geotechnical Investigation
Detailed Slope Stability Assessment
Longwalls S1A to S6A, Bargo

Prepared for
Tahmoor Coal Pty Ltd

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Executive Summary

A detailed stability assessment has been completed for Road Embankments RE1 – RE4, which are located within the study area of LW S1A to S6A. The detailed stability assessment included quantitative and qualitative risk-based assessments of the road embankments. The geotechnical assessment was based on the inputs received from Tahmoor Coal, the subsidence prediction report by MSEC, observations from site inspections and field mapping, subsurface investigation of the road embankments, monitored performance of existing earth embankments during longwall mining of LW W1 – W4.

Slope stability analyses were carried out for the road embankments indicated *Acceptable* factors of safety for RE1, RE2 (SB), RE3 and RE4, and a *Tolerable* factors of safety for RE2 (NB) for the operation of Remembrance under normal operation, a 1 in 100 year flood event and for earthquake loadings without suction. The results of the analyses are generally consistent with previous assessments.

The risk assessments were carried out using the procedure recommended by NSW RMS Slope Risk Analysis Methodology (2014) and informed by quantitative modelling carried out with SlopeW software.

The current assessment indicates that the predicted impacts of subsidence on road embankments in the Study Area will result in a slight increase in risk categories, which have been assessed to be in the range of *Very Low* to *Moderate*. Moderate risk levels are considered to be *Tolerable* and must be managed and kept under review. Provided maintenance and control measures recommended in this report are implemented, the risk level for life is considered to be within the Low and Acceptable range.

It is recommended that a monitoring program including geotechnical inspections and survey is developed and implemented to monitor that the effects of subsidence are within the modelled predictions. Routine inspections and visual observations are key to identifying signs of distress. Ongoing maintenance will be required to minimise the potential for long term instability of road embankments. Mitigation work to strengthen the road embankments prior to the commencement of LW S1A to S6A are not considered to be necessary. Where measurements indicates that subsidence movements are in excess of predictions or signs of distress are observed, Trigger Action Response Plan (TARP) responses must reassess the need for mitigation works.

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1. Introduction

This report presents the results of a geotechnical investigation and detailed stability assessment for four road embankments undertaken for inclusion in the Extraction Plan prepared for Longwalls (LW) South 1A (S1A) to South 6A (S6A) in the Tahmoor South Domain. The report provides an assessment of the risk of slope instability for four road embankments within the Study Area (SA) for LW S1A to S6A. The investigation was commissioned in an email dated 23 March 2022 by Ms April Hudson of Tahmoor Coal Pty Ltd (TC) and was undertaken in accordance with Douglas Partners' proposal 210597.02.P.001.Rev0 dated 15 March 2022.

Remembrance Drive is an arterial road within the Wollondilly Shire Council local government area (LGA). Assessments by others have indicated that surface subsidence caused by longwall mining may have impacts on steep slopes, which includes road embankments, located within the study area, as shown on Figure 1. The purpose of this detailed stability assessment is to identify and assess the risks to the road embankments that may be influenced by the longwall mining. It is noted that rail embankments within the SA will be assessed and reported separately by others.

The aim of the geotechnical investigation is to determine the subsurface profile of the road embankments and their foundations. The assessment also includes slope stability modelling for the road embankments and a qualitative risk assessment to assess the potential risks and consequences due to mine subsidence associated with the extraction of LW S1A to S6A. This assessment has been subdivided into the following parts:

- A review of the geology, geomorphology and site history with respect to natural events that may affect the stability and past performance of the earth embankment in areas of mine subsidence.
- A review of the studies related to subsidence measurements, including records for LW W1 – W4, and the impact of predicted subsidence on the road embankments following the extraction of LW S1A to S6A.
- Details of the results of site inspections, subsurface investigation, laboratory testing and initial monitoring.
- Stability modelling of the road embankments; and
- A risk assessment of the road embankment and identification of the likely consequence of assessed instability.

This report supersedes all previous written and verbal correspondence.

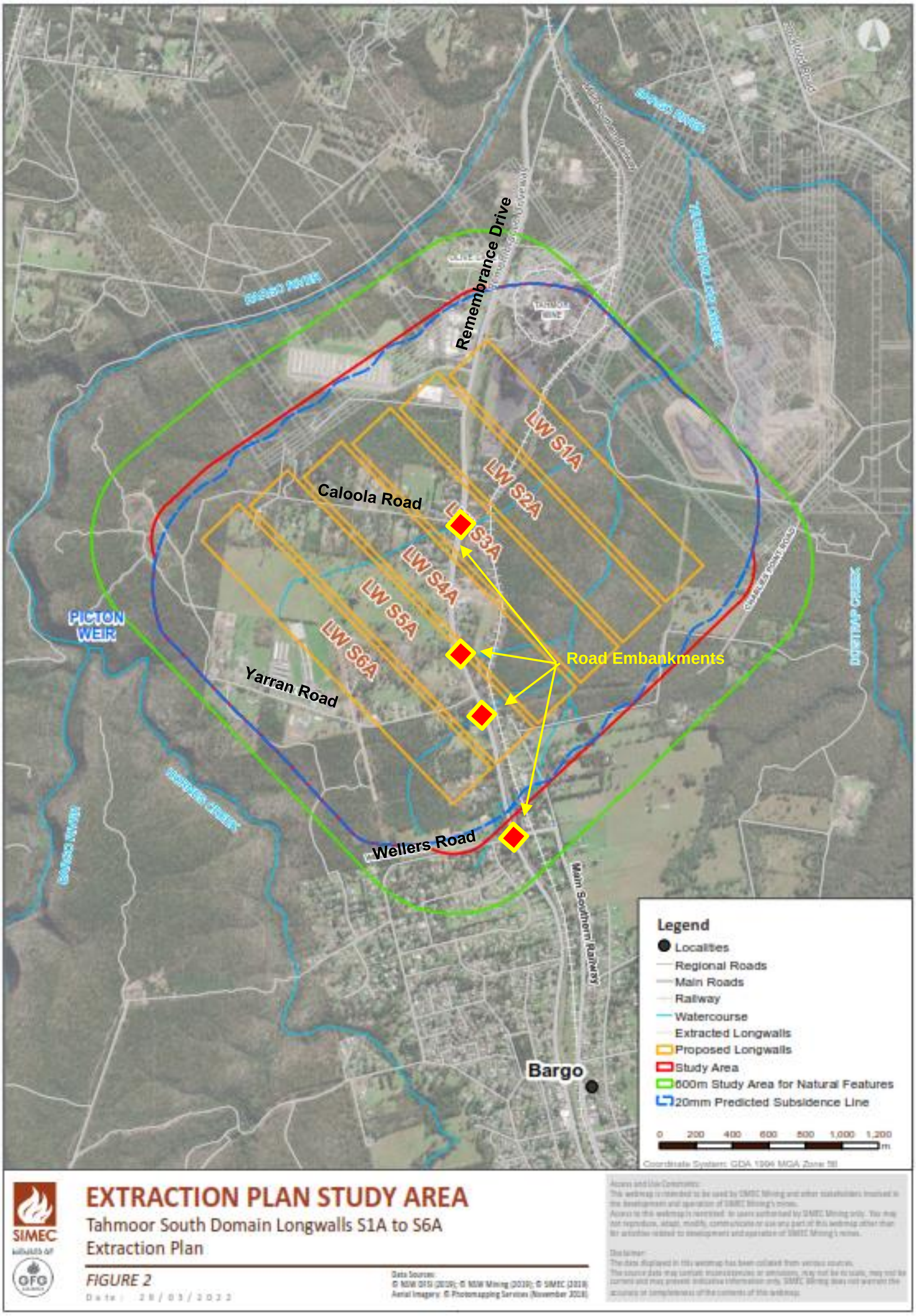

Figure 1: Study Area for Subsidence Effect on Land Features (Courtesy TC)

2. Background

2.1 General

The Old Hume Highway, which is now known as Remembrance Drive in the Study Area, was constructed in the late 1820's through Picton, Tahmoor and Bargo and was part of the original Hume Highway connecting Sydney and Melbourne. There are older sections of the Hume Highway that have previously been deviated, including the construction of road embankment adjacent to Caloola Road (RE4), which was possibly constructed as part of improvement works during the 1967 Bargo River Bridge construction works. In 1980, the dual carriageway, Hume Freeway Campbelltown to Yanderra Bypass was opened, which significantly reduced the traffic volume on the old highway. It is understood that over the 190 years that the four road embankments in this assessment have been in operation, no failures have been recorded.

2.2 Previous Embankment Assessments

DP has previously been involved with the assessment of heritage rail embankments on the Picton to Mittagong Loop Line (PMLL) within Tahmoor Mines Western Domain at Picton. Relevant details and learnings from these previous assessments have been incorporated into the current assessment.

2.3 Performance of Earth Embankments During LW W1 – W4 Extraction

MSEC reports (2020, 2021, 2022a and 2022b) reported that no impacts were observed to the rail earth embankments along the PMLL during extraction of LW W1 to W4 in Tahmoor Mines Western Domain, which included two embankments that were directly undermined with up to 670 mm subsidence recorded. Maximum incremental subsidence of 346 – 452 mm were recorded along the length of the embankment during extraction of LW W2. Minor hairline cracking was observed in the exposed bedrock at the inlet and outlet of the culvert at 88.40 km, with minor cracking also observed to the culverts and head walls.

Weekly geotechnical inspection and analysis of survey and instrumentation data by Newcastle Geotech (NG) reported no impacts were observed to the rail earth embankments and their culverts along the PMLL during extraction of LW W1 and W2, with only minor opening of sandstone block headwall joints at the inlet and outlet of the culvert.

Review of hydrographs of vibrating wireline piezometers installed in boreholes in the rail embankments, which includes readings during the February 2020 and March 2021 heavy rainfall events, indicates that porewater pressures increased by a maximum of 10 kPa (ie the water level rose by up to 1 m) from background levels during these heavy rainfall events.

Review of manual crest extensometers at the rail embankments recorded during LW W1 and W2 extraction confirms negligible increase in embankment crest width and no evidence of embankment instability.

3. Site Description

3.1 General

Tahmoor Mine is an underground coal mine located approximately 80 km southwest of Sydney between the townships of Tahmoor and Bargo in New South Wales (NSW). TC proposes to extend underground coal mining to the south and east of the Bargo River, to the north of the township of Bargo and generally to the west of Charlies Point Road at Bargo and is preparing an Extraction Plan for the extraction of LW S1A to S6A (refer Figure 1).

Remembrance Drive is oriented approximately north-south through the centre of the proposed mining area. Remembrance Drive enters the northern part of the Study Area crossing the northern part of LW S1A, it then crosses above section of LW S1A to LW S5A, and exits the southern part of the Study Area near the northern part of the township of Bargo. Remembrance Drive includes four road embankments in the Study Area (refer Drawing 1), with the details of the individual embankments summarised in Table 1.

Table 1: Road Embankments within the Study Area

Location	Length (m)	Maximum Height (m)	Description	Location Relative to Proposed Longwalls
RE1 (Remembrance Drive intersection with Wellers Road)	249	5.1	Earth Embankment	500 m south of LW S5A
RE2 (Remembrance Drive south of Yarran Road)	218	7.8	Earth Embankment	Directly above LW S5A
RE3 (Remembrance Drive north of Yarran Road)	165	3.9	Earth Embankment	Directly above LW S5A
RE4 (Remembrance Drive adjacent to Caloola Road)	348	4.2	Earth Embankment	Directly above LW S3A

3.2 Site History

Review of Geoscience Australia’s Earthquake Database indicates that since records commenced in the area in 1950’s, four ≥ ML 4.0 earthquakes have been recorded in the vicinity of the site including the ML 5.8 1961 Bowral Earthquake and the ML 5.5 1973 Picton Earthquake.

Rainfall records collected at nearby weather stations, including since 1880 at Picton, indicate nine events where over 200 mm of rainfall have been recorded in a single day. This includes a storm event in June 2016 and heavy rainfall associated with an East Coast Low in February 2020, both of which resulted in flooding that affected Picton’s town centre. It is noted that it doesn’t include recent heavy rainfall events in March 2021, March 2022 and July 2022, which almost resulted in flooding in Picton.

It is understood that no intermediate or deep-seated failures have affected the road embankments since construction or resulting from the above earthquake and flood events.

3.3 Mining Geometry and Surface Topography

The footprints of LW S1A to S6A are shown in Drawing 1. The longwalls are planned to be 283 m to 285 m wide, with tailgate chain pillar widths in between the longwalls of 36 m and 38 m. The total lengths for LW S1A to S6A are between 1711 m and 1998 m. The panels will extract the Bulli Seam from south to north. The extraction height is proposed to be between 2.1 m and 2.2 m. The Bulli Seam dips towards the north east with an average gradient of 1.7% across the mining area. Based on the information provided by the client, the lowest level of the seam floor is about RL 126 m relative to Australian Height Datum (AHD). The depth of cover directly above the proposed longwall varies between a minimum of 365 m above northern end of LW S5A and a maximum of 405 m above northern end of LW S1A.

The surface level contours within the Study Area indicate that the highest point of topography is about 354 m AHD in the ridge line to the west of the northern section of LW S6A. The surface topography comprises a plateau that gently slopes towards the north east with the eastern part of the Study Area incised by creek line gullies with the lowest point at about 265 m AHD in Teatree Hollow. Remembrance Drive generally crosses the central-eastern part of the gently sloping plateau area. Road Embankments RE2 – RE4 have been constructed across broad gullies of creek lines and perennial watercourses on unnamed tributaries of Teatree Hollow and Wirrimbirra Creek. These gullies have been incised into the plateau and include concrete box and pipe culverts at their low points. Road Embankment RE1 has been constructed adjacent to and over the Main Southern railway line (MSL) as part of an overpass bridge across the railway.

Various topographical features of the site are shown in the Photos 1 – 12 (refer Plates 1 – 3) in Appendix B.

4. Regional Geology

The study area lies within the Southern Coalfield of the Sydney Basin. The Permo-Triassic Sydney Basin extends roughly 300 km along the coast of New South Wales and inland for a distance of up to 200 km. The principal coal-bearing sequence in the Southern Coalfield of the Sydney Basin is the Illawarra Coal Measures which consist of numerous coal seams. The uppermost seam is the Bulli Seam which has been extensively mined in the northern part of the coalfield. The Bulli Seam is immediately overlain by the Narrabeen Group which consists of a series of major sandstone and shale units. The Wombarra Shale and Scarborough Sandstone form the immediate and main roof respectively. The Wombarra Shale consists of shale and claystone with minor thin interbeds of fine-grained sandstone. The Scarborough Sandstone comprises coarse grained quartz-lithic sandstone. It is noted that while the Coal Cliff Sandstone is typically located between the Wombarra Shale and Bulli Seam in the eastern part of the Southern Coalfield, it decreases in thickness towards the west becoming a band within the Wombarra Shale before disappearing entirely. It has not been identified in drill core in the Tahmoor area. Overlying the Narrabeen Group is the Hawkesbury Sandstone, which comprises a series of bedded sandstone units which date from the Middle Triassic, and has a thickness of up to 185 m, and then Ashfield Shale. The typical stratigraphic section in the Study Area is shown in Figure 2.

Much of the surface in the Study Area is mapped as being underlain by Hawkesbury Sandstone. The Ashfield Shale is mapped in the northern part of the Study Area underlying the Tahmoor Mine site and the area immediately to the west. The Mittagong Formation, a transitionary unit between the Ashfield Shale and Hawkesbury Sandstone, which consists of interbedded shale, laminite and fine-grained sandstone, is also expected within the Study Area. The Hawkesbury Sandstone crops out along the incised and downstream sections of the local creeks and watercourses and in a road cutting on Remembrance Drive, to the south of the Tahmoor Mine site. Incision tends to follow the dominant joint directions in the rock (ie north and northeast) and it is possible that this influences the orientation of the long axis of the gullies in which the creeks are formed. The sandstone rocks tend to break up into large blocks due to weathering along the near-vertical joint planes and near-horizontal bedding planes.

Regional structural geology mapped within the study area is limited to two faults to the east of the Tahmoor Mine site, which have probably been identified during underground mining or exploration associated with Tahmoor Mine. The closest mapped geological structures to the Study Area are the Nepean Monocline, which is oriented northwest-southeast and located about 500 m to the southwest, and the Bargo Fault, which is oriented approximately north-south and located approximately 1.7 km to the east.

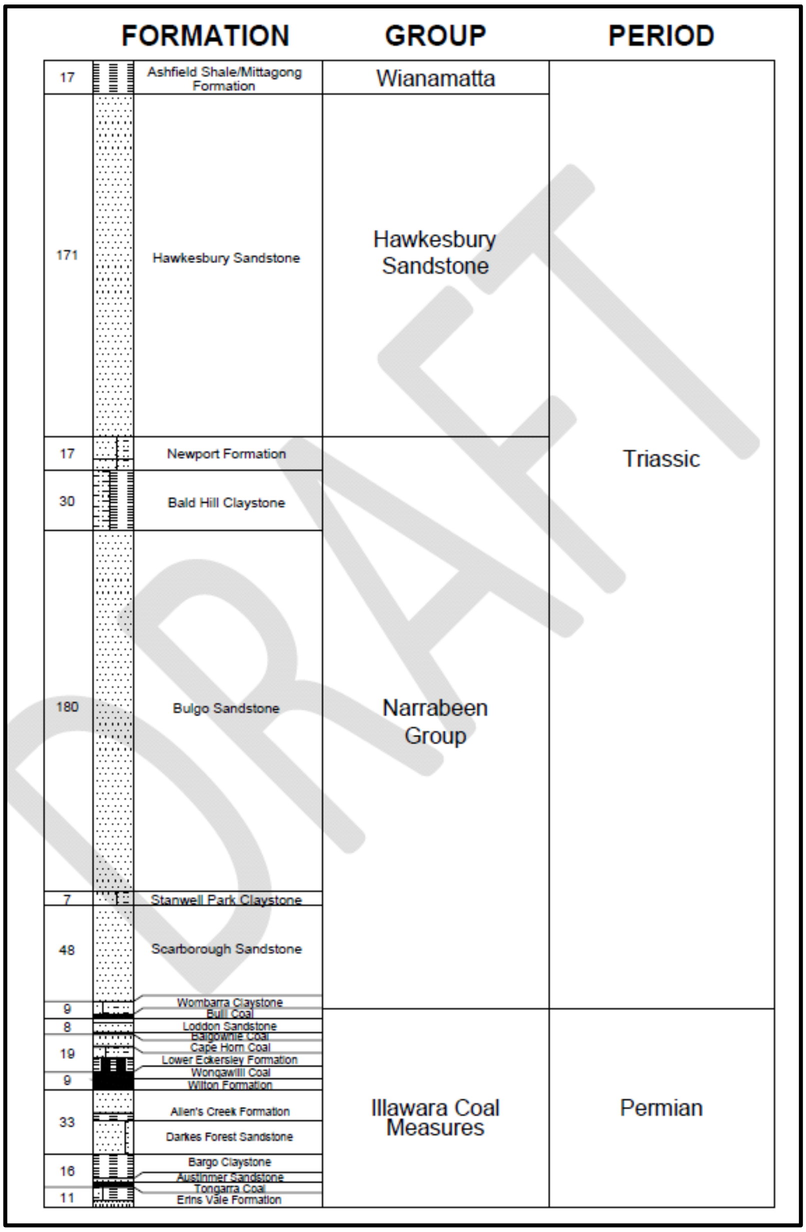

Figure 2: Typical Geological Stratification at Tahmoor (Courtesy MSEC, 2019)

5. Review of Subsidence Predictions

5.1 Reports, Drawings and Databases

Tahmoor Coal provided a MSEC (2022c) report on “subsidence predictions and impact assessment for natural and built features due to the extraction of proposed Longwalls S1A to S6A” for the current assessment. Information from MSEC (2022c) has been used within the current assessment where appropriate.

5.2 Survey

Publicly available LIDAR survey data from the NSW Spatial Portal has been used to delineate the road embankments. The subsidence contour profiles for the planned and adjacent longwall panels discussed in this report are based on the information in the reports provided by Tahmoor Coal and MSEC.

5.3 Summary of Subsidence Predictions

Table 2 summarise the maximum incremental subsidence prediction results due to progressive extraction of LW S1A to LW S6A (studies on calibrated numerical model by MSEC) that Remembrance Drive is likely to experience following extraction of LW S1A to S6A.

Table 2: Predicted incremental subsidence details for LW S1A to S6A (MSEC, 2022c)

Longwall	Maximum predicted incremental subsidence (mm)	Maximum predicted incremental tilt (mm/m)	Maximum predicted incremental hogging curvature (km^{-1})	Maximum predicted incremental sagging curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	950	7.5	0.08	0.22
LW S3A	950	8.0	0.09	0.22
LW S4A	950	8.0	0.09	0.22
LW S5A	950	8.0	0.10	0.22
LW S6A	975	8.3	0.09	0.23

Table 3 summarises the maximum predicted total subsidence results due to extraction of LW S1A to S6A (studies on calibrated numerical model by MSEC) that Remembrance Drive is likely to experience.

Table 3: Predicted total subsidence details for LW S1A to S6A (MSEC, 2022c)

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	1000	8.0	0.10	0.22
LW S3A	1200	8.0	0.10	0.22
LW S4A	1250	8.5	0.13	0.22
LW S5A	1350	9.0	0.14	0.22
LW S6A	1350	9.5	0.14	0.24

Table 4 summarises the predicted maximum total strains in the Study Area likely to be experienced at any time during mining.

Table 4: Predicted maximum strains during extraction of LW S1A to S6A (MSEC, 2022c)

Longwall	Above goaf		Above solid coal	
	Compressive strain (mm/m)	Tensile Strain (mm/m)	Compressive strain (mm/m)	Tensile Strain (mm/m)
95% confidence level	2.2	1.3	<1.0	<1.0
99% confidence level	4.3	2.0	<1.5	<1.5

MSEC (2002c) provides valley closure estimates for Teatree Hollow and Wirrimbirra Creek of 275 – 375 mm, however no estimates are provided for lower order tributaries. Anecdotal information provided by MSEC indicates that damage to culverts along the railway earth embankments has occurred where the culvert was excavated into bedrock and closure values exceeded 20 mm. No repairs have previously been required where culverts are located in fill embankments and clay soils.

6. Field Work Methods

6.1 Horizontal and Vertical Control

All field measurements and mapping for this project have been carried out using the Geodetic Datum of Australia 1994 (GDA94) and the Map Grid of Australia 1994 (MGA94), Zone 56. Digital mapping has been carried out in a Geographic Information System (GIS) environment using QGIS software. All reduced levels are given in relation to Australian Height Datum (AHD).

6.2 Geological Mapping

Geological mapping of the site was undertaken on 23 December 2021 and between 3 – 6 May 2022 by a DP Senior Engineering Geologist to establish the embankment geometry, site geomorphology and geology, to identify and assess areas of potential slope instability and to identify locations for subsurface investigation.

6.3 Boreholes

The field work included four boreholes (Bores 1 – 4) drilled using a track-mounted soil sampling and drilling rig. The boreholes were drilled using a combination of 100 mm diameter spiral flight augers and rotary drilling to termination depths of 4.6 – 10.8 m. The boreholes were then extended into the underlying rock using NMLC (50 mm diameter core) diamond drilling equipment to the termination depths of 8.4 – 13.8 m.

Standard penetration testing (SPT) was carried out at regular intervals within the embankment fill and foundation material for evaluation of the in-situ soil consistency and to obtain samples for strata identification and laboratory testing. The SPT procedure is given in the notes (Appendix A) and the penetration “N” values are shown on the borehole log. Logging of soil was carried out by a geotechnical engineer.

On completion of the drilling, standpipe piezometers were installed at each borehole location to facilitate monitoring of groundwater levels.

The locations of the boreholes are shown on Drawings 2 – 5 in Appendix D. The surface levels to AHD and coordinates to Map Grid Australia (MGA) Zone 56 were collected on site using a differential GPS unit for which a nominal accuracy of ± 20 mm is typical.

7. Field Work Results

7.1 Inspection

Inspection of Road Embankments RE1 – RE4 were carried out by a Senior Engineering Geologist on 23 December 2021 and between 3 – 6 May 2022. The site observations are summarised in Table 5 with selected items additionally shown in Photos 1 – 12 on Plates 1 – 3 (Appendix C).

Table 5: Site Observations

Feature ID	Location	Date Inspected	Site Observations
RE1	Remembrance Drive intersection with Wellers Road	23/12/2021 & 6/5/2022	– Variable batter slopes measured to be between 30° and 38°, increasing local to 45°. – The soil exposed in the embankment comprises clay and gravel fill (refer Photo 1) including shale, carbonaceous siltstone and sandstone. – There is rutting, crocodile cracking, shoving and bleeding in the Remembrance Drive wearing course and a number of patches in both lanes (refer Photo 3). Table drains are located on both sides of the Remembrance Drive roadway to the north of the intersection with Wellers Road. – The surface of the road embankment batter on the eastern side of Remembrance Drive, approximately 130 m to the north of the intersection, has an irregular surface. – There were no discernible signs of seepage at accessible locations from the road embankment or foundation area of the embankment. – No signs of deep-seated movement in the pavement. – A high-pressure gas pipeline is located along the eastern side of the embankment.

Table 5: Site Observations

Feature ID	Location	Date Inspected	Site Observations
RE2	Remembrance Drive south of Yarran Road	23/12/2021 & 4/5/2022	– Variable batter slopes measured to be between 35° and 40°, increasing local to 45°. – Mature trees are growing in the embankment (refer Photos 4 and 5). – Cracking in the kerb, offsets of up to 20 mm and gaps of up to 70 mm of the north-bound lane, approximately 170 m south of Yarran Road. – An 1800 mm diameter concrete pipe culvert is located in the base of the gully that the road embankment is constructed across. – There were no discernible signs of seepage at accessible locations from the road embankment or foundation area of the embankment. – No signs of deep-seated movement in the pavement. – A high-pressure gas pipeline is located along the eastern side of the embankment.
RE3	Remembrance Drive north of Yarran Road	23/12/2021 & 4/5/2022	– Variable batter slopes measured to be between 30° and 36°, increasing local to 38°. – The upstream face is generally grassed (refer Photos 6 – 8) while the downstream face was obscured with long grass and shrubs. – A 900 mm diameter concrete pipe culvert is located in the base of the gully that the road embankment is constructed across. – There were no discernible signs of seepage at accessible locations from the road embankment or foundation area of the embankment. – No signs of deep-seated movement in the pavement. – A high-pressure gas pipeline is located along the eastern side of the embankment.

Table 5: Site Observations

Feature ID	Location	Date Inspected	Site Observations
RE4	Remembrance Drive at the Caloola Road	23/12/2021 & 3/5/2022	– Variable batter slopes measured to be between 30° and 38°, increasing local to 40°. – Trees growing along the western side of the embankment, approximately 80 m south of Caloola Road, have a slight lean downslope (refer Photo 10). – The toe along the western side of the embankment has been cut-back to construct a drain along the edge of the road (refer Photos 11 and 12). – The soil exposed in the embankment comprises clayey gravel/gravelly clay fill (refer Photo 12) with sandstone cobbles and boulders. – Twin 1200 mm diameter concrete pipe culverts are located in the base of the gully that the road embankment is constructed across. – There were no discernible signs of seepage at accessible locations from the road embankment or foundation area of the embankment. – No signs of deep-seated movement in the pavement. – A high-pressure gas pipeline is located along the eastern side of the embankment.

7.2 Subsurface Investigation

Details of the subsurface conditions encountered during the current field investigation are given on the borehole logs in Appendix B, together with notes defining classification methods and descriptive terms.

The field work indicated generally uniform subsurface conditions within the road embankments, with the general succession of strata broadly summarised below and strata depths summarised in Table 6:

Road Pavements: comprising a heavy duty 220 – 230 mm thick bituminous concrete encountered in Bores 1 and 3 (Remembrance Drive), an 80 mm thick bituminous concrete wearing course overlying a 90 mm thick lightly bound basecourse in Bore 2 (Remembrance Drive), and a 20 mm spray seal overlying a 380 mm thick crushed sandstone basecourse in Bore 4 (Wellers Road).

Embankment (Clay) Fill: encountered at all test locations. The embankment fill typically comprised moderately to well compacted silty clay, sandy clay, sand silty clay. Some layers of sandy gravel (ie crushed sandstone) and a bituminous concrete (ie from a previous pavement wearing course) were also encountered.

Alluvial Soil: inferred in Bores 1 and 2. The alluvium comprised silty clay, silty sandy clay and clayey silt of low to medium plasticity and very soft to very stiff consistency.

Residual Soil: encountered at all test locations. The residual soil comprised silty clay, sandy silty clay and sandy clay of low to high plasticity, stiff to hard consistency and grading into extremely to highly weathered sandstone.

Bedrock: initially comprising medium strength sandstone with clay and very low to low strength seams in Bores 1, 2 and 4. Consistent medium high strength sandstone was encountered at all test locations.

Table 6: Summary of Borehole Strata

Strata	Bore 1	Bore 2	Bore 3	Bore 4
	Depth to top of Strata (m)	Depth to top of Strata (m)	Depth to top of Strata (m)	Depth to top of Strata (m)
Pavement	0.0	0.0	0.0	0.0
Embankment Fill	0.22	0.17	0.23	0.4
Alluvial Clay	3.6	3.7	n/e	n/e
Residual Clay	5.4	6.3	10.4	1.8
Extremely to Highly Weathered Sandstone	5.8	6.5	n/e	5.7
Moderately Weathered to Fresh Sandstone	6.1	7.9	10.6	5.9

where: n/e = not encountered.

7.3 Groundwater

Free groundwater was encountered during auger drilling at a depth of 4.6 m in Bore 2. No free groundwater was observed in the remaining boreholes during auger drilling. Water loss occurred during diamond core drilling of Bore 3, between depths of 10.8 m and 13.8 m (ie within the bedrock). The use of water as a drilling fluid during rotary drilling prevented groundwater observations being made thereafter.

Subsequent monitoring of standpipe piezometer installed in the boreholes indicated the following groundwater depths and levels on 20 May 2022:

- Bore 1: 8.6 m (RL 293.1 m);
- Bore 2: 4.2 m (RL 309.3 m);
- Bore 3: 8.6 m (RL 306.2 m); and
- Bore 4: 3.2 m (RL 320.9 m).

The results of groundwater level measurement indicate that the groundwater levels were below the base of the embankments, variably occurring in the natural soil profile or in bedrock. Groundwater levels are subject to soil permeability and preceding climatic conditions, and as such, will vary over time.

8. Laboratory Testing

8.1 Moisture Content and Standard Compaction Testing

Field moisture testing was carried out to determine moisture profiles at selected test locations. Compaction testing was carried out to determine compaction curves for remoulded triaxial tests. The results of testing are summarised in Table 7 and the detailed laboratory test sheets are in Appendix C.

Table 7: Results of Field Moisture and Compaction Testing

Test Location	Depth (m)	Field Moisture Content (%)	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	Material
1	1.0 – 1.45	10.0	-	-	FILL/Silty CLAY
1	2.0 – 2.95	16.3	-	-	FILL/Silty CLAY
1	1.0 – 3.0	12.2	1.95	12.5	FILL/Silty CLAY
1	4.0 – 4.45	12.7	-	-	FILL/Silty Sandy CLAY
1	5.0 – 5.45	12.6	-	-	FILL/Silty Sandy CLAY
1	5.6 – 5.8	11.1	-	-	Silty CLAY
2	1.5 – 1.95	12.7	-	-	FILL/Silty CLAY
2	3.0 – 3.45	14.6	-	-	FILL/Silty CLAY
2	4.0 – 4.45	17.8			Silty CLAY
2	5.0 – 5.45	25.8	-	-	Silty CLAY
2	6.0 – 6.45	15.1	-	-	Sandy Silty CLAY
3	1.0 – 1.45	8.6	-	-	FILL/Silty CLAY
3	2.0 – 3.5	10.3	1.96	11.5	FILL/Silty CLAY
3	3.0 – 3.45	8.9	-	-	FILL/Silty CLAY
3	5.1 – 5.55	10.7	-	-	FILL/Silty CLAY
3	7.0 – 7.45	12.1	-	-	FILL/Silty CLAY
3	8.0 – 8.45	19.7	-	-	Silty CLAY
3	9.5 – 9.85	17.3			Sandy CLAY
3	10.5 – 10.75	16.2	-	-	Sandy CLAY
4	2.0 – 2.45	15.4	-	-	Sandy Silty CLAY
4	4.0 – 4.3	11.9	-	-	Clayey SILT

The results of field moisture testing generally indicates that the moisture content of embankment fill samples are close to the optimum moisture contents, which is consistent with field observations and the results of insitu strength testing. The results of field moisture testing on embankment foundations indicates some samples with elevated moisture contents, which is consistent with field observations and insitu strength testing.

8.2 Atterberg Limits and Linear Shrinkage

Atterberg limits and linear shrinkage were determined on selected samples collected from the boreholes. The results of testing are summarised in Table 8 and the detailed laboratory test sheets are in Appendix C.

Table 8: Results of Atterberg Limit Testing

Test Location	Depth (m)	FMC (%)	LL (%)	PL (%)	PI (%)	LS (%)	Material
1	1.0 – 3.0	-	29	12	17	8.0	FILL/Silty CLAY
1	5.6 – 5.8	11.1	34	15	19	-	Silty CLAY
2	2.0 – 2.4	13.1	38	15	23	11.0	FILL/Silty CLAY
2	5.0 – 5.45	25.8	33	18	15	-	Silty CLAY
3	2.0 – 3.5	10.3	33	13	20	9.0	FILL/Silty CLAY
3	8.6 – 9.0	17.1	24	15	9	5.0	Silty CLAY
3	9.5 – 9.95	17.3	43	20	23	-	Sandy CLAY
4	1.0 – 1.4	18.8	43	24	19	8.5	FILL/Sandy Silty CLAY

where:
W_F = Field Moisture Content
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
LS = Linear Shrinkage

The results of testing indicate that the embankment fill and natural clay samples tested were of low to medium plasticity. The embankment fill samples tested were 1.9 and 5.2 percentage points dry of the plastic limit. Clay foundation samples were variably 3.9 percentage points dry to 7.8 percentage points wet of the plastic limit.

8.3 Triaxial Testing

Two remoulded samples (Bores 1 and 3) and two undisturbed samples (Bores 2 and 4) of embankment fill, and one sample of the natural clay were tested under Consolidated Undrained (CU) conditions with pore pressure measurements of samples. The remoulded samples were compacted to 95% Standard. The results of testing are summarised in Table 9 and the detailed laboratory test sheets are in Appendix C.

Table 9: Results of Triaxial Testing.

Test Location	Depth (m)	Material	Compaction Level (SMMD, %)	Initial / Final Moisture Content (%)	Estimated Effective Cohesion (c', kPa)	Estimated Effective Friction Angle (ϕ, °)
1	2.0 – 3.5	FILL/Silty CLAY	95	12.0 / 14.7	1.5	28
2	2.0 – 2.4	FILL/Silty CLAY	n/a	13.1 / 15.3	10	28
3	2.0 – 3.5	FILL/Silty CLAY	95	11.8 / 14.8	9	27
3	8.6 – 9.0	Silty CLAY	n/a	17.1 / 16.2	5	30
4	1.0 – 1.4	FILL/Sandy Silty CLAY	n/a	18.8 / 22.5	5	32

The results of CU testing indicates that the samples compacted to 95% Standard Maximum Dry Density were generally lower than undisturbed samples tested, and therefore higher compaction levels are probably present in the field, which is consistent with the majority of SPT's within the embankment fill.

9. Comments

9.1 Geotechnical Model

The geological model for the road embankments and immediate adjacent area is based on site mapping and subsurface investigation. The geological model comprises:

- Remembrance Drive pavement comprising a heavy duty bituminous concrete at RE2 and RE4, 220 – 230 mm thick, and flexible pavements at RE1 and RE3, 170 – 400 mm thick. For the purpose of slope stability modelling, flexible pavements have been modelled at all locations.
- Road embankments, up to 7.8 m high, generally comprising clay with sandstone gravel. Based on the age and performance of the embankments, it is inferred that the material was probably 'tracked in' with little or no control over the moisture content. It is further noted that the road embankment has been subject to for about 150 years (including highway traffic volumes for at least 30 years following WWII) prior to the opening of the Hume Freeway Campbelltown to Yanderra Bypass in 1980, and following that by regular road loads.
- Alluvial clay soil, 1.6 – 2.4 m thick, including low strength material in the embankment foundation at RE1 and RE2. It is noted that the depth of embankment fill in Bore 3 exceeds the height of the embankment, which indicating that possibly alluvial material was stripped from the centre of the gully prior to the construction of the RE3 road embankment.

- Residual clay soil, up to 2.7 m thick, of stiff to hard consistency grading into extremely to highly weathered sandstone.
- Hawkesbury Sandstone and Mittagong Formation comprising sandstone and siltstone. Initially of extremely to highly weathered material, becoming slightly weathered to fresh at depth.
- The groundwater measurements in the boreholes indicate that groundwater levels were within the clay foundations for RE1 – RE3 and within the bedrock in RE4. It is noted that the boreholes were drilled and monitored during an extended period of above average rainfall.

9.2 Slope Instability Risks – General

Stability of existing slopes is typically dependant on a number of key factors including the surface slope, the type and strength of soil or rock, the presence of water and applied surface loads. While an area may be assessed as being currently stable, changes including mine subsidence, or a lack of maintenance may trigger slope instability. Alternatively, sites which are assessed as having some risk of slope instability may be improved by unloading the slopes, transferring loads to below the potential failure surfaces and the installation of such features as surface and subsurface drains, reducing batter slopes or construction of retaining structures.

Subsidence due to longwall mining of LW S1A to S6A could result in surface cracking, heaving, buckling, stepping and closure which can influence the road embankments. The location of these features is considered to be the first step in managing prediction uncertainties and potential impacts associated with subsidence. The final step is to identify the methods of monitoring and mitigation in order to reduce the subsidence effect to ‘repairable level’ or to be as low as practicable.

It is noted that the regulator is the appropriate authority to set standards for tolerable risk. Definitions of acceptable and tolerable risk as included in the AGS Guidelines are as follows:

Acceptable Risk – a risk for which, for the purposes of life or work, owners/clients are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure justifiable in further reducing such risks. An acceptable risk to property is typically qualitatively described as being of low or very low classification.

Tolerable Risk – a risk that society is willing to live with to secure certain net benefits in the confidence that it is being properly controlled, kept under review (eg by installation of monitoring such as piezometers or inclinometers) and further reduced as and when possible. AGS suggests that for most developments in existing urban areas, criteria based on Tolerable Risks levels, typically moderate risk, are applicable because of the trade-off between the risks, the benefits of development and the cost of risk mitigation.

9.2.1 Slope Instability Hazards

Based on the current assessment, the slope instability hazard assessed as affecting or potentially affecting the operation of the road embankments are considered to be:

- Rapid, shallow soil slumping through embankment fill;
- Slow, intermediate-depth failure through the road embankment extending into the trafficable lanes; and
- Slow, deep-seated failure through embankment fill and clay foundation extending into the trafficable lanes.

9.2.2 Stability Analysis

Detailed stability analyses were carried out for the road embankments using Slope/W slope stability programme distributed by Geo-slope International Ltd. Slope/W uses limit equilibrium methods (the Morgenstern-Price Method was used for the current assessment) for the analysis of circular and non-circular failure surfaces. The method calculates a factor of safety (FoS) as the ratio of the restoring moment to the overturning moment. Typically, an acceptable FoS for slope stability associated with an existing slope in the long-term would be 1.3.

The models were initially constructed using the existing slope geometry derived from LiDAR shown in the SlopeW model on Drawings 6 – 9 and calibrated using various soil parameter combinations taking into account the results of the field investigations and laboratory testing, DP's involvement with similar assessments and the site history. The range of material parameters adopted for the various strata are summarised in Table 10. The analyses also include the following:

- The embankments have an alluvial and/or residual clay soil foundation.
- Traffic loads of 20 kPa, applied as uniformly distributed load to the carriageway surface.
- Exclusion of any shallow failure surface that do not affect the operation of the trafficked lanes (ie the analysis has not considered shallow failures that may affect the location of the high pressure gas pipeline).
- Phreatic surfaces within the clay foundations of the RE1 – RE4 road embankments. For RE1 – RE3, which had been constructed across broad gullies, the phreatic surface modelled was 1 m below the ground surface, which is considered to represent a 1 in 100 year flood event (ie 1% Annual Exceedance Probability [AEP]). For RE4, which had been constructed on the plateau, the phreatic surface modelled was 2 m above the soil-rock interface. It is considered that provided hazard reduction works are carried out and maintained, there is unlikely to be any significant increase in pore water pressure in response to major flooding.
- Consideration of earthquake loading using a horizontal seismic coefficient of 0.09.
- Zero negative pore pressure (ie no suction).

Table 10: Range of Material Parameters Selected for Analyses

Material	Bulk Density (γ', kN/m^3)	Cohesion (c', kPa)	Internal Friction Angle (ϕ', °)
PAVEMENT	22	0	40
EMBANKMENT FILL: CLAY	20	1.5 – 5	26 – 27
EMBANKMENT FILL: Crushed Sandstone	20	0	33
ALLUVIAL CLAY	18	0	20
RESIDUAL CLAY	20	2	25
BEDROCK: Interbedded VL – M	24	20	35
BEDROCK: M – H	High Strength		

Stability analyses have been carried out for both South Bound (SB) and North Bound (NB) carriageways. The results of the analyses are shown on Drawings 10 – 25 in Appendix D and are summarised in Table 11.

Table 11: Summary of Stability Analysis Results

Embankment	Calculated Factor of Safety (FoS)(1)			
	NB 1% AEP Flood	NB EQ	SB 1 in 100 AEP Flood	SB EQ
RE1	2.48	1.87	2.01	1.47
RE2	1.27	1.05	1.78	1.39
RE3	3.80	2.23	1.71	1.31
RE4	1.94	1.48	1.41	1.15

Notes:
(1) Scenario's do not consider cohesion provided to the slope by root reinforcement in the upper profile or unsaturated conditions which develop during periods of 'low' and/or 'normal' groundwater levels.
EQ Scenario with earthquake loading
SB South Bound Carriageway
NB North Bound Carriageway
🟩 FoS acceptable (ie ≥ 1.3 and ≥ 1.15 for EQ))
🟧 FoS tolerable (ie ≥ 1.2 for 1% AEP Flood and ≥ 1.0 for EQ)
🟥 FoS unacceptable (ie <1.2 for 1% AEP Flood and <1.0 for EQ)

In summary, the results of stability analysis for Road Embankments RE 1, RE2 (SB), RE3 and RE4 indicates an acceptable factor of safety of at least 1.3, though typically greater than 1.5, for 1 in 100 year flood conditions for the road embankments. Road Embankment RE2 (NB) was assessed to have a tolerable factory of safety. Consideration of earthquake loading in the stability analyses for the Road Embankments RE 1, RE2 (SB), RE3 and RE4 also indicates factors of safety greater than 1.15, and typically greater than 1.4. Road Embankment RE2 (NB) was assessed to have a tolerable factor of safety for earthquake loading. The results of the analysis are considered to be accurate for the scenarios modelled. It is noted that the combination of parameters are consistent with laboratory testing from the current investigation.

9.2.3 Mine Subsidence Effects on the Landslide Risk

The potential for increased risk of slope instability associated with the expected mine subsidence impacts can be caused by:

- Tilting – during the subsidence, minor tilts may alter the geometry of the embankment including batter slope angles and the contact between strata. Instability can be triggered where tilt increases the angle of the slide planes in the down-slope direction. The predicted tilts are less than 0.9% for the longwalls panels the road embankments are located above. These tilt movements may result in some soil movement resulting in a slightly increased risk to instability to the down-tilted side of the embankment and reduced risk for the up-tilted side of the embankment when considered with other contributing factors such as prolonged rainfall events, poor drainage or erosion-induced instability.
- Reduced shear strength – subsidence movements can reduce the shear strength within an embankment or embankment foundation by introducing cracking. Tensile cracks can form in areas of bulging, valley opening and during relaxation of the ground towards a subsidence bowl. Also, differential movement along low angle bedding planes, which can occur during relaxation of the ground towards a subsidence bowl, can introduce shearing along the plane. These shear movements reduce the available shear strength of the plane and can contribute to slope failure. The expected subsidence impacts on the potential instability identified within the study area are minor and are not expected to produce significant cracking or differential lateral movements.
- Water concentration – Cracks developed due to tensile or shear failures can allow ingress of water into a slope. This can potentially trigger instability due to loss of cohesion due to piping effects. The water in these cracks may also apply additional pore pressure to potential failure planes and increase the size of the cracks. The estimated subsidence movements on the surface within the study area are unlikely to produce cracking of significant dimension in areas above solid coal for RE2 – RE4. The estimated subsidence impacts at RE1, which is located across the 20 mm subsidence line, is also unlikely to produce cracking of significant dimension.

Road embankments (RE2 – RE4) are located above Longwall panels S3A to S5A. Subsidence predictions for the site indicate maximum incremental subsidence of the order of 950 mm during longwall mining for LW S3A and S5A and total subsidence of up to 1350 mm. Subsidence will take place over a broad subsidence bowl such that incremental changes in relief across the area will be minor. The risk of a slope instability incidents, if any, may be expected to occur following undermining of road embankments and following the development of the full subsidence bowl during mining of subsequent longwall panels. The subsidence study conducted by MSEC (2022c) indicated tensile strains of up to 2.0 mm/m in the study area. There are other possible mechanisms that may affect the risk of slope instability affecting property due to mine subsidence, such as curvature, compression and tilt, however tensile strain (cracking and shear failure) was considered more likely to influence the risk of slope instability in road embankments rather than these other mechanisms. The subsidence effects are expected to take place over a broad area, due to the depth of mining (greater than 365 m), however localised concentration of stress or strain my result in damage.

9.2.4 Traffic Data

NSW Transport's online traffic volume viewer has a station on Remembrance Drive, Station ID T0492, located 580 m to the west of Lupton Road and approximately 4 km south of the Study Area, which indicates an average annual daily two-way traffic volume of 4644 vehicles for 2022. The traffic distribution is 90% cars and light vehicles and 10% heavy vehicles. The station has been recording since 2015. Over the last eight years, annual average daily traffic volumes have varied between

4532 – 5033, and the traffic distribution has varied between 90-92% light vehicles and 8-10% heavy vehicles.

9.2.5 NSW RMS Slope Risk Analysis Methodology

The NSW RMS slope risk analysis method is based upon an underlying quantitative framework and derives an Assessed Risk Level (**ARL**) for a slope from specific rules to rate source qualitative descriptive elements such as the annual average daily traffic, describing likelihood (eg the probability of an embankment failure to extend to a traffic lane) and consequence of slope hazards on such traffic. These are then combined using matrices to give the **ARL**.

There are five **ARL** levels ranging from **ARL1** (the highest risk level) to **ARL5** (the lowest risk level). The medial quantitative probabilities of loss of life implied by the **ARL** levels are approximately one order of magnitude apart, with **ARL1** approximately equating to an annual risk of death of $>10^{-3}$, **ARL3** approximately equating to an annual risk of death of 10^{-5} and **ARL5** an annual risk of death of $<10^{-6}$.

Road Embankments RE2 – RE4 all have shoulder lanes on either side of the carriageway which are at least 2.7 m wide. RE1 has a reduced should width of between approximately 1.5 m and 2.3 m. The carriageway (ie trafficked lanes) is setback back at least 3.0 – 4.0 m for RE2 – RE4 and about 2.0 – 3.0 m for RE1 from the crest of the road embankment.

For the road embankments (RE1 – RE4) under consideration, the relevant inputs and outcomes are considered to be:

Likelihood: the product of the probability value [*P(d)*] for a hazard occurring (eg shallow, intermediate or depth failure) and the probability value [P*(t)*] of the hazard extending/regressing into the trafficked lane, which result in Likelihood ratings. For the current assessment, likelihoods in the range **L3** to **L4** have been assessed. Failure mechanisms include mine subsidence-induced cracking, east coast low storm events and extended periods of rainfall resulting in the saturation and reduction of shear strength of site soils. It is noted that the likelihood also reflects the risk that the failure will or will not extended into the trafficked lane.

Temporal Probability: based on an Annual Average Daily Traffic (AADT) of up to 5033, a traffic volume of 2517 vehicles/lane/day has been adopted for this assessment. This traffic volume results in a temporal probability rating of **T3** for road embankments.

Vulnerability: for impact by a vehicle with a void or stepped surface, vulnerability is a function of both void size and vehicle speed. For the assessment, an average speed of 80 km/hr has been used. The combination of a speed of 80 km/hr and irregular surfaces (<0.1m steps), and stepped surfaces with 0.1 – 0.2 m and 0.2 – 0.5 m step ranges results in vulnerability ratings of **V4** to **V3** respectively.

Assessed Risk Levels: the application of the above ratings for various hazards along the assessed road section to the RMS risk matrix determination of **ARL** levels is summarised in Table 12.

Table 12: Summary of Assessed Risk Levels

Hazard	Location	Likelihood Rating (L)		Temporal Probability (T)	Vulnerability Rating (V)	Consequence Rating (C)	ARL
		P(d)	P(t)				
Shallow soil slump	RE1, RE2 (SB), RE3 &RE4	0.1	0.01	T3	V4	C4	ARL5
		L4					
Intermediate-depth failure	RE1, RE2 (SB), RE3 &RE4	0.01	0.1	T3	V4	C4	ARL5
		L4					
Deep-seated failure	RE1, RE2 (SB), RE3 &RE4	0.001	1.0	T3	V3	C3	ARL4
		L4					
Shallow soil slump	RE2 (NB)	0.1	0.01	T3	V4	C4	ARL5
		L4					
Intermediate-depth failure	RE2 (NB)	0.1	0.1	T3	V4	C4	ARL4
		L3					
Deep-seated failure	RE2 (NB)	0.01	1.0	T3	V3	C3	ARL3
		L3					

The above assessment indicates that a deep-seated failure extending into the trafficked lane for Road Embankment RE2 (NB) is **ARL3**, and is therefore within a *Tolerable* risk range (ie ARL2 – ARL3) based on the slope and lane geometry. The remaining hazards were assessed to be **ARL4** and **ARL5**, which are generally considered to be within an *Acceptable* risk level.

Due to the ARL3 rating for RE2 (NB), it is recommended that survey stations are installed along the shoulder lane and toe of the road embankment to monitor the ground movements response during active mine subsidence and to provide an early alert to potential slope instability.

All the road embankments within the Study Area should include periodic surveillance with regards to visual inspection for crack development in the embankment and wearing course surface. It is understood that TC will prepare a Wollondilly Shire Council Management Plan (WSCMP), which will include details on performance measures, monitoring program, triggers, actions and responses for potential mine subsidence impacts (ie a Trigger Action Response Plan [TARP]). A geotechnical review of the WSCMP will be carried out by DP to confirm that the requirements of this report have been incorporated in the infrastructure management plan, or to suggest amendments to meet the requirements of this report.

Where survey or observations exceed trigger action thresholds detailed in the WSCMP, assessment of the cause/s of triggered exceedances must be carried out and actions implemented to minimise impacts and/or damage that is assessed to be due to mine subsidence. Road embankments may require remedial works to restore the embankments to their pre-mining condition. Reduction in speed limits may also be considered as an option during mining to further reduce the risk levels.

9.3 Hazard Reduction and Precautionary Works

Based on the results of stability modelling and the risk assessment for road embankments, the following hazard reduction and precautionary works are recommended to reduce and/or maintain the consequent risk of slope instability to property and life to within acceptable levels for the proposed development:

- Maintenance of drains along the edges of the pavements, on embankment batters and along the toe of the embankments to provide water a preferential pathway away from the embankment and to protect embankment batters from erosion and erosion-induced failures.
- The provision of positive drainage for existing culverts to ensure that water is not pooled at the base of the embankment. This will require inspections, cleaning and ongoing maintenance (ie to ensure that blockages from debris and silting-up does not occur).
- Regular geotechnical inspections and surveys for the road embankment during active mine subsidence for LW S1A to S6A will allow early detections of signs of distress and for the development of subsidence for monitoring and comparing to modelled predictions. The early detection of signs of distress and subsidence prediction exceedance, if any, will allow for additional remedial measures to be implemented if needed. Monitoring should continue following the completion of active subsidence, at reduced intervals, for a minimum period of 12 months.

The results of the stability modelling and the risk assessment for road embankments does not indicate that mitigation works to strengthen any sections of the will be required prior to the commencement of LW S1A to S6A.

10. References

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11. Limitations

Douglas Partners (DP) has prepared this report for this project at Remembrance Drive in Bargo in accordance with DP's Proposal 210597.02.P.001.Rev0 dated 15 March 2022 and acceptance received from Tahmoor Coal Pty Ltd dated 23 March 2022. The work was carried out under TC's and DP's Umbrella Agreement for Consultancy Services (Contract TAHC0612 executed on 15 October 2019). This report is provided for the exclusive use of Tahmoor Coal Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or another site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations.

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

Dry (D)	Non-cohesive and free-running.
Moist (M)	Soil feels cool, darkened in colour. Soil tends to stick together. Sand forms weak ball but breaks easily.
Wet (W)	Soil feels cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Rock Descriptions

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $Is_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections > 100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

May 2017

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

■	Asphalt
░	Road base
░	Concrete
▩	Filling

Soils

▨	Topsoil
░	Peat
▨	Clay
▨	Silty clay
▨	Sandy clay
▨	Gravelly clay
▨	Shaly clay
▥	Silt
▥	Clayey silt
▥	Sandy silt
░	Sand
▨	Clayey sand
▥	Silty sand
░	Gravel
░	Sandy gravel
░	Cobbles, boulders
░	Talus

Sedimentary Rocks

░	Boulder conglomerate
░	Conglomerate
░	Conglomeratic sandstone
░	Sandstone
▤	Siltstone
▤	Laminite
▤	Mudstone, claystone, shale
■	Coal
▦	Limestone

Metamorphic Rocks

░	Slate, phyllite, schist
░	Gneiss
□	Quartzite

Igneous Rocks

░	Granite
░	Dolerite, basalt, andesite
░	Dacite, epidote
░	Tuff, breccia
□	Porphyry

May 2017

Appendix B

Plates 1 – 3 (Photos 1 – 12)
Results of Field Work

Photo 1: View looking south towards the Wellers Road overpass bridge, along the crest of the downstream face for the RE1 road embankment.

Photo 2: View looking south east across the south western corner of the RE1 road embankment.

Photo 3: View looking north west at rutting and crocodile cracking in the Remembrance Drive wearing course to the south of the intersection with Wellers Road (RE1).

Photo 4: View looking north along the upstream face for RE2.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd		**Site Photographs 1 to 4**	PROJECT No:	210597.02
OFFICE: Wollongong	DRAWN BY: RJH	**Detailed Stability Assessment**	PLATE No:	1
SCALE: NTS	DATE: 23 Dec 2021	**Longwall S1A to S6A, Bargo**	REVISION:	0

Photo 5: View looking north along the upstream face for RE2. Note: the dwelling at the toe of the embankment, which is downstream from FD51.

Photo 6: View looking north along the downstream face for RE3.

Photo 7: View looking towards the upstream culvert for RE3.

Photo 8: View looking south along the downstream face crest for RE3.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	NTS	DATE:	23 Dec 2021

Site Photographs 5 to 8
Detailed Stability Assessment
Longwall S1A to S6A, Bargo

PROJECT No:	210597.02
PLATE No:	2
REVISION:	0

Photo 9: View looking south along the crest of the downstream face for RE4.

Photo 10: View looking along the crest of the upstream face for RE4.

Photo 11: View looking south along the upstream face of RE4 opposite No. 3100 Remembrance Drive. Note: the drain cut into the toe of the embankment.

Photo 12: View looking north along the upstream face of RE4 opposite No. 3088 Remembrance Drive.

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CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	NTS	DATE:	23 Dec 2021

Site Photographs 9 to 12
Detailed Stability Assessment
Longwall S1A to S6A, Bargo

PROJECT No:	210597.02
PLATE No:	3
REVISION:	0

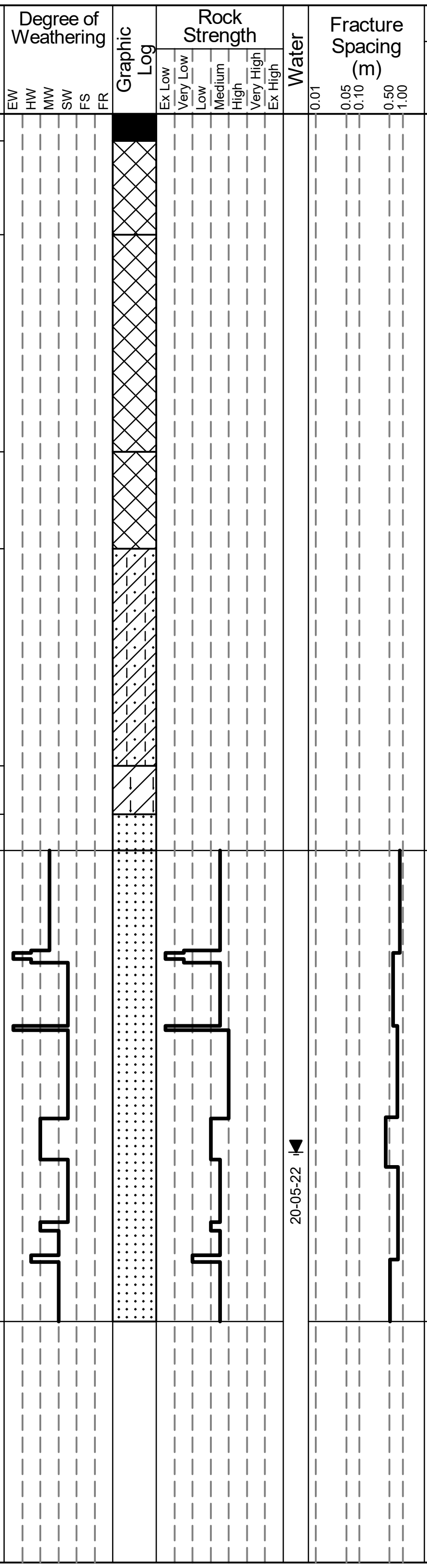
BOREHOLE LOG

CLIENT: Tahmoor Coal Pty Ltd
PROJECT: Detailed Slope Stability Assessment
LOCATION: Remembrance Drive, Bargo

SURFACE LEVEL: 301.7 AHD
EASTING: 276877
NORTHING: 6206265
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 210597.02
DATE: 3/5/2022
SHEET 1 OF 1

Depth (m)	Description of Strata
	BITUMINOUS CONCRETE: dark grey to black, fine to coarse basalt aggregate, bituminous binder, <2% voids, wearing course
0.22	FILL/Sandy gravelly CLAY CL: low plasticity, pale brown and grey, fine to medium sandstone gravel, with silt, w~PL
1.0	FILL/Silty CLAY CL: low plasticity, orange grey brown mottled white, with fine to medium subangular to rounded sandstone gravel, w~PL - sandstone boulder at 2.3m
2.8	FILL/Sandy GRAVEL GP: poorly sorted, pale grey and dark grey, fine to medium angular to subangular sandstone gravel, moist, crushed sandstone
3.6	Silty Sandy CLAY CL: low plasticity, orange brown and pale brown white, with medium to medium sandstone gravel, w<PL, stiff to very stiff, probable alluvial
5.4	Silty CLAY CI: medium plasticity, brown, with fine to medium siltstone and sandstone gravel, w<PL, stiff, residual
5.8	SANDSTONE: fine to medium grained, orange brown, interbedded very low to medium strength, highly weathered, Hawksbury Sandstone
6.1	SANDSTONE: medium grained, medium to thickly bedded, orange brown and pale grey, medium strength, moderately to slightly weathered, slightly fractured, with some extremely low to low strength, extremely to highly weathered seams, Hawkesbury Sandstone
10.0	Bore discontinued at 10.0m Limit of investigation



Discontinuities
B - Bedding J - Joint
S - Shear F - Fault

Unless otherwise stated, rock is fractured along rough, planar, bedding partings & joints

6.95m: B 5° 50mm cly
7.55m: B 5° 40mm cly
8.31m: J 75-90° cly vnr
8.72m: J 30-40° fe-stn
9.48m: B 5° 30mm HW

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			10,9,11 N = 20
S			4,25/150 refusal
S			10,25/150 refusal
A			
S			6,7,9 N = 16
S			6,6,5 N = 11
S			25/50 refusal
C	100	92	PL(A) = 0.8 PL(A) = 1
C	100	85	PL(A) = 0.9 PL(A) = 0.5

RIG: Hanjin 8D **DRILLER:** South Coast Drilling **LOGGED:** AR/AM **CASING:** HWT to 6.0m

TYPE OF BORING: Dia tube to 0.22m, SFA (TC bit) to 6.0m, rotary (water) to 6.1, coring (NMLC) to 10.0m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w = moisture conent, PL = Plastic Limit
standpipe piezeometer installed: slotted 2-10m, sand 1.4-10m , bentonite 0.6-1.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

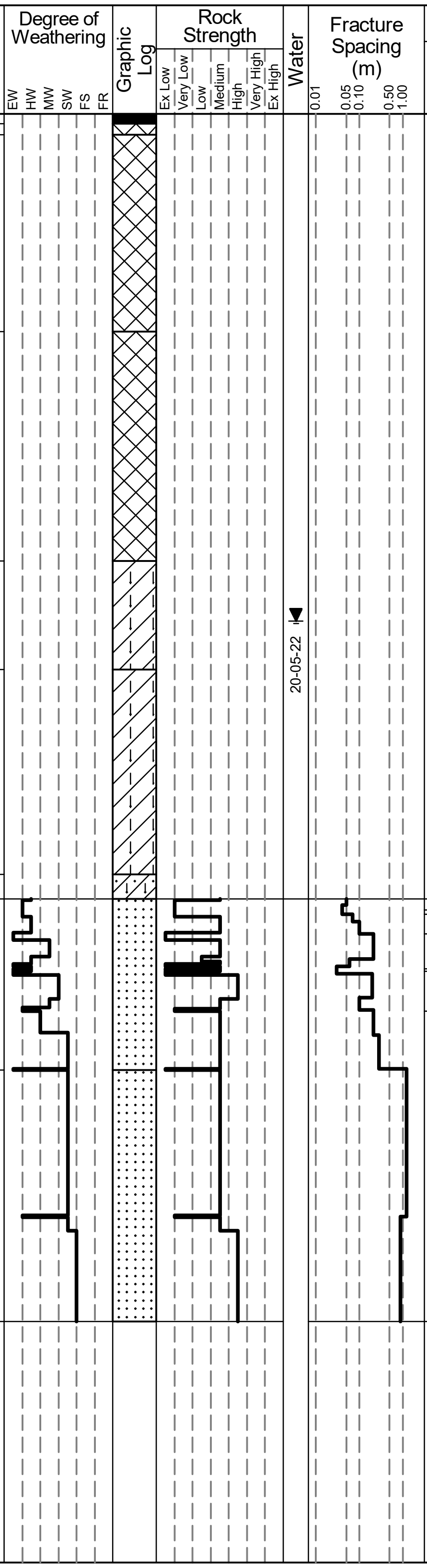
Project No: 210597.02
BH ID: 1
Depth: 6.10 – 10.00m
Core Box No.: 1

BOREHOLE LOG

CLIENT: Tahmoor Coal Pty Ltd
PROJECT: Detailed Slope Stability Assessment
LOCATION: Remembrance Drive, Bargo

SURFACE LEVEL: 313.5 AHD
EASTING: 276726
NORTHING: 6205502
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 210597.02
DATE: 4/5/2022
SHEET 1 **OF** 1



RL	Depth (m)	Description of Strata	Water	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
313	0.08 0.17	BITUMINOUS CONCRETE: dark grey to black, fine to medium aggregate, bituminous binder, wearing course			A A			
	1	FILL/Sandy GRAVEL GW: well graded, brown grey, fine to coarse basalt, lightly bound, dry, basecourse			A U			
312	1.8 2	FILL/Sandy CLAY CL: low plasticity, pale orange brown, fine to medium sand, with fine to medium sandstone gravel, w~PL			S U			7,7,9 N = 16 pp = 500-600
311 310	3	FILL/Silty CLAY CL: low plasticity, orange grey brown mottled white, with medium to coarse sandstone gravel, w~PL			S			3,5,5 N = 10
309	3.7 4	Silty CLAY CI: medium plasticity, pale grey and orange brown, trace fine to medium sandstone gravel, w>PL, soft, alluvial	20-05-22		A S			3,3,4 N = 7
308	4.6 5	Silty CLAY CI: low plasticity, orange brown, with fine to medium sandstone gravel, w<PL, very soft to soft, alluvial		Unless otherwise stated, rock is fractured along rough, planar, iron stained bedding partings	S			0,0,2 N = 2
	6	- becoming soft to firm below 6.0m			S			2,2,25/120 refusal
307	6.3 6.5 7	Sandy Silty CLAY CI: medium plasticity, red mottled orange brown and pale grey, with fine to medium sandstone gravel, w<PL, very stiff to hard, residual		6.55m: B 0-10° 50mm cly 6.59m: B 0-5° 10mm cly 6.63m: B 0-5° 40mm cly 6.79m: B 0-5° 60mm cly	C	100		PL(A) = 0.9
306 305	7.92 8	SANDSTONE: fine to medium grained, orange brown and pale grey, thinly to medium bedded, medium to high strength, highly to moderately weathered, fractured to slightly fractured, with clay seams, Hawbesbury Sandstone		7.08m: B 0-5° 10mm cly 7.1m: B 0-5° 30mm cly 7.43m: B 0-5° 15mm cly 7.91m: B 0-5° 5mm cly			58 100	PL(A) = 1.2 PL(A) = 0.6
304	9	SANDSTONE: fine to medium grained, brown to pale grey, thickly bedded, medium to high strength, slightly weathered to fresh stained, slightly fractured, Hawkesbury Sandstone			C	100	99	PL(A) = 1.3
303 302	10 10.0 11	Bore discontinued at 10.0m Limit of investigation						

RIG: Hanjin 8D **DRILLER:** South Coast Drilling **LOGGED:** AR **CASING:** HWT to 5.5m

TYPE OF BORING: Dia tube to 0.2m, SFA (TC bit) to 5.0m, rotary (water) to 6.5m, coring (NMLC) to 10.0m

WATER OBSERVATIONS: Free groundwater observed at 4.6m

REMARKS: w = moisture conent, PL = Plastic Limit
standpipe piezeometer installed: slotted 2-10 m, sand 1.5-10m , bentonite 0.5-1.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Project No: 210597.02
BH ID: 2
Depth: 6.50 – 10.00m
Core Box No.: 1

BOREHOLE LOG

CLIENT: Tahmoor Coal Pty Ltd
PROJECT: Detailed Slope Stability Assessment
LOCATION: Remembrance Drive, Bargo

SURFACE LEVEL: 314.8 AHD
EASTING: 276600
NORTHING: 6205222
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 210597.02
DATE: 5/5/2022
SHEET 1 OF 2

Depth (m)	Description of Strata
0.04	BITUMINOUS CONCRETE: black, fine to medium aggregate, bituminous binder, 5% voids, probable overlay
0.23	BITUMEN CONCRETE: black, fine to coarse aggregate, bitumen binder, voids 1%
1.5	FILL/Sandy CLAY CL: low plasticity, pale brown and grey, fine to medium sand, with fine to medium sandstone gravel, w<PL
	FILL/Silty CLAY CI: medium plasticity, pale grey mottled orange red brown, with fine to medium sandstone gravel, w<PL
7.1	BITUMINOUS CONCRETE: black, fine to medium basalt aggregate
7.3	FILL/Silty CLAY CI: medium plasticity, dark brown and orange brown mottled pale grey, fine to coarse sandstone gravel, w~PL
8.2	Silty CLAY CL: low plasticity, dark grey brown mottled orange brown, with subangular sandstone gravels, w~PL, stiff, probable residual - becoming orange brown below 9.5m
10.4	Sandy CLAY CL: low plasticity, orange brown mottled grey, fine to medium sand, w⩽PL, stiff, residual
10.6	

Water: ▼ 20-05-22

Discontinuities: B - Bedding J - Joint S - Shear F - Fault

Unless otherwise stated, rock is fractured along rough, planar, iron stained bedding partings and joints

11.42m: B 10°

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			17,19,16 N = 35
S			9,14,20 N = 34
S			12,15,16 N = 31
S			9,15,11 N = 26
U			
S			10,15,17 N = 32
S			10,12,12 N = 24
A			
S			14,10,12 N = 22
S			9,7,6 N = 13
U			
S			3,4,6 N = 10
S			7,25/100 refusal
C	100	98	PL(A) = 1.2 PL(A) = 1.1

RIG: Hanjin 8D **DRILLER:** South Coast Drilling **LOGGED:** AR **CASING:** HWT to 8.5m

TYPE OF BORING: Dia tube to 0.23m, SFA (TC bit) to 8.0m, rotary (water) to 10.75m, coring (NMLC) to 13.75m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w = moisture conent, PL = Plastic Limit, 50% water loss observed between 10.75-13.75m
standpipe piezeometer installed: slotted 1.75m-13.75m, sand 1.4-13.75m, bentonite 0.8-1.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Project No: 210597.02
BH ID: 3
Depth: 10.75 – 13.75m
Core Box No.: 1

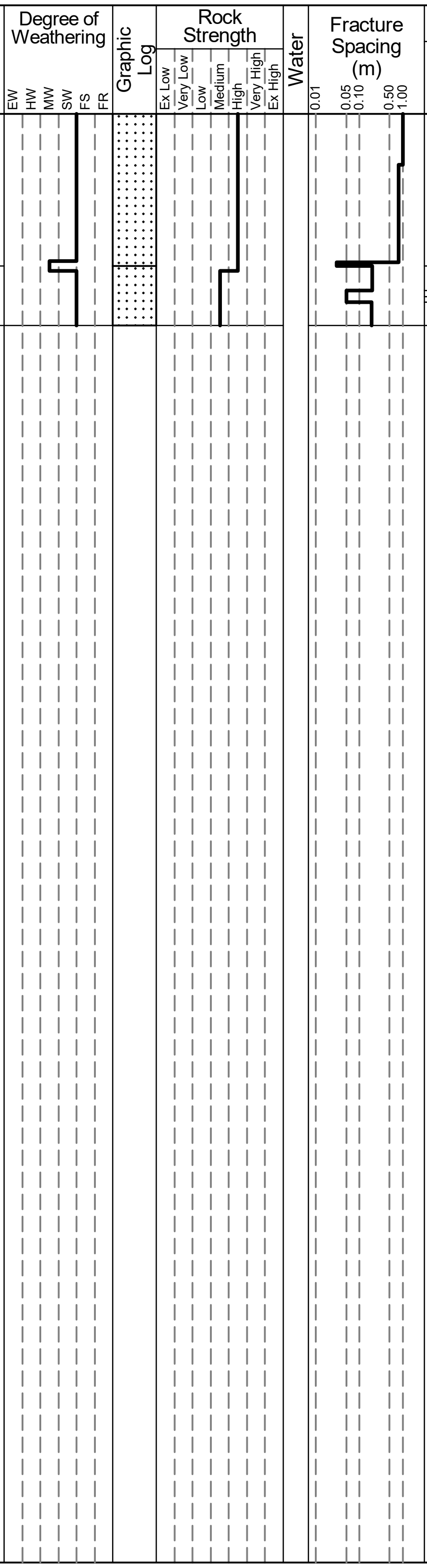
BOREHOLE LOG

CLIENT: Tahmoor Coal Pty Ltd
PROJECT: Detailed Slope Stability Assessment
LOCATION: Remembrance Drive, Bargo

SURFACE LEVEL: 314.8 AHD
EASTING: 276600
NORTHING: 6205222
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 210597.02
DATE: 5/5/2022
SHEET 2 **OF** 2

RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
302	13	SANDSTONE: fine to medium grained, pale brown grey and orange brown, thickly bedded, high strength, moderately weathered becoming slightly weathered to fresh stained, slightly fractured, Hawkesbury Sandstone *(continued)*	12.42m: B 5° cly vnr	C	100	98	PL(A) = 1.2
301	13.26	SANDSTONE: finegrained, orange brown and white, thinly to medium bedded, medium strength, moderately weathered becoming slightly weathered to fresh stained, fractured to slightly fractured, Hawkesbury Sandstone	13.23m: B 5° cly vnr 13.26m: B 5° 13.46m: B 5° 13.51m: B 5° 13.56m: J 40°		100	72	PL(A) = 0.7
	13.75	Bore discontinued at 13.75m Limit of investigation					



RIG: Hanjin 8D **DRILLER:** South Coast Drilling **LOGGED:** AR **CASING:** HWT to 8.5m

TYPE OF BORING: Dia tube to 0.23m, SFA (TC bit) to 8.0m, rotary (water) to 10.75m, coring (NMLC) to 13.75m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w = moisture conent, PL = Plastic Limit, 50% water loss observed between 10.75-13.75m
standpipe piezeometer installed: slotted 1.75m-13.75m, sand 1.4-13.75m, bentonite 0.8-1.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

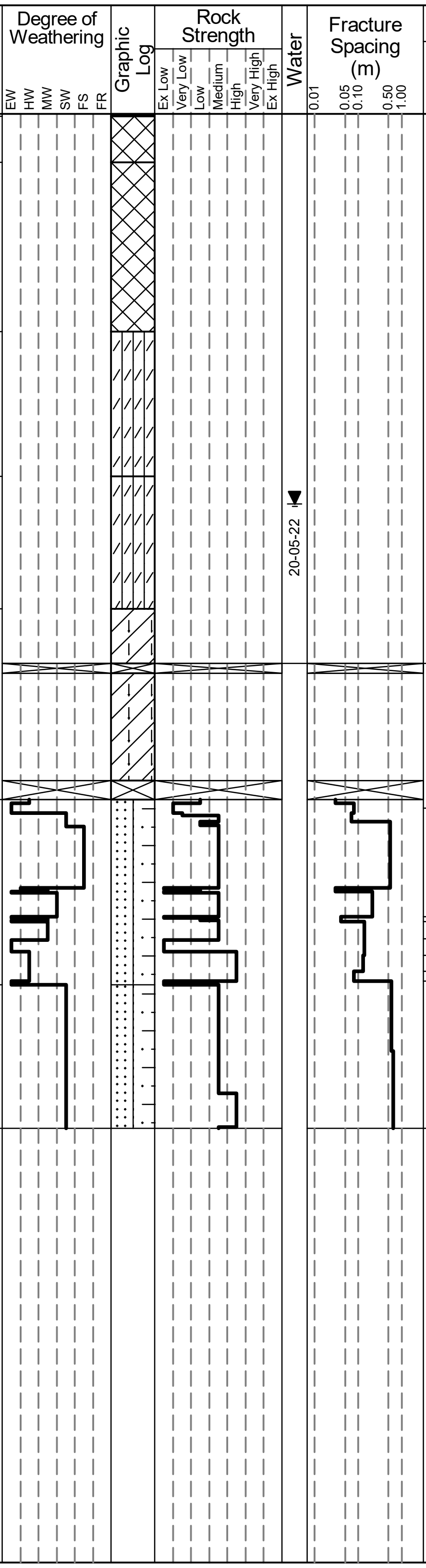
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tahmoor Coal Pty Ltd
PROJECT: Detailed Slope Stability Assessment
LOCATION: Remembrance Drive, Bargo

SURFACE LEVEL: 324.1 AHD
EASTING: 276615
NORTHING: 6204514
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 210597.02
DATE: 6/5/2022
SHEET 1 OF 1



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
324	0.02	BITUMEN CONCRETE: black, fine to medium aggregate, bituminous binder, spray seal		A			
	0.4	FILL/SAND SP: poorly graded, pale orange brown, fine to medium, with medium to coarse sandstone gravels, moist, basecourse		A			
323	1			A U			
		FILL/Sandy Silty CLAY CL: low plasticity, dark brown mottled orange brown, fine to medium sand, with fine to coarse sandstone gravel, w<PL					
	1.8	Clayey SILT MI: medium plasticity, white mottled orange red brown, with medium to coarse sandstone gravel, w>PL, firm, alluvial					
322	2			S			4,3,4 N = 7
321	3 / 3.0	Silty Clay CI: medium plasticity, white mottled orange red brown, with medium to coarse sandstone gravel, w<PL, hard, residual	Unless otherwise stated, rock is fractured along smooth to rough, planar, iron stained, near-horizontal bedding parting	U			pp = 550-600
320	4 / 4.1	Silty CLAY CH: high plasticity, orange brown mottled pale grey, with bands of very low to medium strength sandstone seams, w⩽PL, stiff to hard, extremely weathered sandstone		S			13,25/150 refusal
	4.63		4.55m: CORE LOSS: 80mm	C	87		
319	5		5.52m: CORE LOSS: 160mm				
318	5.68 / 6	INTERBEDDED SANDSTONE/SILTSTONE: thinly bedded/laminated, pale grey and orange brown, low to medium strength, highly weathered to moderately weathered, fractured, with extremely low to extremely weathered seams, Mittagong Formation	5.75m: B 0-5° 6.17m: J 65° healed 6.41m: B 5° 15mm clay 6.58m: J 80° healed 6.65m: J 85° 10mm cly 6.69m: J 40° 10mm cly 6.83m: B 5° 100mm clay 6.97m: J 30° HW 7.1m: J 20° HW 7.18m: B 5° 30mm cly	C	100	38	PL(A) = 0.7 PL(A) = 0.5 PL(A) = 1.5
317	7 / 7.21	INTERBEDDED SANDSTONE/SILTSTONE, thinly to medium bedded, orange brown and grey, medium to high, slightly weathered, slightly fractured, Mittagong Formation				100	PL(A) = 0.7 PL(A) = 1.3
316	8						
	8.4	Bore discontinued at 8.4m Limit of investigation					
315	9						
314	10						
313	11						

RIG: Hanjin 8D **DRILLER:** South Coast Drilling **LOGGED:** AR/RJH **CASING:** HWT to 4.1m

TYPE OF BORING: Dia tube to 0.02m, SFA (Tc bit) to 4.0m, rotary (water) to 4.55m, coring (NMLC) to 8.4m

WATER OBSERVATIONS: No free groundwater observed during auger drilling

REMARKS: w = moisture conent, PL = Plastic Limit
standpipe piezeometer installed: slotted 2.4-8.4m, sand 1.2-8.4m, bentonite 0.3-1.2m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Project No: 210597.02
BH ID: 4
Depth: 4.55 – 8.45m
Core Box No.: 1

Appendix C

Results of Laboratory Testing

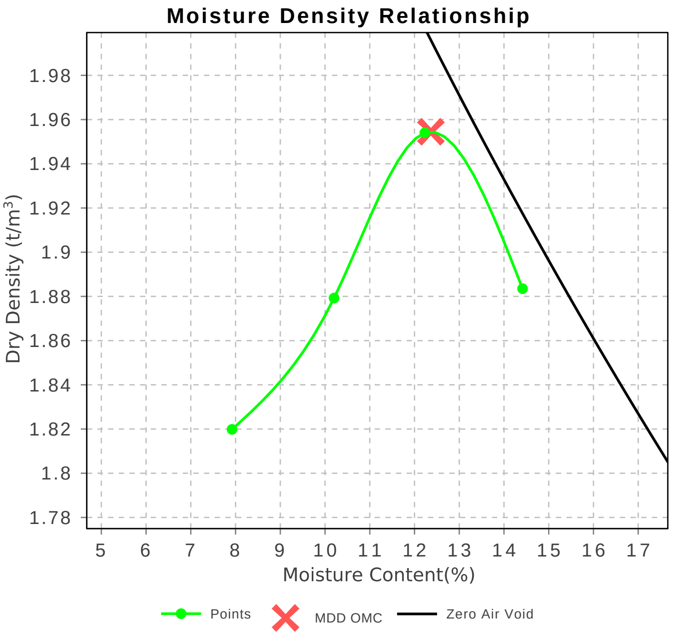
Material Test Report

Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Melbourne Laboratory
231 Normanby Road South Melbourne Vic 3205
Phone: (03) 9673 3500
Email: scott.benbow@douglaspartners.com.au

Report Number: **PREVIEW**
Issue Number:
Date Issued:
Client: Tahmoor Coal Pty Ltd
PO Box 100, Tahmoor NSW 2573
Project Number: 210597.02
Project Name: Stability Assessment
Project Location: Remembrance Drive, Bargo NSW
Work Request: 4489
Sample Number: ME-4489A
Date Sampled: 03/05/2022
Dates Tested: 11/05/2022 - 13/05/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH1 , Depth: 1.0-3.0m**
Material: Silty Clay

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)		Min	Max
Mould Type	1 LITRE MOULD A		
Compaction	Standard		
Maximum Dry Density (t/m^3)	1.95		
Optimum Moisture Content (%)	12.5		
Oversize Sieve (mm)	19.0		
Oversize Material Wet (%)	0		
Method used to Determine Plasticity	Visual Assessment		
Curing Hours (h)	24.1		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	12.2



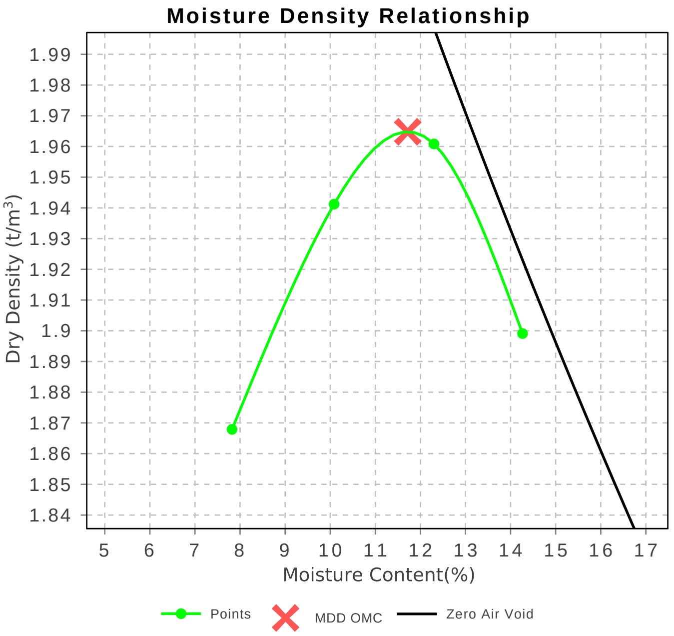
Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Melbourne Laboratory
231 Normanby Road South Melbourne Vic 3205
Phone: (03) 9673 3500
Email: scott.benbow@douglaspartners.com.au

Report Number: **PREVIEW**
Issue Number:
Date Issued:
Client: Tahmoor Coal Pty Ltd
PO Box 100, Tahmoor NSW 2573
Project Number: 210597.02
Project Name: Stability Assessment
Project Location: Remembrance Drive, Bargo NSW
Work Request: 4489
Sample Number: ME-4489C
Date Sampled: 03/05/2022
Dates Tested: 11/05/2022 - 13/05/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH3 , Depth: 2.0-3.5m**
Material: Silty Clay

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)		Min	Max
Mould Type	1 LITRE MOULD A		
Compaction	Standard		
Maximum Dry Density (t/m^3)	1.96		
Optimum Moisture Content (%)	11.5		
Oversize Sieve (mm)	19.0		
Oversize Material Wet (%)	0		
Method used to Determine Plasticity	Visual Assessment		
Curing Hours (h)	24.3		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	10.3



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Unanderra Laboratory
Unit 1/1 Luso Drive Unanderra NSW 2526
Phone: (02) 4271 1836
Email: kevin.spicer@douglaspartners.com.au

Report Number: **210597.02-1**
Issue Number: 1
Date Issued: 16/05/2022
Client: Tahmoor Coal Pty Ltd
PO Box 100, Tahmoor NSW 2573
Contact: April Hudson
Project Number: 210597.02
Project Name: Stability Assessment
Project Location: Remembrance Drive, Bargo NSW
Work Request: 8376
Date Sampled: 03/05/2022
Dates Tested: 10/05/2022 - 11/05/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Location: Remembrance Drive, Bargo

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Kevin Spicer
Laboratory Manager
Laboratory Accreditation Number: 828

Moisture Content AS 1289 2.1.1

Sample Number	Sample Location	Moisture Content (%)	Material
WO-8376A	BH 1 , Depth: 1.0 - 1.45m	10.0 %	FILL/Silty CLAY
WO-8376B	BH 1 , Depth: 2.0 - 2.95m	16.3 %	FILL/Silty CLAY
WO-8376C	BH 1 , Depth: 4.0 - 4.45m	12.7 %	FILL/Silty Sandy CLAY
WO-8376D	BH 1 , Depth: 5.0 - 5.45m	12.6 %	FILL/Silty Sandy CLAY
WO-8376E	BH 1 , Depth: 5.6 - 5.8m	11.1 %	Silty CLAY
WO-8376F	BH 2 , Depth: 1.5 - 1.95m	12.7 %	FILL/Silty CLAY
WO-8376G	BH 2 , Depth: 3.0 - 3.45m	14.6 %	FILL/Silty CLAY
WO-8376H	BH 2 , Depth: 4.0 - 4.45m	17.8 %	Silty CLAY
WO-8376I	BH 2 , Depth: 5.0 - 5.45m	25.8 %	Silty CLAY
WO-8376J	BH 2 , Depth: 6.0 - 6.45m	15.1 %	Sandy Silty CLAY
WO-8376K	BH 3 , Depth: 1.0 - 1.45m	8.6 %	FILL/Silty CLAY
WO-8376L	BH 3 , Depth: 3.0 - 3.45m	8.9 %	FILL/Silty CLAY
WO-8376M	BH 3 , Depth: 5.1 - 5.55m	10.7 %	FILL/Silty CLAY
WO-8376N	BH 3 , Depth: 7.0 - 7.45m	12.1 %	FILL/Silty CLAY
WO-8376O	BH 3 , Depth: 8.0 - 8.45m	19.7 %	Silty CLAY
WO-8376P	BH 3 , Depth: 9.5 - 9.95m	17.3 %	Sandy CLAY
WO-8376Q	BH 3 , Depth: 10.5 - 10.75m	16.2 %	Sandy CLAY
WO-8376R	BH 4 , Depth: 2.0 - 2.45m	15.4 %	Sandy Silty CLAY
WO-8376S	BH 4 , Depth: 4.0 - 4.3m	11.9 %	Clayey SILT

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Unanderra Laboratory
Unit 1/1 Luso Drive Unanderra NSW 2526
Phone: (02) 4271 1836
Email: kevin.spicer@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Kevin Spicer
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**210597.02-1**
Issue Number:	1
Date Issued:	16/05/2022
Client:	Tahmoor Coal Pty Ltd PO Box 100, Tahmoor NSW 2573
Contact:	April Hudson
Project Number:	210597.02
Project Name:	Stability Assessment
Project Location:	Remembrance Drive, Bargo NSW
Work Request:	8376
Sample Number:	WO-8376E
Date Sampled:	03/05/2022
Dates Tested:	10/05/2022 - 13/05/2022
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Sample Location:	**BH 1 , Depth: 5.6 - 5.8m**
Material:	Silty CLAY

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	15		
Plasticity Index (%)	**19**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Unanderra Laboratory
Unit 1/1 Luso Drive Unanderra NSW 2526
Phone: (02) 4271 1836
Email: kevin.spicer@douglaspartners.com.au

Report Number:	**210597.02-1**
Issue Number:	1
Date Issued:	16/05/2022
Client:	Tahmoor Coal Pty Ltd PO Box 100, Tahmoor NSW 2573
Contact:	April Hudson
Project Number:	210597.02
Project Name:	Stability Assessment
Project Location:	Remembrance Drive, Bargo NSW
Work Request:	8376
Sample Number:	WO-8376I
Date Sampled:	03/05/2022
Dates Tested:	10/05/2022 - 13/05/2022
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Sample Location:	**BH 2 , Depth: 5.0 - 5.45m**
Material:	Silty CLAY

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Approved Signatory: Kevin Spicer
Laboratory Manager
Laboratory Accreditation Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	33		
Plastic Limit (%)	18		
Plasticity Index (%)	**15**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Unanderra Laboratory
Unit 1/1 Luso Drive Unanderra NSW 2526
Phone: (02) 4271 1836
Email: kevin.spicer@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Kevin Spicer
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number:	**210597.02-1**
Issue Number:	1
Date Issued:	16/05/2022
Client:	Tahmoor Coal Pty Ltd PO Box 100, Tahmoor NSW 2573
Contact:	April Hudson
Project Number:	210597.02
Project Name:	Stability Assessment
Project Location:	Remembrance Drive, Bargo NSW
Work Request:	8376
Sample Number:	WO-8376P
Date Sampled:	03/05/2022
Dates Tested:	10/05/2022 - 13/05/2022
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Sample Location:	**BH 3 , Depth: 9.5 - 9.95m**
Material:	Sandy CLAY

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	43		
Plastic Limit (%)	20		
Plasticity Index (%)	**23**		

Material Test Report

Douglas Partners Pty Ltd
Melbourne Laboratory
231 Normanby Road South Melbourne Vic 3205
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Benbow
Lab Manager
Laboratory Accreditation Number: 828

Report Number: **210597.02-7**
Issue Number: 1
Date Issued: 31/05/2022
Client: Tahmoor Coal Pty Ltd
PO Box 100, Tahmoor NSW 2573
Project Number: 210597.02
Project Name: Stability Assessment
Project Location: Remembrance Drive, Bargo NSW
Work Request: 4489
Sample Number: ME-4489A
Date Sampled: 03/05/2022
Dates Tested: 11/05/2022 - 17/05/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH1 , Depth: 1.0-3.0m**
Material: Silty Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	12.2

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	29		
Plastic Limit (%)	12		
Plasticity Index (%)	**17**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	8.0		
Cracking Crumbling Curling	None		

Material Test Report

Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Melbourne Laboratory
231 Normanby Road South Melbourne Vic 3205
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Benbow
Lab Manager
Laboratory Accreditation Number: 828

Report Number: **210597.02-7**
Issue Number: 1
Date Issued: 31/05/2022
Client: Tahmoor Coal Pty Ltd
PO Box 100, Tahmoor NSW 2573
Project Number: 210597.02
Project Name: Stability Assessment
Project Location: Remembrance Drive, Bargo NSW
Work Request: 4489
Sample Number: ME-4489B
Date Sampled: 03/05/2022
Dates Tested: 11/05/2022 - 26/05/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH2 , Depth: 2.0-2.4m**
Material: Silty Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	13.1

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	38		
Plastic Limit (%)	15		
Plasticity Index (%)	**23**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	11.0		
Cracking Crumbling Curling	None		

Material Test Report

Report Number: **210597.02-7**
Issue Number: 1
Date Issued: 31/05/2022
Client: Tahmoor Coal Pty Ltd
PO Box 100, Tahmoor NSW 2573
Project Number: 210597.02
Project Name: Stability Assessment
Project Location: Remembrance Drive, Bargo NSW
Work Request: 4489
Sample Number: ME-4489C
Date Sampled: 03/05/2022
Dates Tested: 11/05/2022 - 17/05/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH3 , Depth: 2.0-3.5m**
Material: Silty Clay

Douglas Partners
Geotechnics / Environment / Groundwater
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231 Normanby Road South Melbourne Vic 3205
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Benbow
Lab Manager
Laboratory Accreditation Number: 828

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	10.3

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	33		
Plastic Limit (%)	13		
Plasticity Index (%)	**20**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	Curling		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
Melbourne Laboratory
231 Normanby Road South Melbourne Vic 3205
Phone: (03) 9673 3500
Email: scott.benbow@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Benbow
Lab Manager
Laboratory Accreditation Number: 828

Report Number:	**210597.02-7**
Issue Number:	1
Date Issued:	31/05/2022
Client:	Tahmoor Coal Pty Ltd PO Box 100, Tahmoor NSW 2573
Project Number:	210597.02
Project Name:	Stability Assessment
Project Location:	Remembrance Drive, Bargo NSW
Work Request:	4489
Sample Number:	ME-4489D
Date Sampled:	03/05/2022
Dates Tested:	11/05/2022 - 27/05/2022
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**BH3 , Depth: 8.6-9.0m**
Material:	Silty Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	17.0

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	24		
Plastic Limit (%)	15		
Plasticity Index (%)	**9**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	5.0		
Cracking Crumbling Curling	Cracking		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Melbourne Laboratory
231 Normanby Road South Melbourne Vic 3205
Phone: (03) 9673 3500
Email: scott.benbow@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Scott Benbow
Lab Manager
Laboratory Accreditation Number: 828

Report Number:	**210597.02-7**
Issue Number:	1
Date Issued:	31/05/2022
Client:	Tahmoor Coal Pty Ltd PO Box 100, Tahmoor NSW 2573
Project Number:	210597.02
Project Name:	Stability Assessment
Project Location:	Remembrance Drive, Bargo NSW
Work Request:	4489
Sample Number:	ME-4489E
Date Sampled:	03/05/2022
Dates Tested:	11/05/2022 - 26/05/2022
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Sample Location:	**BH4 , Depth: 1.0-1.4m**
Material:	Sandy Silty Clay

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	18.8

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	43		
Plastic Limit (%)	24		
Plasticity Index (%)	**19**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	8.5		
Cracking Crumbling Curling	None		

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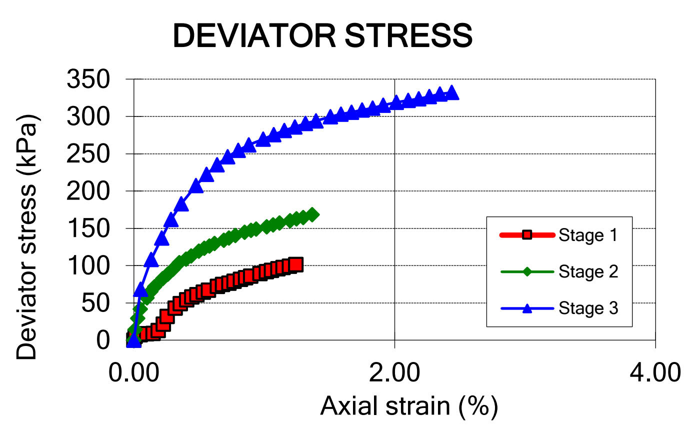
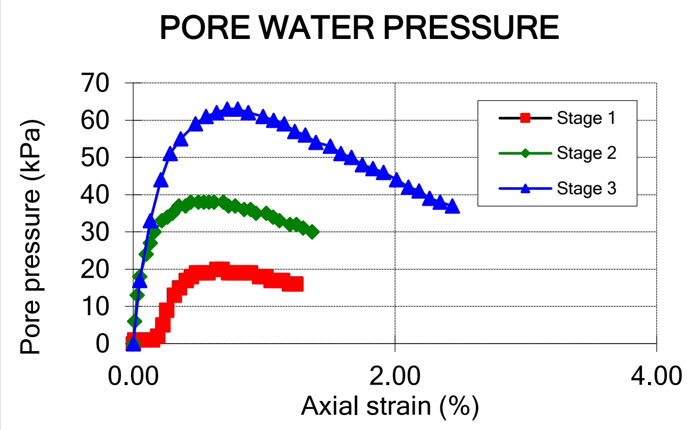
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client : Tahmoor Coal Pty Ltd
Project : Stability Assessment
Location : Remembrance Drive, Bargo NSW
Test Location : BH2
Depth / Layer : 2.0-2.4(m)
Sample Description: Silty CLAY

Project No. : 210597.02
Report No. : 210597.02-2
Report Date : 19 May 2022
Date Sampled : 03 May 2022
Date of Test: 05 Dec 2022
Sample Type: Undisturbed
Page: 1 of 4
Geotester Ref: ME-4489B





STAGE DETAILS

	STAGE		
	1	2	3
Cell pressure (kPa)	640	680	760
Back pressure (kPa)	600	600	600
Volume change (%)	2.0	3.0	4.0
Strain rate (mm/min)	0.024	0.024	0.024
		AT FAILURE	
Strain (%)	1.1	1.2	1.5
Deviator Stress (kPa)	97	163	300
Pore pressure (kPa)	618	632	653
Stress ratio	5.4	4.4	3.8

SAMPLE: BEFORE | AFTER TEST

NOTES

1. Test Technique: multi-staged., failure criteria: maximum stress ratio.
2. Specimen was fitted with side drains.
3. Specimen was saturated with an applied pressures of 610 kPa (Cell) and 600 kPa (Back).
4. Membrane corrections were applied to the deviator stress according to figure 4 of BS 1377 : Part 8 : 1990.
5. Consolidation pore pressure was completely dissipated prior to testing
6. Water used for testing was not deaired prior to use.

SPECIMEN DETAILS	Initial	Final
Moisture content (%)	13.1	15.3
Dry density (t/m3)	1.94	
B' value after saturation	0.96	

Sample Type	Undisturbed	
	Length	Diameter
Sample Dimensions (mm, Averaged)	102	51

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: PW
Checked: PW

Peter Chan
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Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client : Tahmoor Coal Pty Ltd

Project : Stability Assessment

Location : Remembrance Drive, Bargo NSW

Test Location : BH2

Depth / Layer : 2.0-2.4(m)

Sample Description: Silty CLAY

Project No. : 210597.02

Report No. : 210597.02-2

Report Date : 19 May 2022

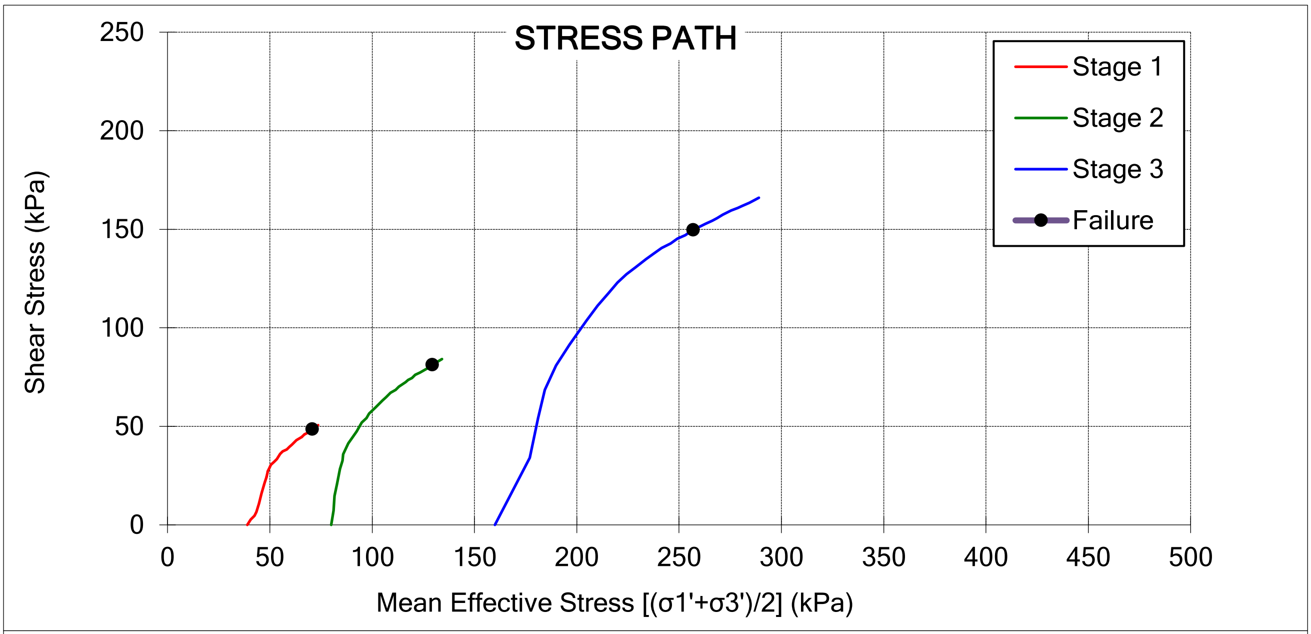
Date Sampled : 03 May 2022

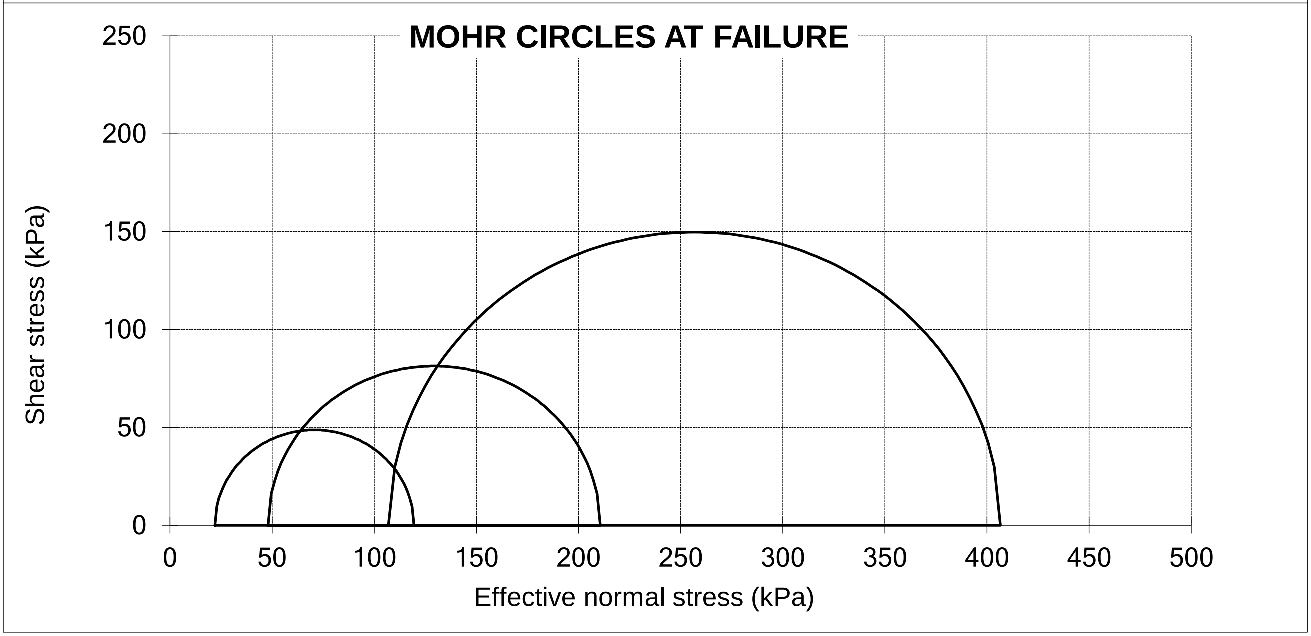
Date of Test: 05 Dec 2022

Sample Type: Undisturbed

Page: 2 of 4

Geotester Ref: ME-4489B





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828

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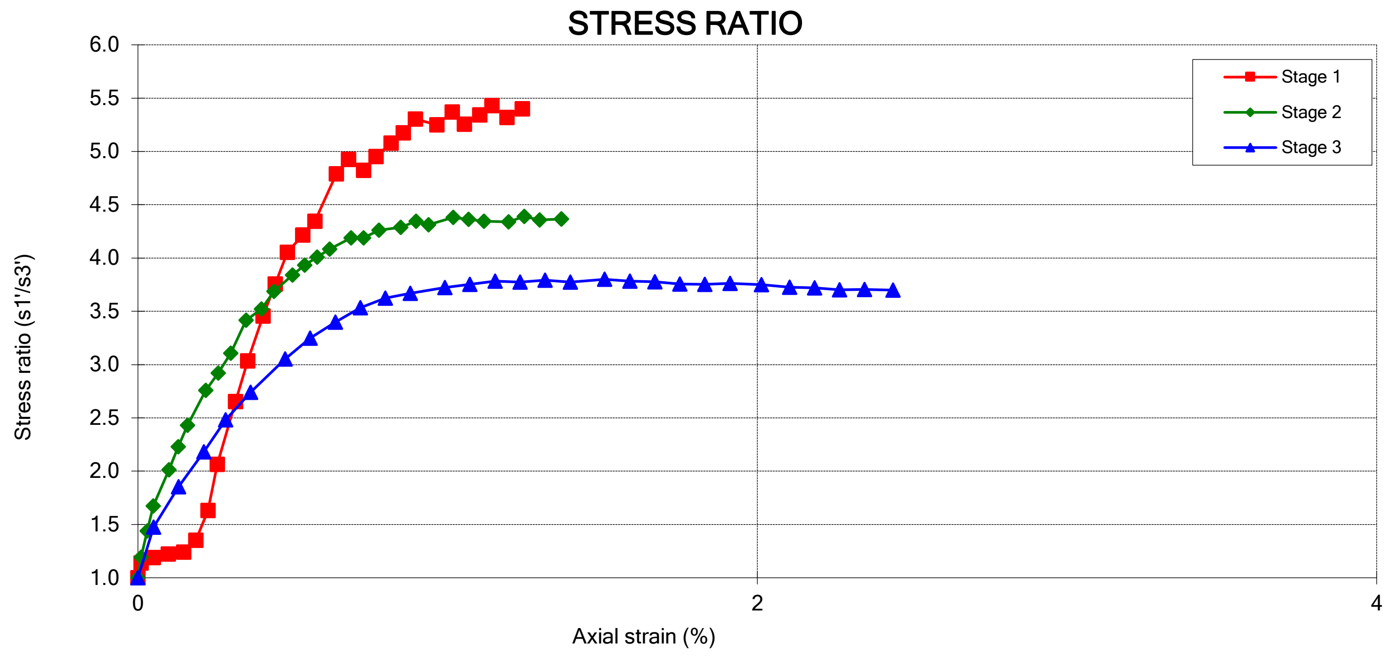
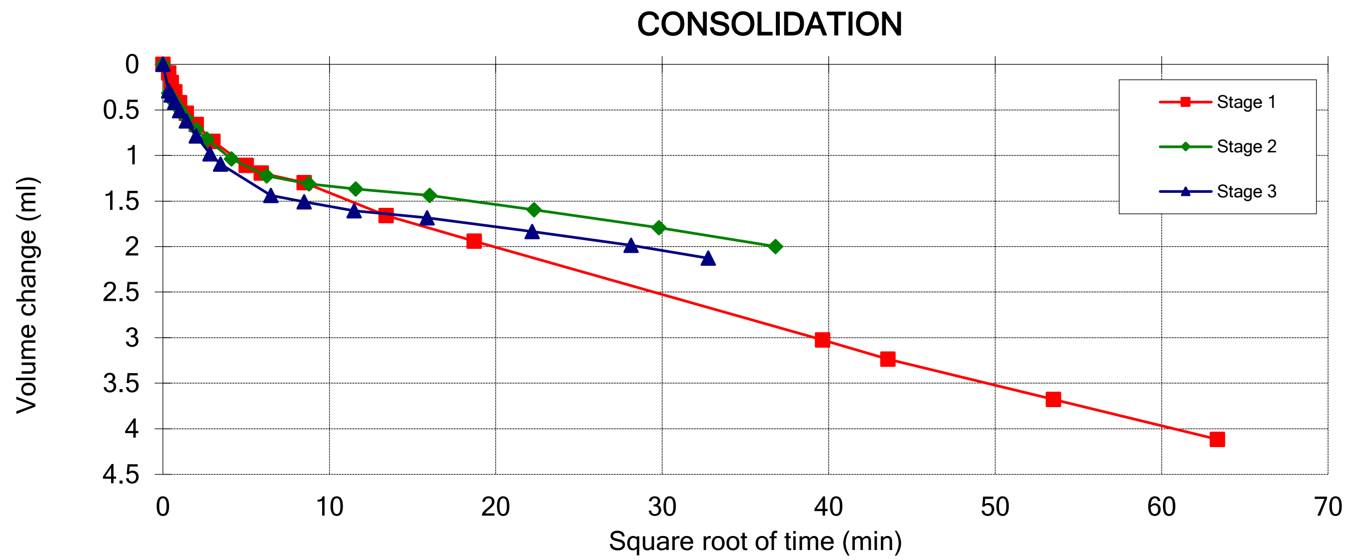
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-2
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	05 Dec 2022
Test Location :	BH2	**Sample Type:**	Undisturbed
Depth / Layer :	2.0-2.4(m)	**Page:**	3 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489B





Sampling Method(s):	Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s):	AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
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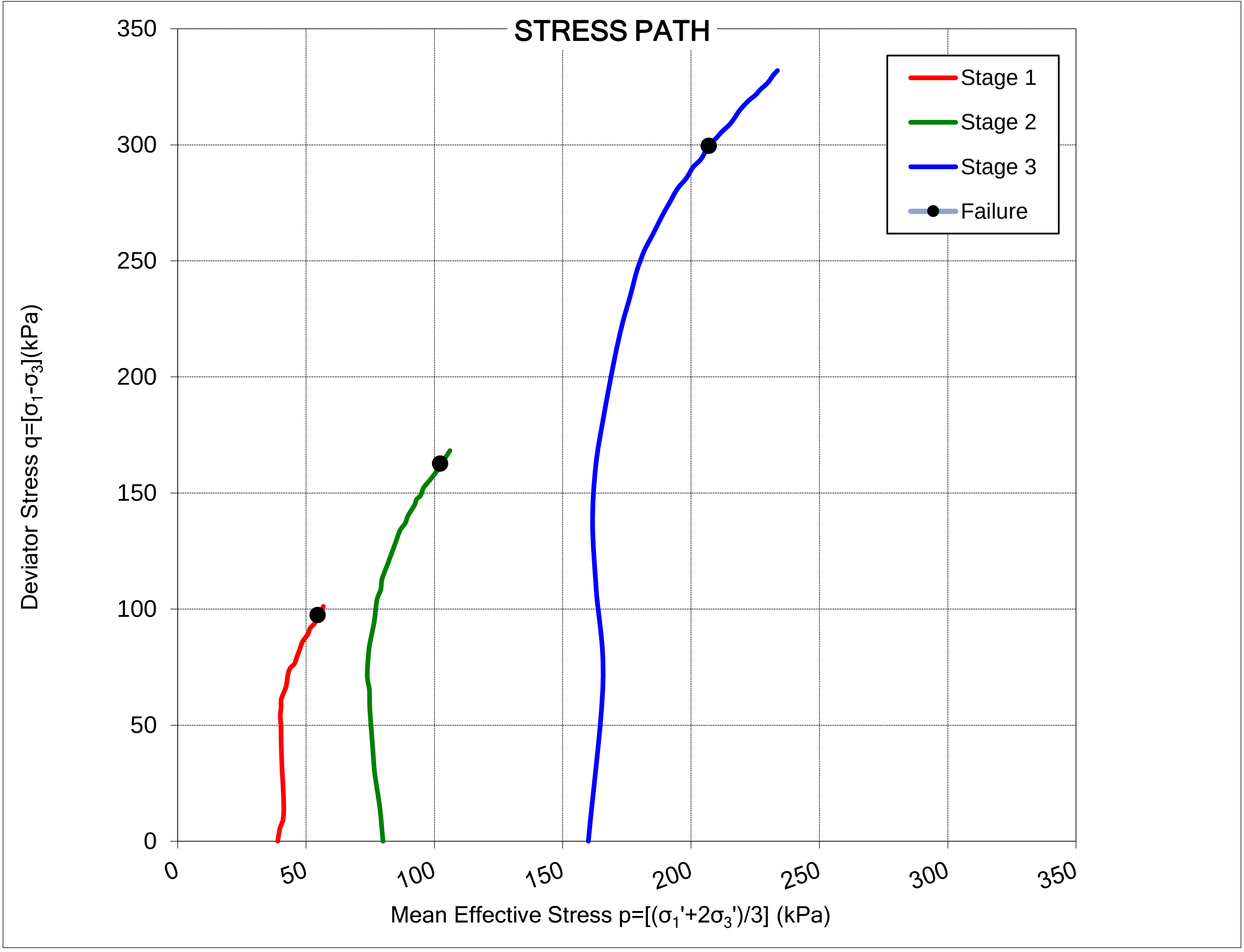
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client : Tahmoor Coal Pty Ltd
Project : Stability Assessment
Location : Remembrance Drive, Bargo NSW
Test Location : BH2
Depth / Layer : 2.0-2.4(m)
Sample Description: Silty CLAY

Project No. : 210597.02
Report No. : 210597.02-2
Report Date : 19 May 2022
Date Sampled : 03 May 2022
Date of Test: 05 Dec 2022
Sample Type: Undisturbed
Page: 4 of 4
Geotester Ref: ME-4489B



At Failure (kPa):

Stage	σ1'	σ3'	p'	q'	s'	t
1	119	22	54	97	71	49
2	211	48	102	163	129	81
3	407	107	207	300	257	150

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
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NATA WORLD RECOGNISED ACCREDITATION

Tested: PW
Checked: PW

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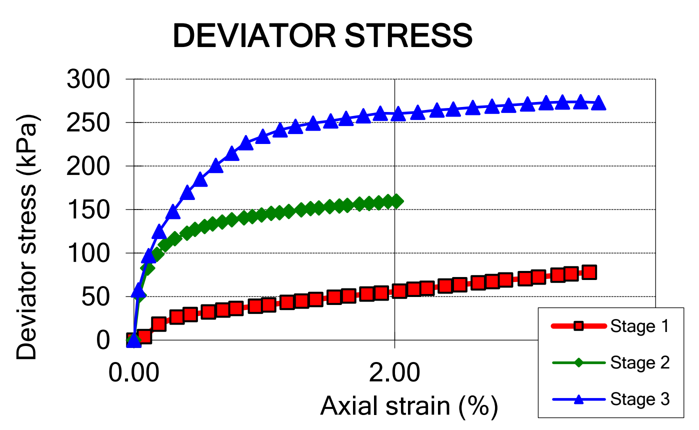
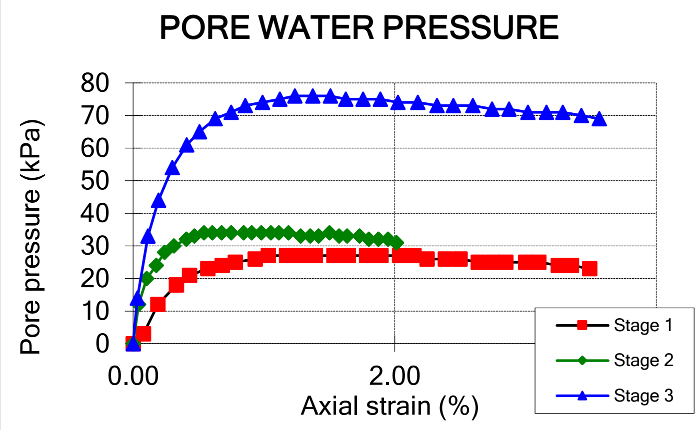
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client : Tahmoor Coal Pty Ltd
Project : Stability Assessment
Location : Remembrance Drive, Bargo NSW
Test Location : BH3
Depth / Layer : 8.6-9.0(m)
Sample Description: Silty CLAY

Project No. : 210597.02
Report No. : 210597.02-3
Report Date : 19 May 2022
Date Sampled : 03 May 2022
Date of Test: 12 May 2022
Sample Type: Undisturbed
Page: 1 of 4
Geotester Ref: ME-4489D

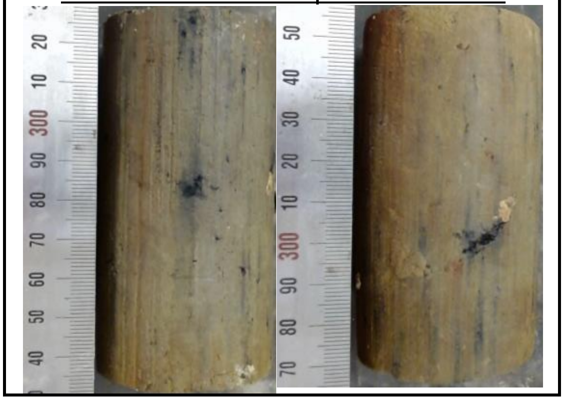




STAGE DETAILS

	STAGE		
	1	2	3
Cell pressure (kPa)	640	680	760
Back pressure (kPa)	600	600	600
Volume change (%)	1.4	2.7	4.1
Strain rate (mm/min)	0.033	0.017	0.016
		AT FAILURE	
Strain (%)	3.1	1.5	3.3
Deviator Stress (kPa)	72	153	274
Pore pressure (kPa)	624	634	671
Stress ratio	5.5	4.3	4.1

SAMPLE: BEFORE | AFTER TEST



SPECIMEN DETAILS

	Initial	Final
Moisture content (%)	17.1	16.2
Dry density (t/m3)	1.83	
B' value after saturation	0.99	

NOTES

1. Test Technique: multi-staged., failure criteria: maximum stress ratio.
2. Specimen was fitted with side drains.
3. Specimen was saturated with an applied pressures of 610 kPa (Cell) and 600 kPa (Back).
4. Membrane corrections were applied to the deviator stress according to figure 4 of BS 1377 : Part 8 : 1990.
5. Consolidation pore pressure was completely dissipated prior to testing
6. Water used for testing was not deaired prior to use.

Sample Type	Undisturbed	
	Length	Diameter
Sample Dimensions (mm, Averaged)	100	50

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED
ACCREDITATION

Tested: PW
Checked: PW

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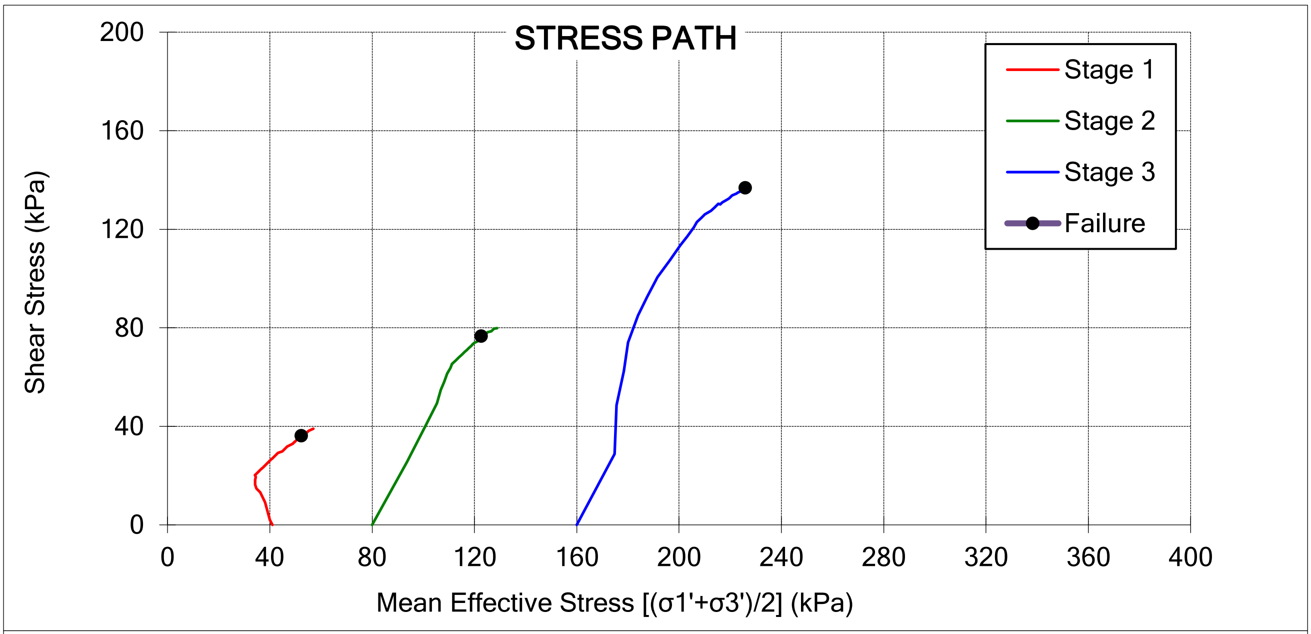
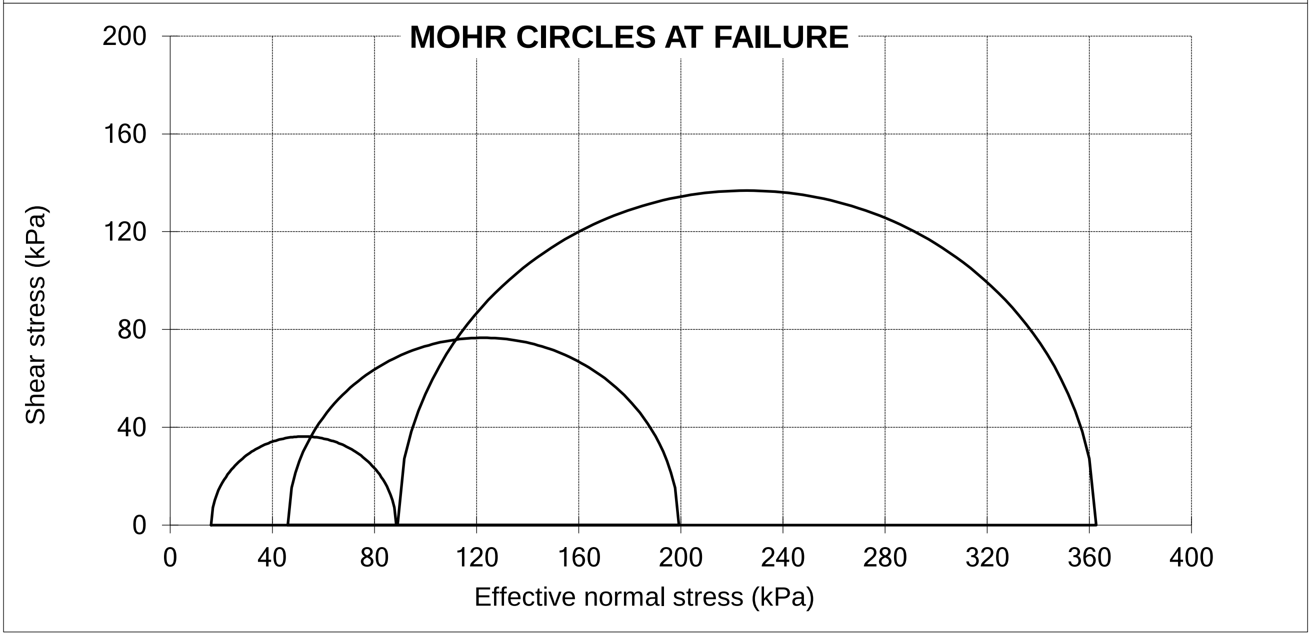
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-3
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	12 May 2022
Test Location :	BH3	**Sample Type:**	Undisturbed
Depth / Layer :	8.6-9.0(m)	**Page:**	2 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489D





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828

Accredited for compliance with ISO/IEC 17025 - Testing

Tested: PW
Checked: PW

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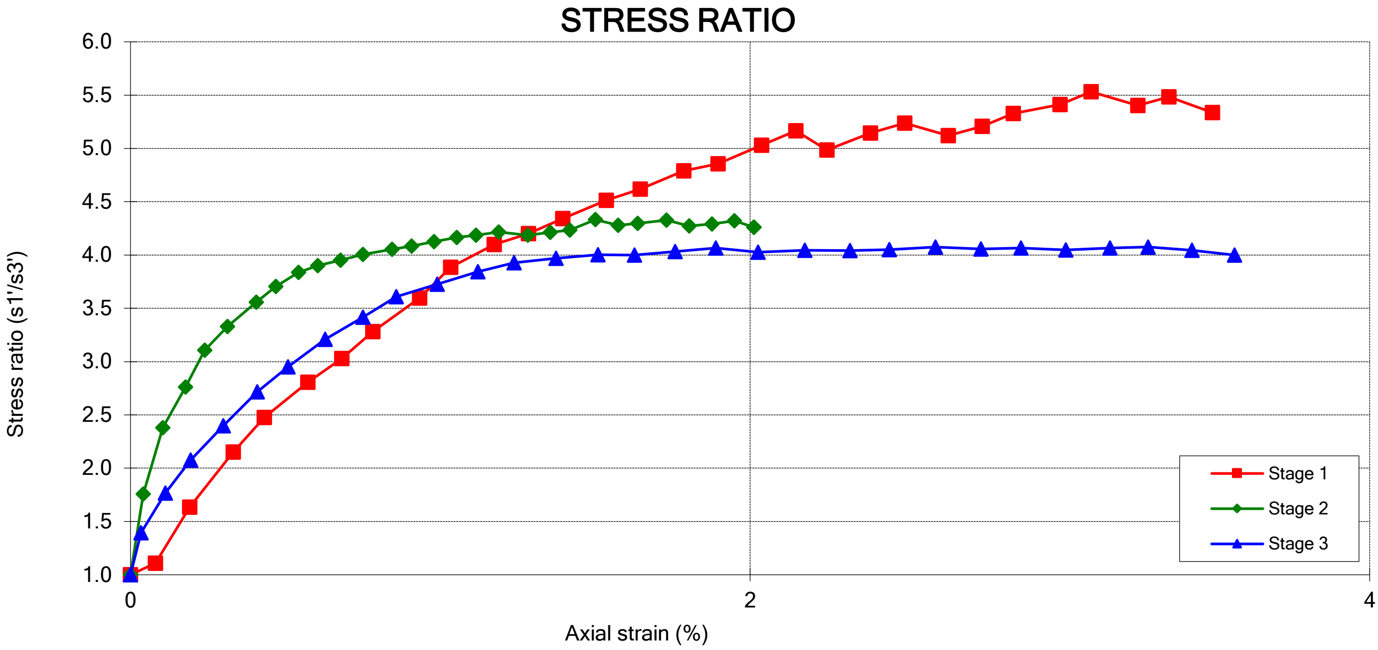
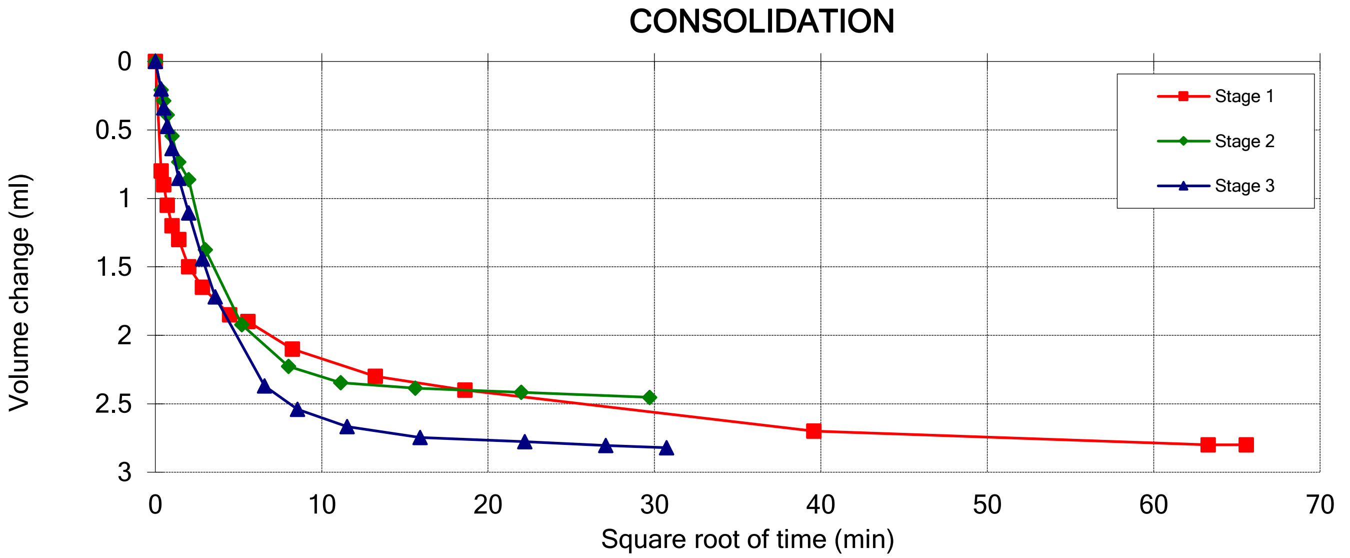
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-3
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	12 May 2022
Test Location :	BH3	**Sample Type:**	Undisturbed
Depth / Layer :	8.6-9.0(m)	**Page:**	3 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489D





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828

Accredited for compliance with ISO/IEC 17025 - Testing

Tested: PW
Checked: PW

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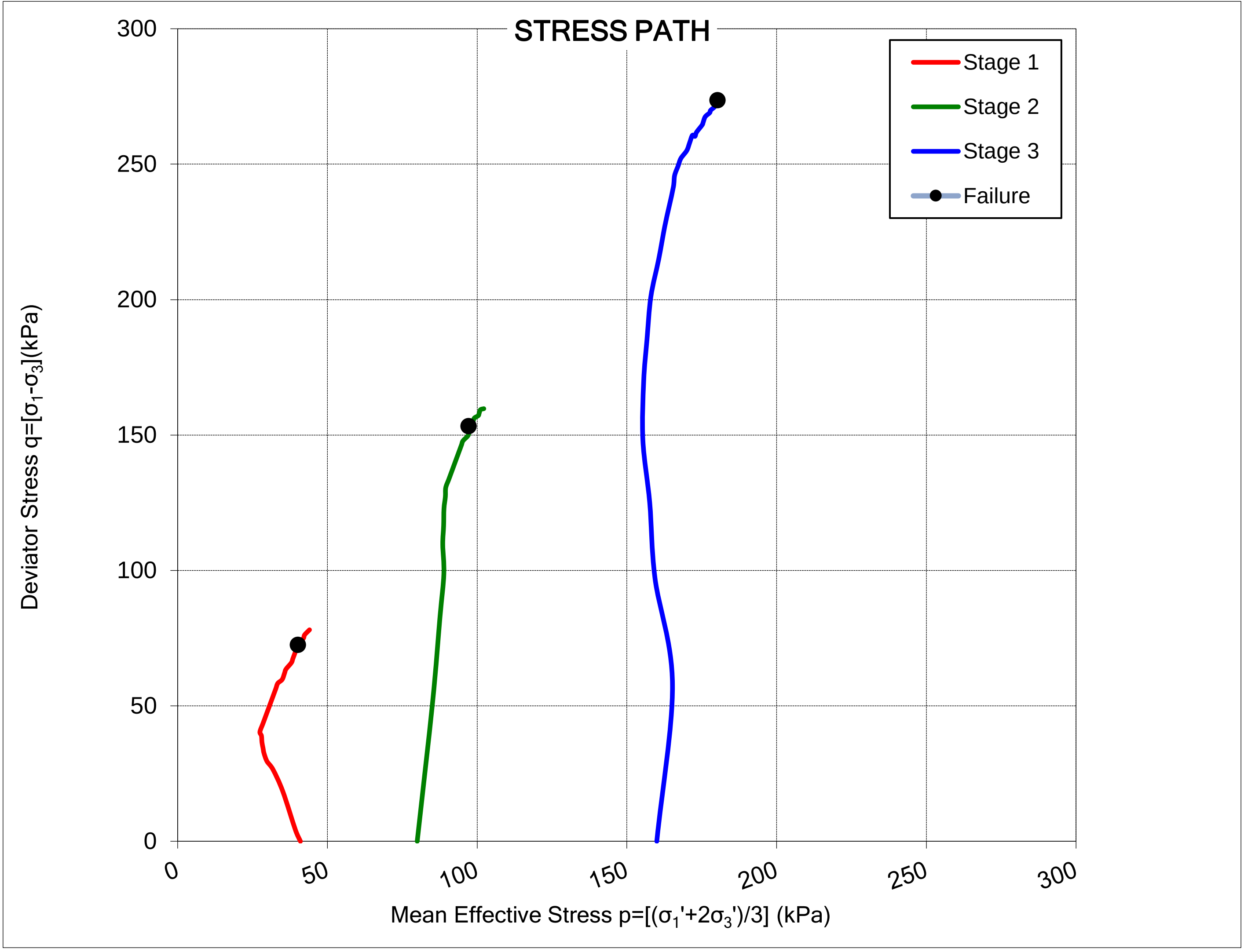
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client : Tahmoor Coal Pty Ltd
Project : Stability Assessment
Location : Remembrance Drive, Bargo NSW
Test Location : BH3
Depth / Layer : 8.6-9.0(m)
Sample Description: Silty CLAY

Project No. : 210597.02
Report No. : 210597.02-3
Report Date : 19 May 2022
Date Sampled : 03 May 2022
Date of Test: 12 May 2022
Sample Type: Undisturbed
Page: 4 of 4
Geotester Ref: ME-4489D



At Failure (kPa):

Stage	σ1'	σ3'	p'	q'	s'	t
1	88	16	40	72	52	36
2	199	46	97	153	123	77
3	363	89	180	274	226	137

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: PW
Checked: PW

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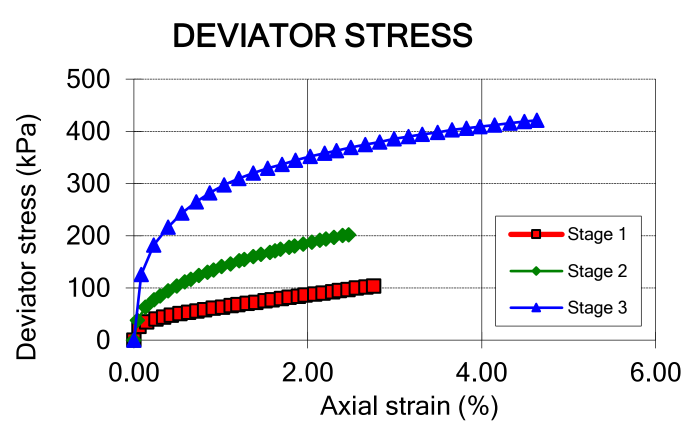
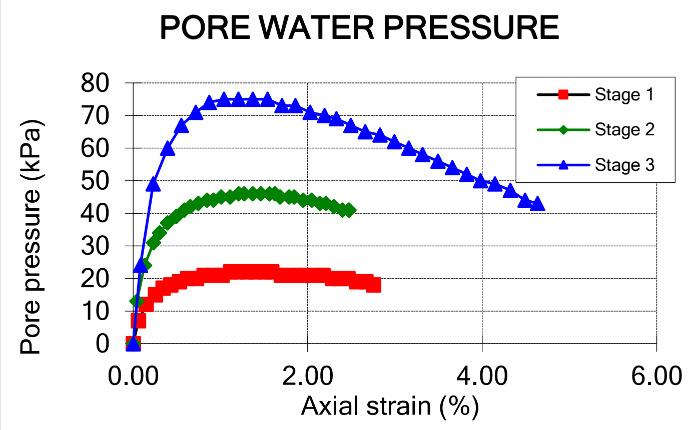
Triaxial Compression Test Results

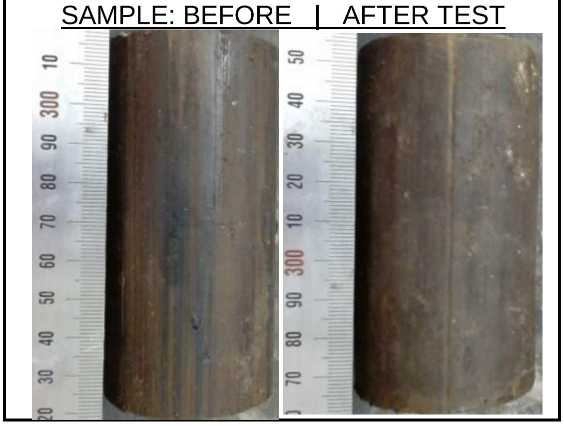
(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-4
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	13 May 2022
Test Location :	BH4	**Sample Type:**	Undisturbed
Depth / Layer :	1.0-1.4(m)	**Page:**	1 of 4
Sample Description:	Sandy Silty CLAY	**Geotester Ref:**	ME-4489E





SAMPLE: BEFORE | AFTER TEST



STAGE DETAILS

	STAGE		
	1	2	3
Cell pressure (kPa)	640	680	760
Back pressure (kPa)	600	600	600
Volume change (%)	1.1	2.9	4.3
Strain rate (mm/min)	0.033	0.030	0.030
	AT FAILURE		
Strain (%)	2.7	2.2	2.3
Deviator Stress (kPa)	102	194	363
Pore pressure (kPa)	619	643	669
Stress ratio	5.9	6.2	5.0

SPECIMEN DETAILS

	Initial	Final
Moisture content (%)	18.8	22.5
Dry density (t/m3)	1.68	
B' value after saturation	0.99	
Pocket Penetrometer Reading(kPa)	>600	

Sample Type	Undisturbed	
	Length	Diameter
Sample Dimensions (mm, Averaged)	102	51

NOTES

1. Test Technique: multi-staged., failure criteria: maximum stress ratio.
2. Specimen was fitted with side drains.
3. Specimen was saturated with an applied pressures of 613 kPa (Cell) and 600 kPa (Back).
4. Membrane corrections were applied to the deviator stress according to figure 4 of BS 1377 : Part 8 : 1990.
5. Consolidation pore pressure was completely dissipated prior to testing
6. Water used for testing was not deaired prior to use.
7. Note that NATA accreditation does not cover the performance of pocket penetrometer readings.

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: PW/AFD
Checked: PW

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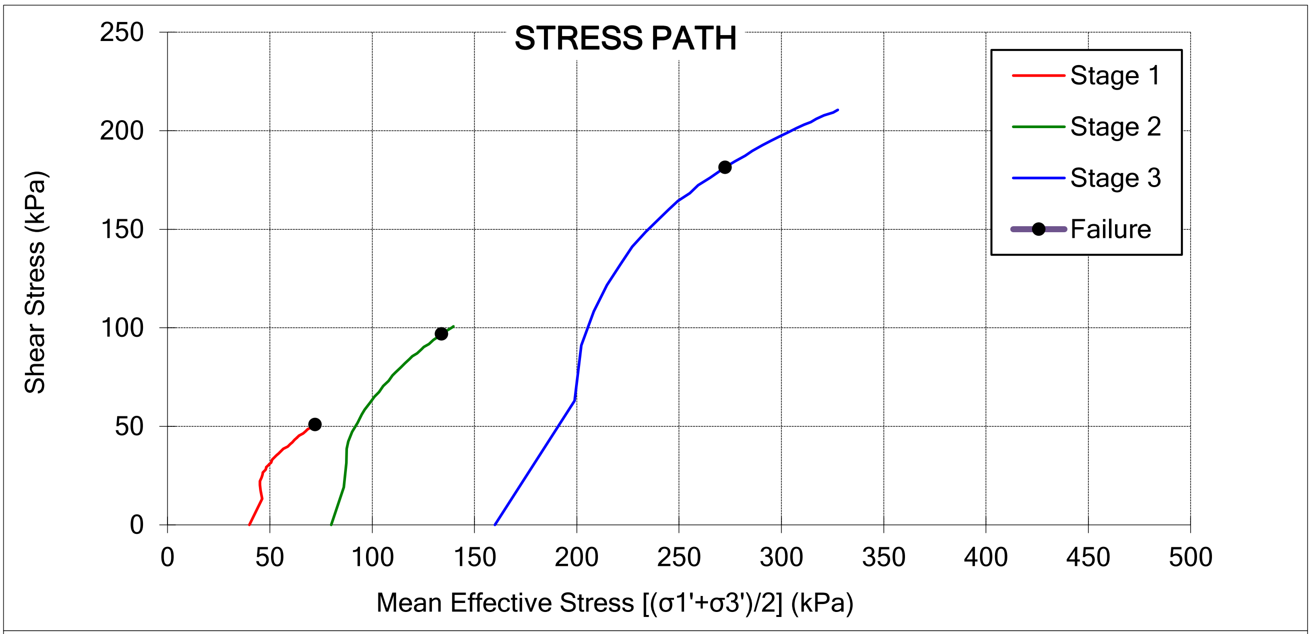
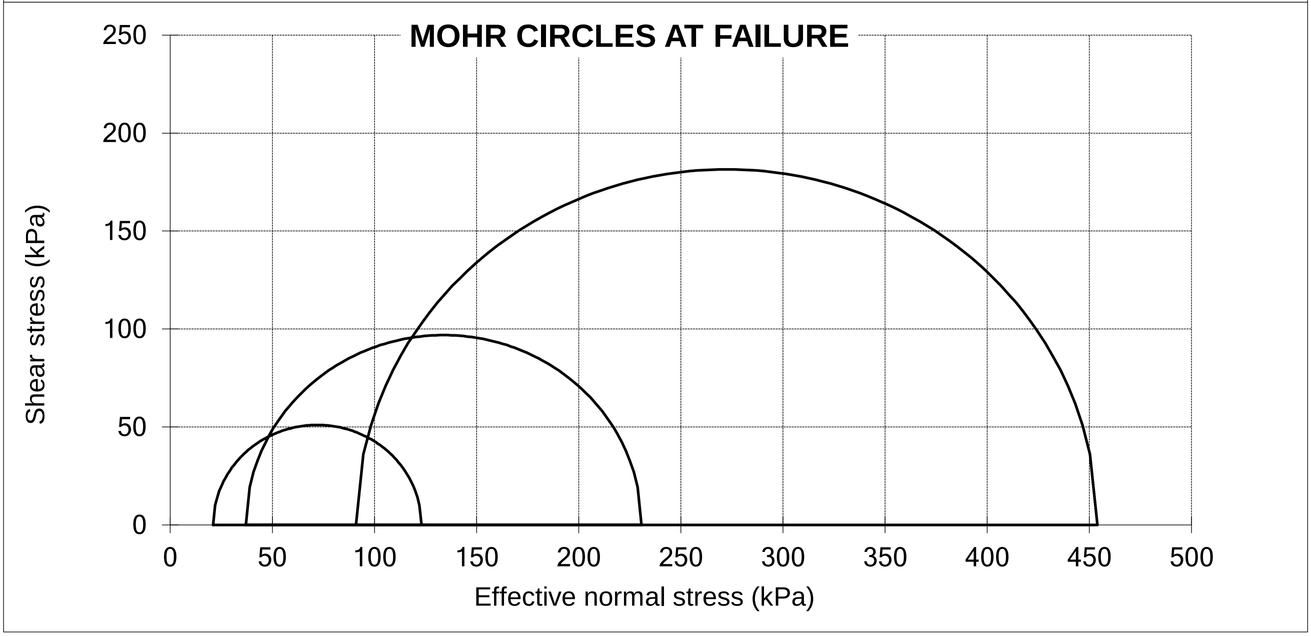
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-4
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	13 May 2022
Test Location :	BH4	**Sample Type:**	Undisturbed
Depth / Layer :	1.0-1.4(m)	**Page:**	2 of 4
Sample Description:	Sandy Silty CLAY	**Geotester Ref:**	ME-4489E





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
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Tested: PW/AFD
Checked: PW

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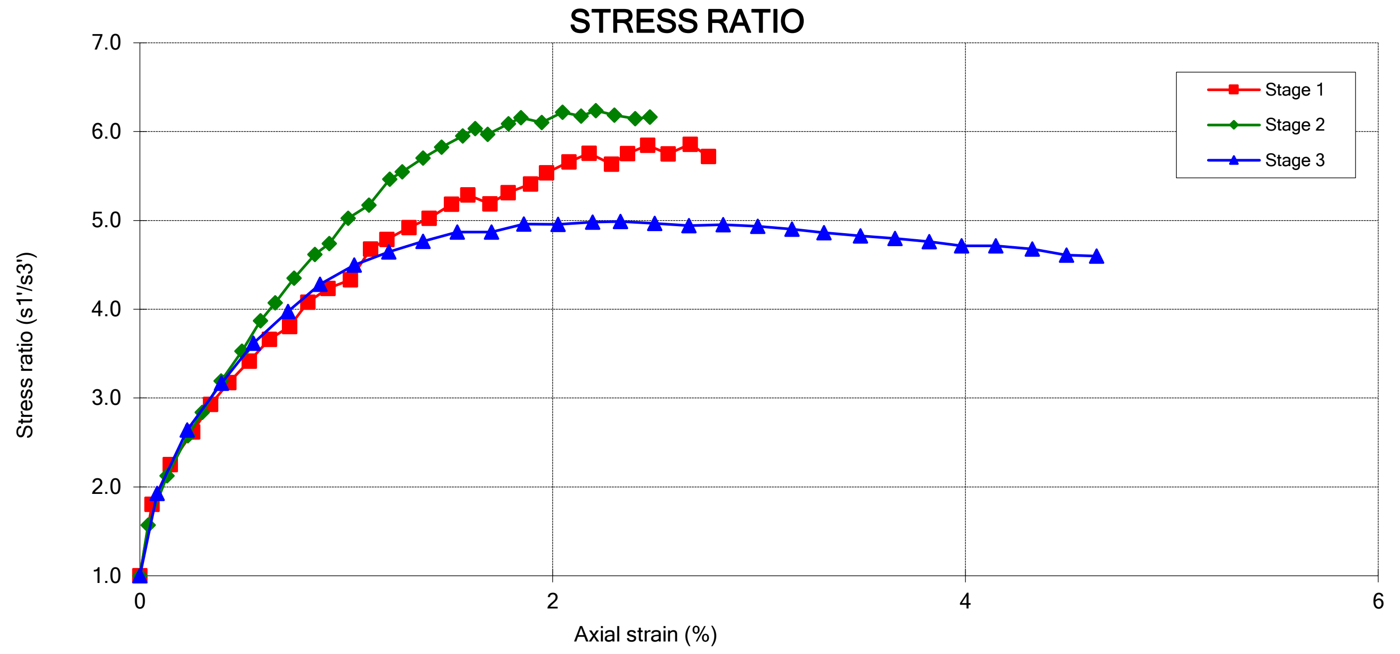
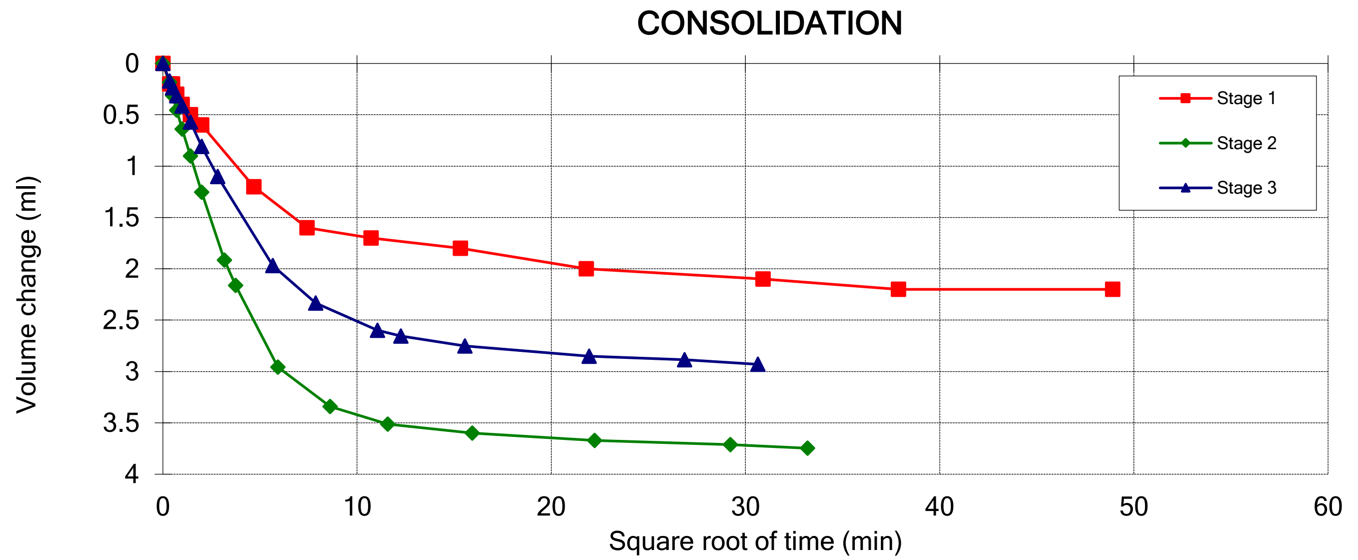
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-4
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	13 May 2022
Test Location :	BH4	**Sample Type:**	Undisturbed
Depth / Layer :	1.0-1.4(m)	**Page:**	3 of 4
Sample Description:	Sandy Silty CLAY	**Geotester Ref:**	ME-4489E





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828

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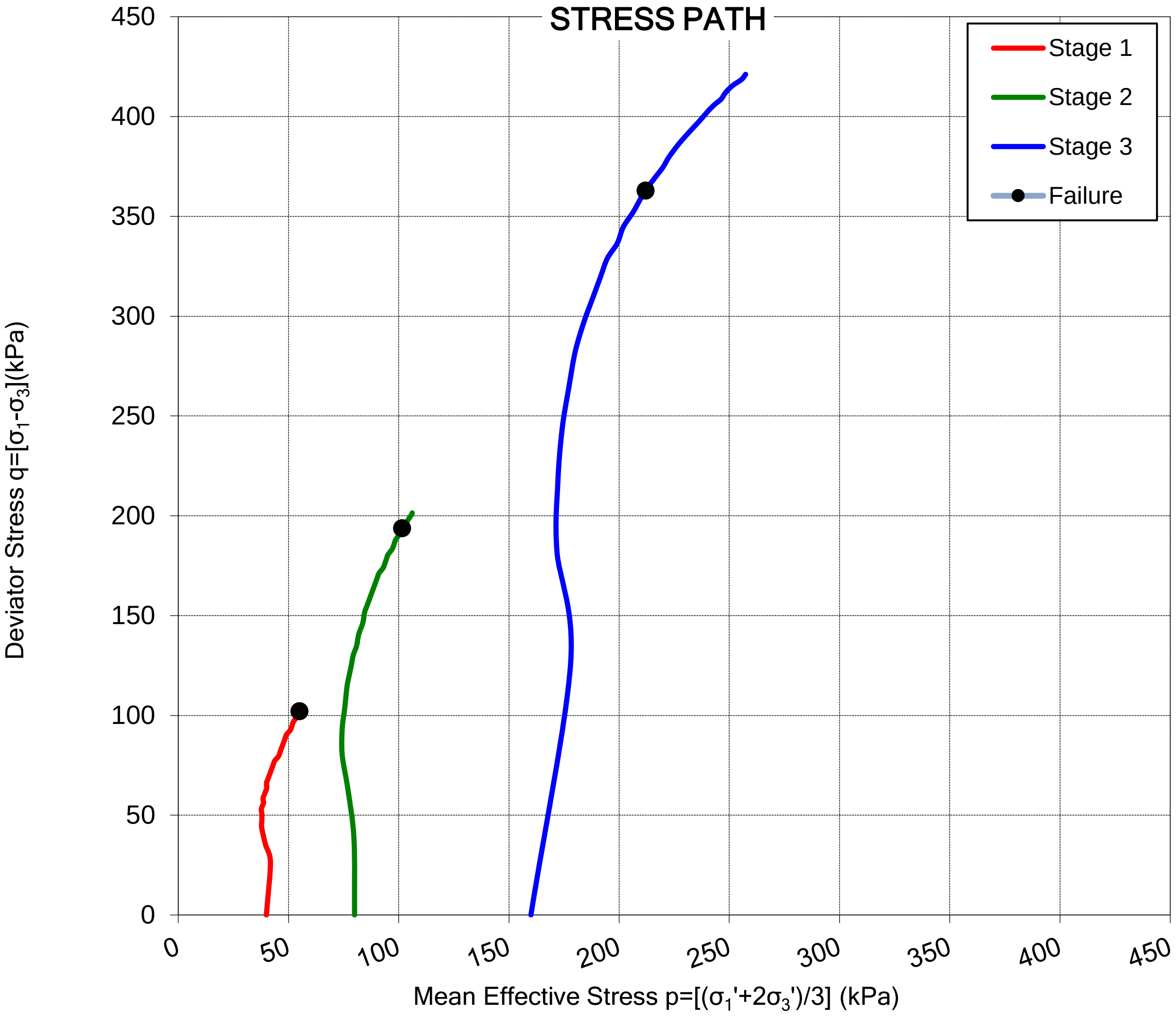
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-4
Project :	Stability Assessment	**Report Date :**	19 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	13 May 2022
Test Location :	BH4	**Sample Type:**	Undisturbed
Depth / Layer :	1.0-1.4(m)	**Page:**	4 of 4
Sample Description:	Sandy Silty CLAY	**Geotester Ref:**	ME-4489E



At Failure (kPa):	Stage	σ1'	σ3'	p'	q'	s'	t
	1	123	21	55	102	72	51
	2	231	37	102	194	134	97
	3	454	91	212	363	272	181

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: PW/AFD
Checked: PW

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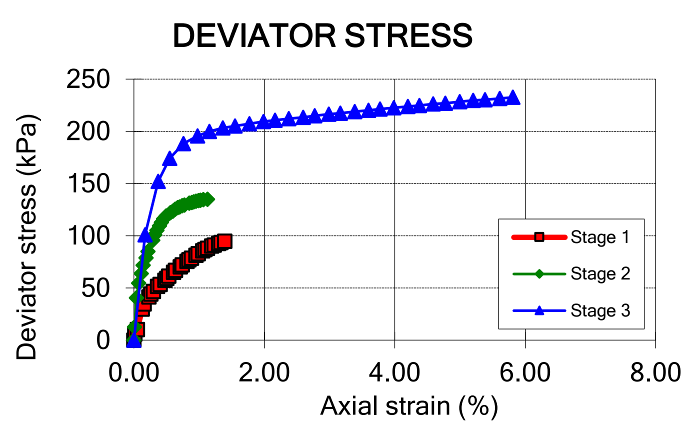
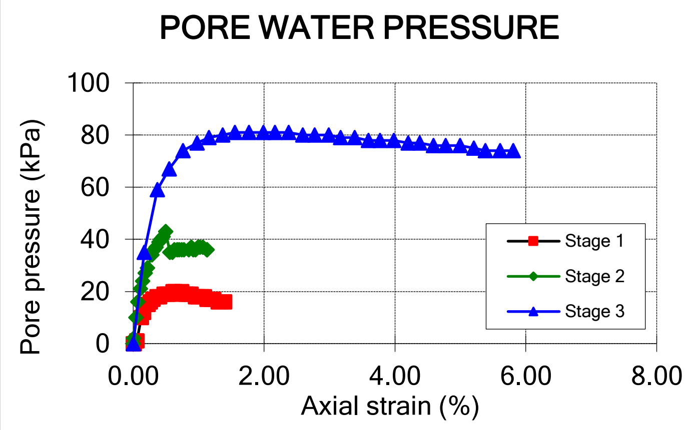
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-5
Project :	Stability Assessment	**Report Date :**	23 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	17 May 2022
Test Location :	BH3	**Sample Type:**	Remoulded
Depth / Layer :	2.0-3.5(m)	**Page:**	1 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489C





STAGE DETAILS

	STAGE		
	1	2	3
Cell pressure (kPa)	640	680	760
Back pressure (kPa)	600	600	600
Volume change (%)	0.9	1.8	2.9
Strain rate (mm/min)	0.042	0.042	0.042

	AT FAILURE		
Strain (%)	1.2	0.5	5.0
Deviator Stress (kPa)	91	119	228
Pore pressure (kPa)	617	643	676
Stress ratio	5.0	4.2	3.7

SAMPLE: BEFORE | AFTER TEST

SPECIMEN DETAILS

	Initial	Final
Moisture content (%)	11.8	14.8
Dry density (t/m3)	1.92	
B' value after saturation	0.96	

NOTES

1. Test Technique: multi-staged., failure criteria: maximum stress ratio.
2. Specimen was fitted with side drains.
3. Specimen was saturated with an applied pressures of 614 kPa (Cell) and 600 kPa (Back).
4. Membrane corrections were applied to the deviator stress according to figure 4 of BS 1377 : Part 8 : 1990.
5. Consolidation pore pressure was completely dissipated prior to testing
6. Water used for testing was not deaired prior to use.
7. Remould to 98% MDD (MDD = 1.965 t/m3) and at OMC (11.7 %)

Sample Type	Remoulded	
	Length	Diameter
Sample Dimensions (mm, Averaged)	127	63

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD
Checked: PW

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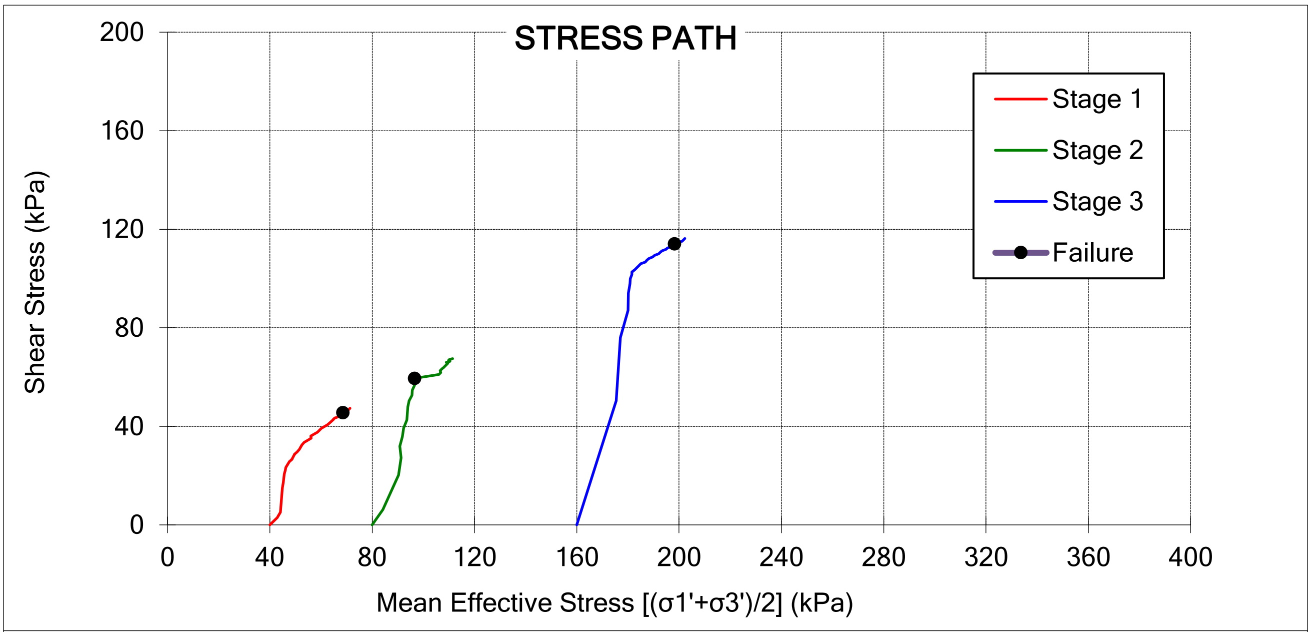
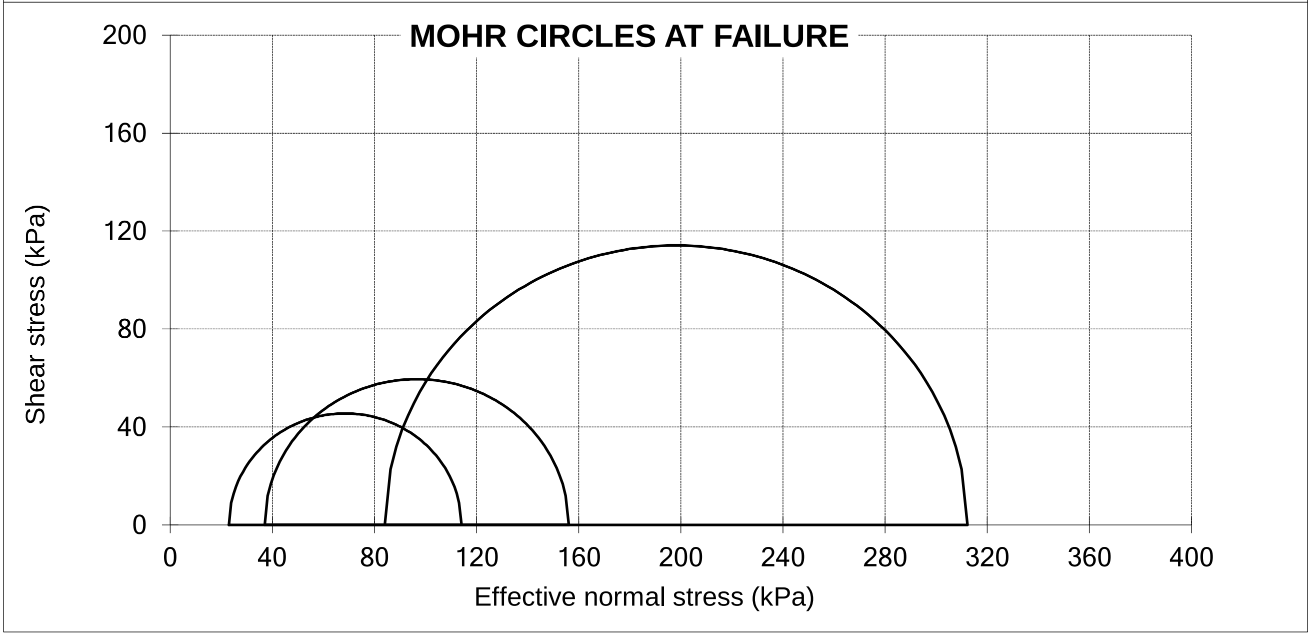
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-5
Project :	Stability Assessment	**Report Date :**	23 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	17 May 2022
Test Location :	BH3	**Sample Type:**	Remoulded
Depth / Layer :	2.0-3.5(m)	**Page:**	2 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489C





FORM R24A REV 4 MARCH 2021

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory Number: 828

Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD
Checked: PW

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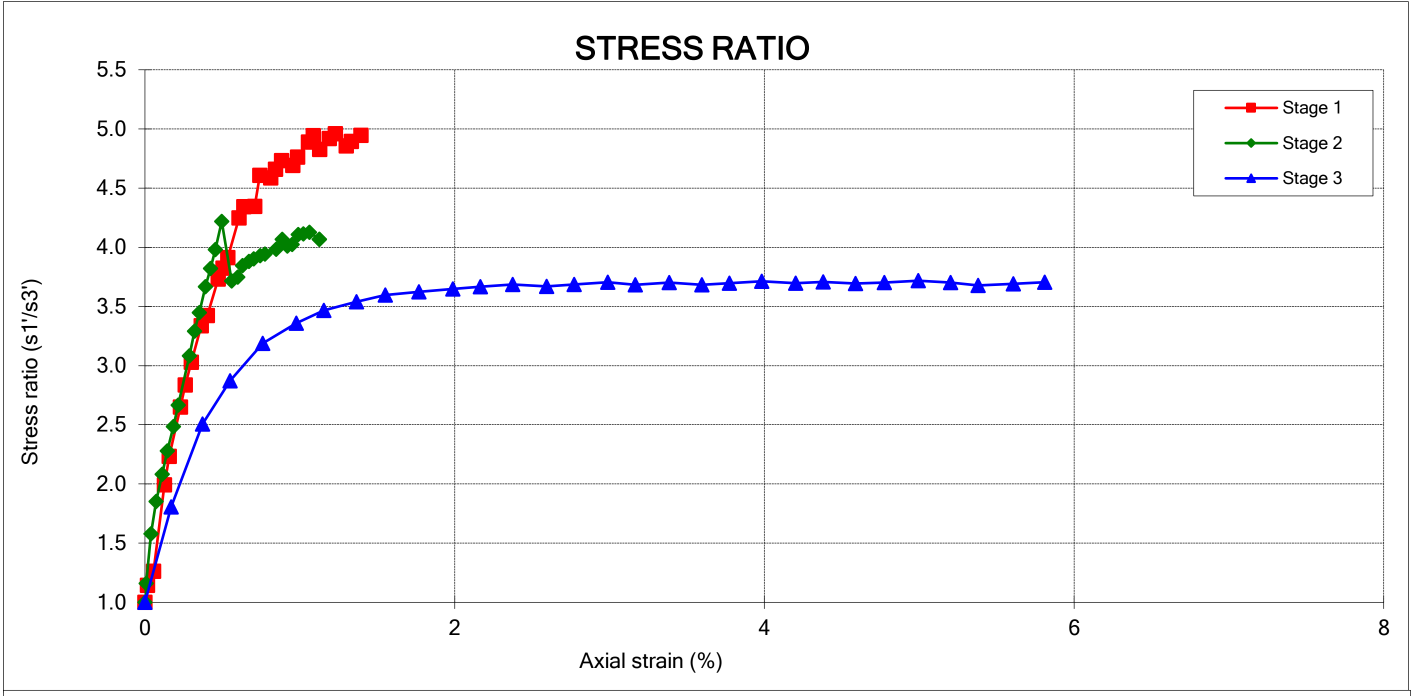
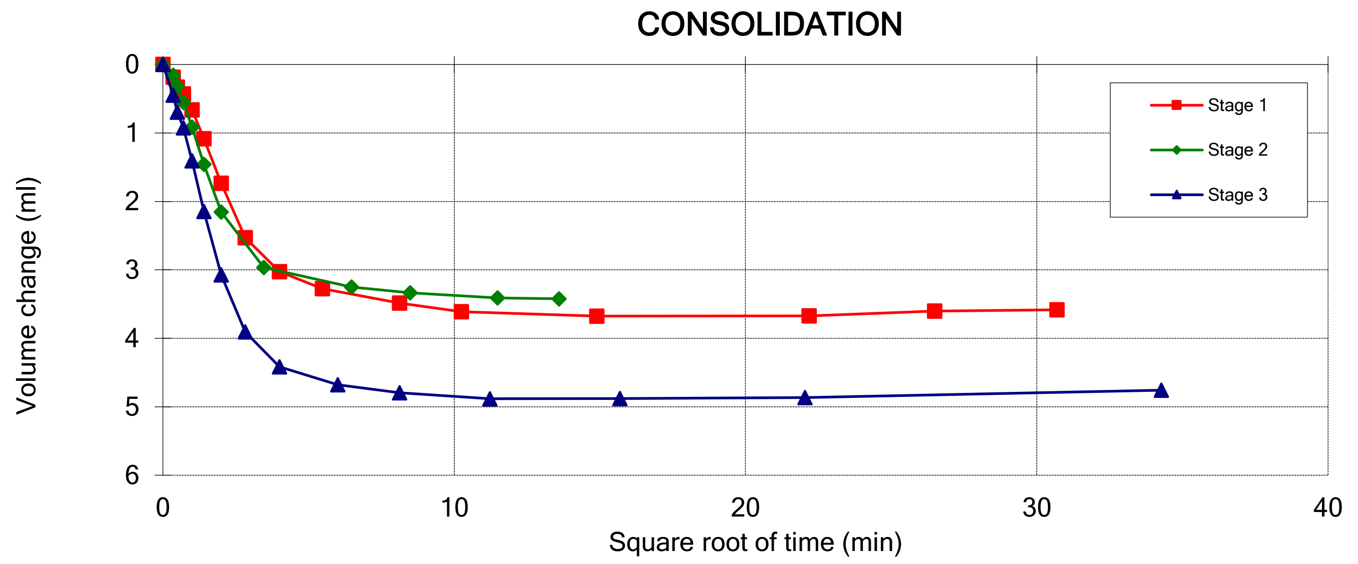
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-5
Project :	Stability Assessment	**Report Date :**	23 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	17 May 2022
Test Location :	BH3	**Sample Type:**	Remoulded
Depth / Layer :	2.0-3.5(m)	**Page:**	3 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489C





Sampling Method(s):	Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s):	AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD
Checked: PW

Peter Chan
Associate

Triaxial Compression Test Results

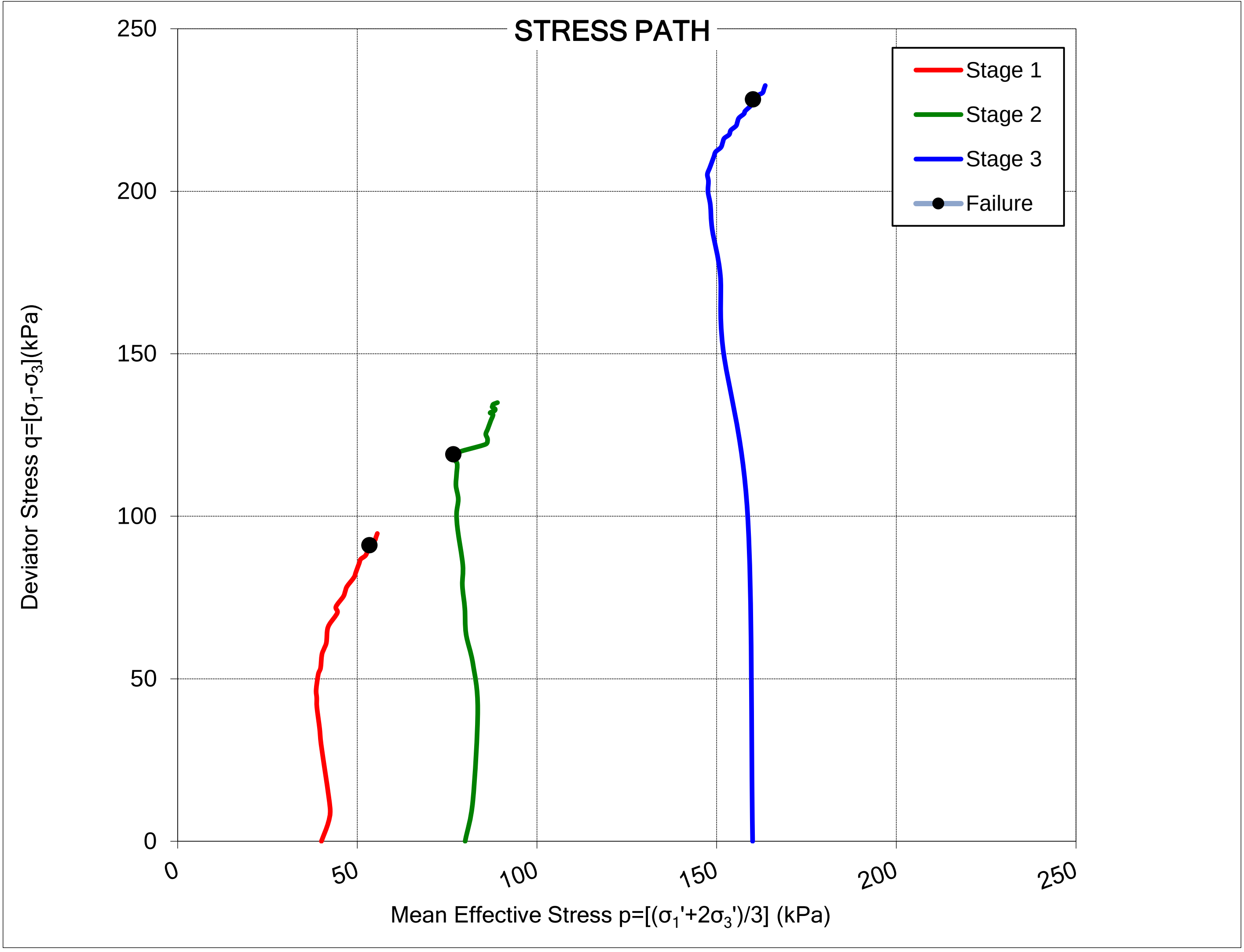
(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client : Tahmoor Coal Pty Ltd

Project : Stability Assessment

Location : Remembrance Drive, Bargo NSW
Test Location : BH3
Depth / Layer : 2.0-3.5(m)
Sample Description: Silty CLAY

Project No. : 210597.02
Report No. : 210597.02-5
Report Date : 23 May 2022
Date Sampled : 03 May 2022
Date of Test: 17 May 2022
Sample Type: Remoulded
Page: 4 of 4
Geotester Ref: ME-4489C



At Failure (kPa):

Stage	σ1'	σ3'	p'	q'	s'	t
1	114	23	53	ing was r	69	46
2	156	37	77	119	97	60
3	312	84	160	228	198	114

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD
Checked: PW

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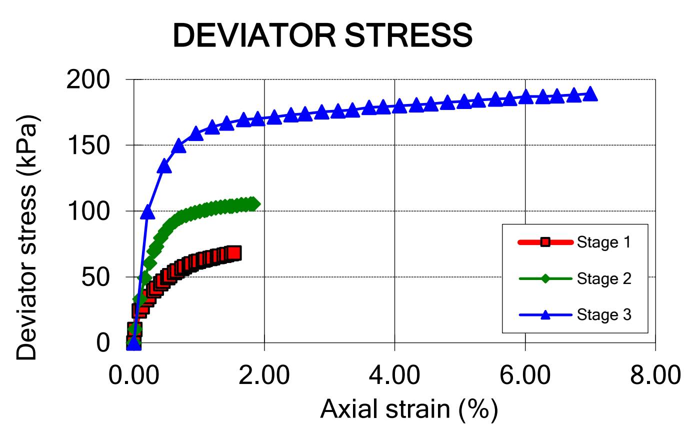
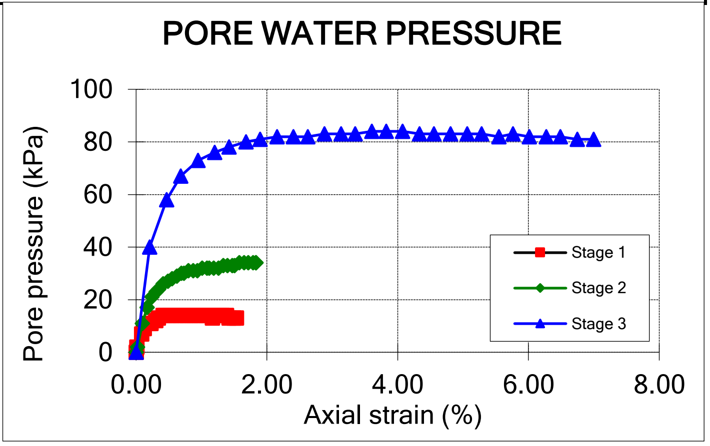
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-6
Project :	Stability Assessment	**Report Date :**	25 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	18 May 2022
Test Location :	BH1	**Sample Type:**	Remoulded
Depth / Layer :	1.0-3.0(m)	**Page:**	1 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489A





STAGE DETAILS		**STAGE**	
	1	2	3
Cell pressure (kPa)	690	730	810
Back pressure (kPa)	650	650	650
Volume change (%)	1.3	2.2	3.5
Strain rate (mm/min)	0.051	0.051	0.051
		AT FAILURE	
Strain (%)	1.4	1.8	5.8
Deviator Stress (kPa)	66	105	186
Pore pressure (kPa)	664	684	733
Stress ratio	3.6	3.3	3.4

SAMPLE: BEFORE | AFTER TEST

SPECIMEN DETAILS	Initial	Final
Moisture content (%)	12.0	14.7
Dry density (t/m3)	1.90	
B' value after saturation	0.98	

NOTES

1. Test Technique: multi-staged., failure criteria: maximum stress ratio.
2. Specimen was fitted with side drains.
3. Specimen was saturated with an applied pressures of 654 kPa (Cell) and 650 kPa (Back).
4. Membrane corrections were applied to the deviator stress according to figure 4 of BS 1377 : Part 8 : 1990.
5. Consolidation pore pressure was completely dissipated prior to testing
6. Water used for testing was not deaired prior to use.
7. Remould to 98% MDD (MDD = 1.954 t/m3) and at OMC (12.4 %)

Sample Type	Remoulded	
	Length	Diameter
Sample Dimensions (mm, Averaged)	153	76

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD/PW
Checked: PW

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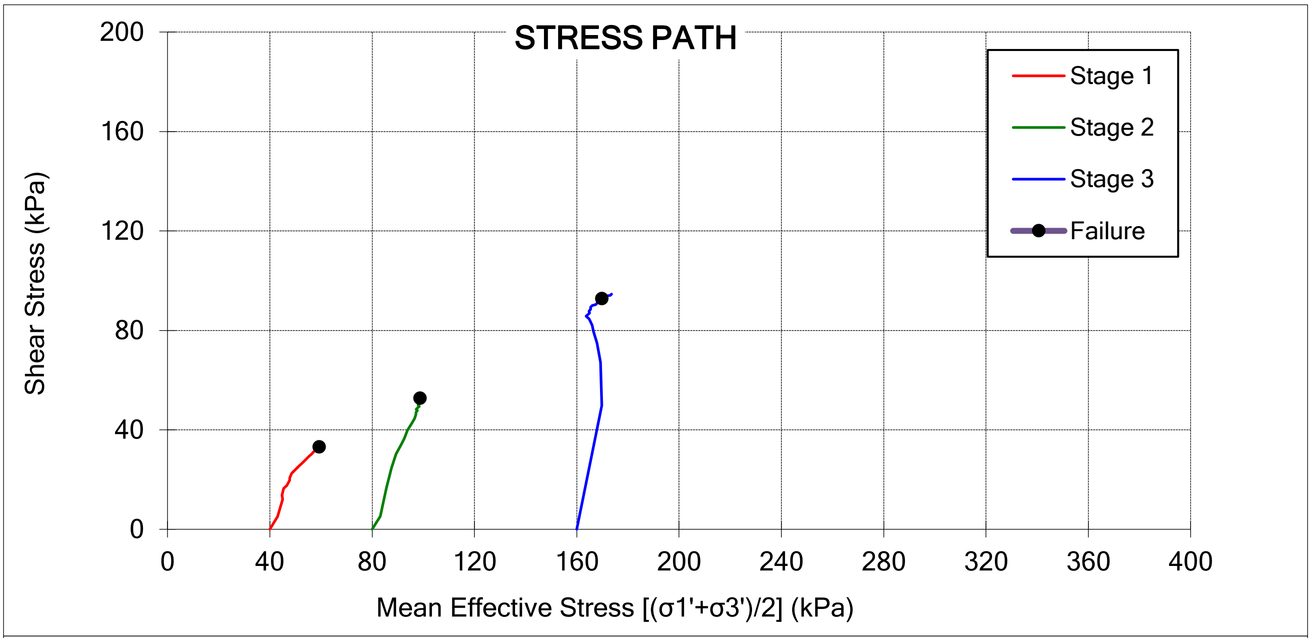
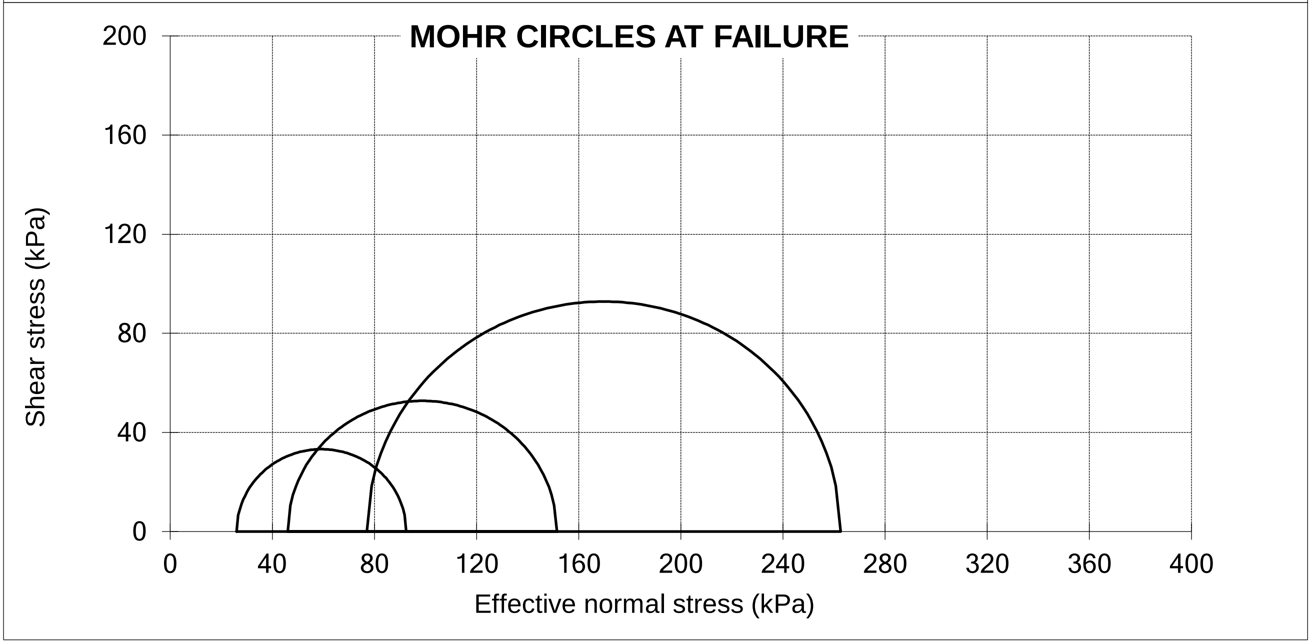
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-6
Project :	Stability Assessment	**Report Date :**	25 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	18 May 2022
Test Location :	BH1	**Sample Type:**	Remoulded
Depth / Layer :	1.0-3.0(m)	**Page:**	2 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489A





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD/PW
Checked: PW

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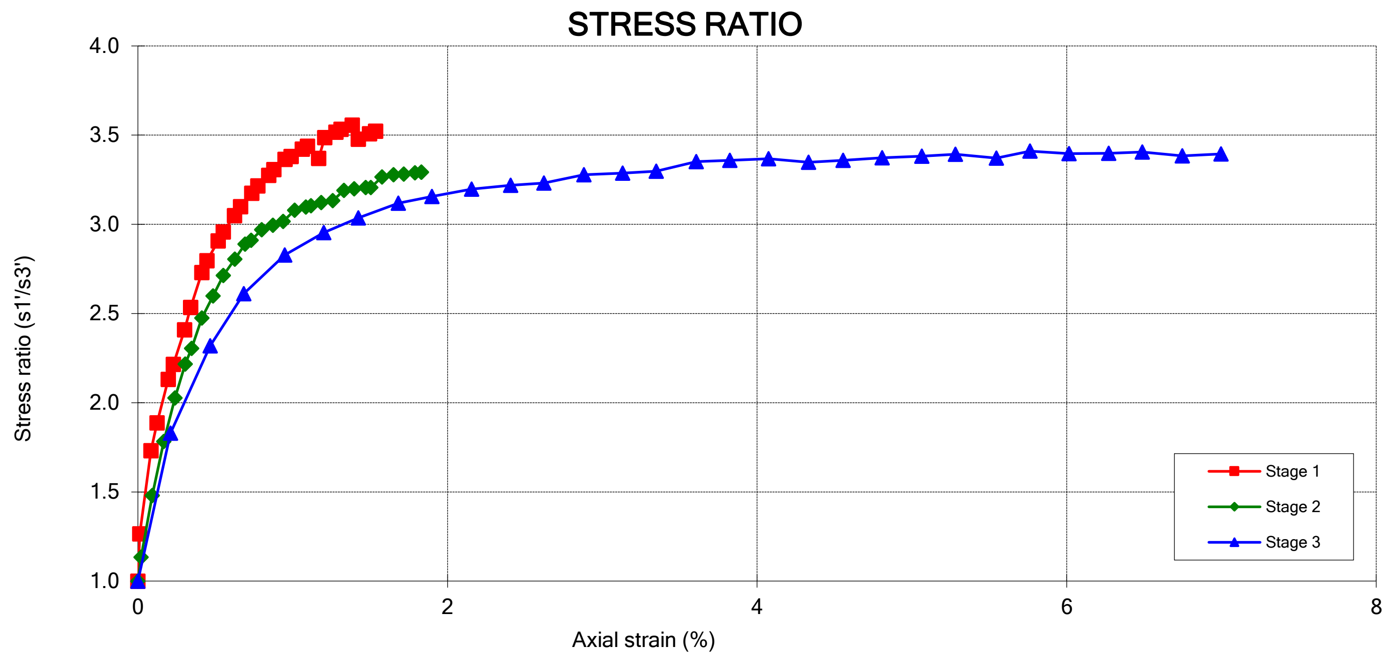
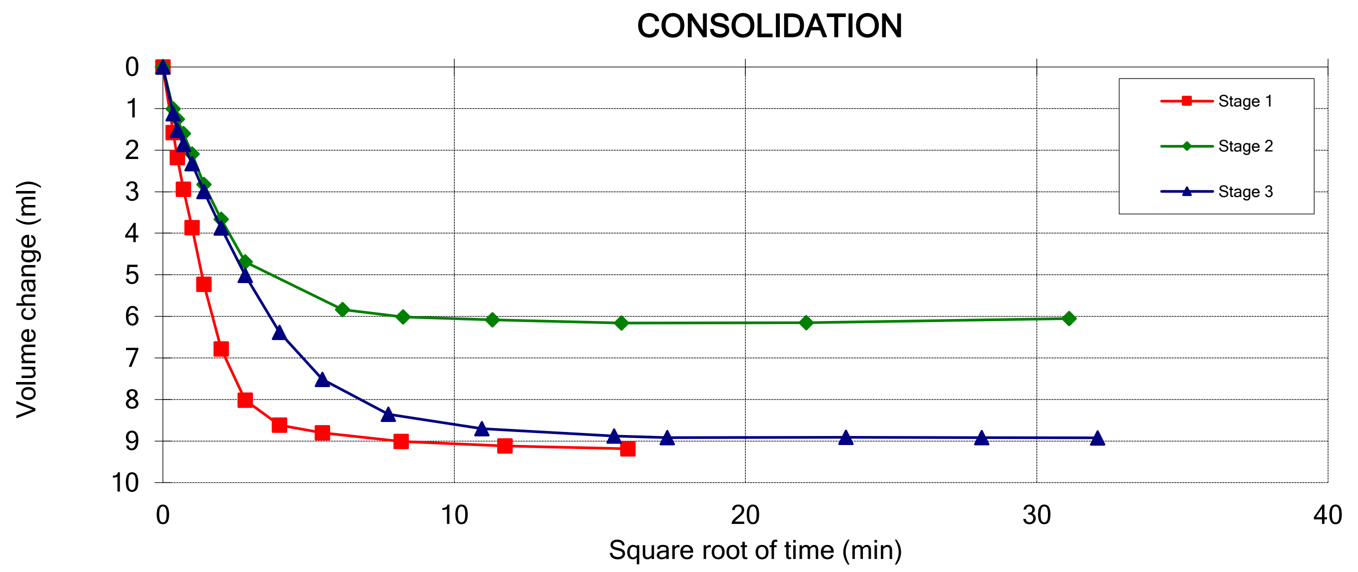
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-6
Project :	Stability Assessment	**Report Date :**	25 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	18 May 2022
Test Location :	BH1	**Sample Type:**	Remoulded
Depth / Layer :	1.0-3.0(m)	**Page:**	3 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489A





Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.

Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

NATA Accredited Laboratory Number: 828

Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD/PW
Checked: PW

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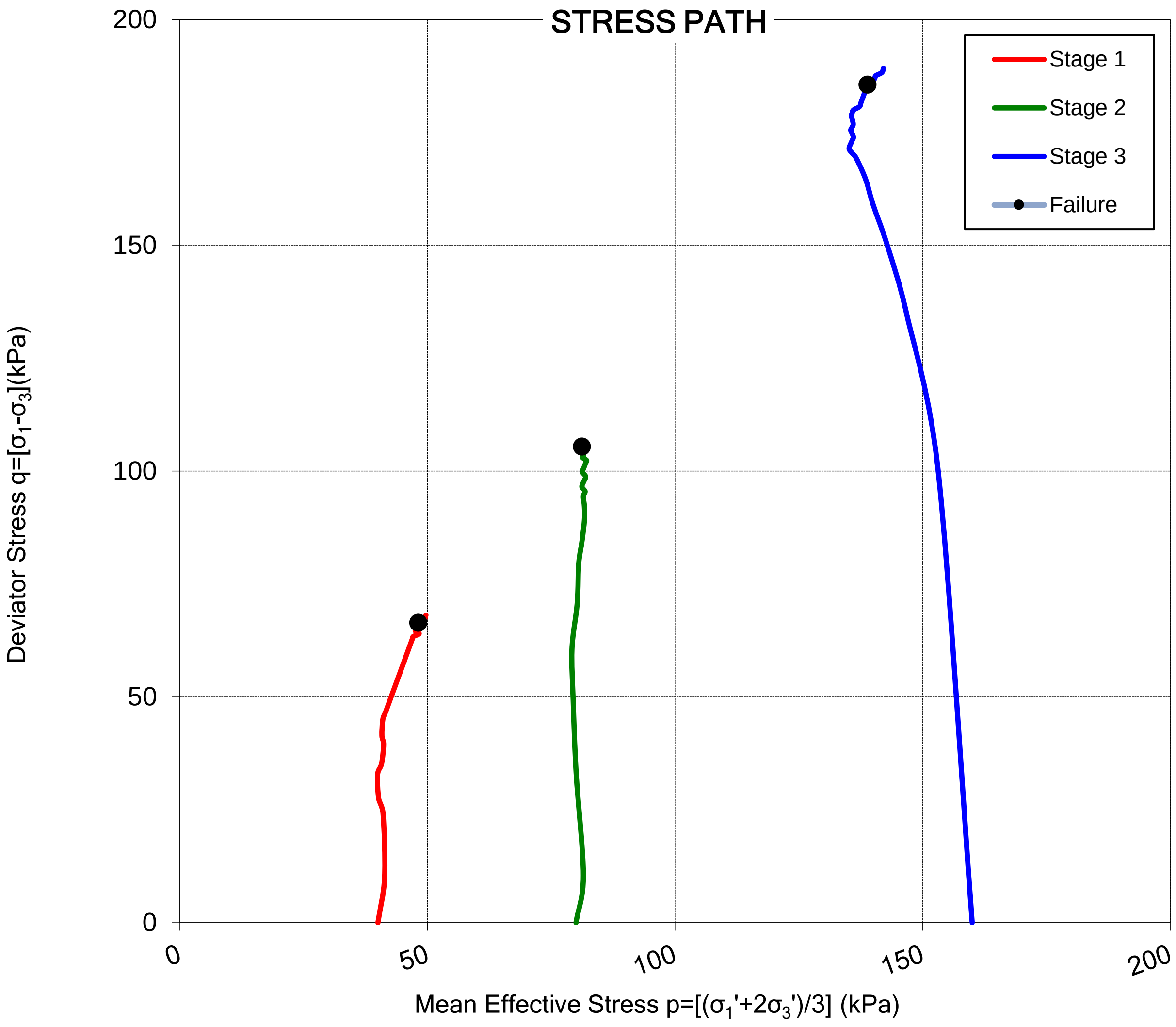
Triaxial Compression Test Results

(CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT)

Client :	Tahmoor Coal Pty Ltd	**Project No. :**	210597.02
		Report No. :	210597.02-6
Project :	Stability Assessment	**Report Date :**	25 May 2022
		Date Sampled :	03 May 2022
Location :	Remembrance Drive, Bargo NSW	**Date of Test:**	18 May 2022
Test Location :	BH1	**Sample Type:**	Remoulded
Depth / Layer :	1.0-3.0(m)	**Page:**	4 of 4
Sample Description:	Silty CLAY	**Geotester Ref:**	ME-4489A



At Failure (kPa):

Stage	σ1'	σ3'	p'	q'	s'	t
1	92	26	48	66	59	33
2	151	46	81	105	99	53
3	263	77	139	186	170	93

Sampling Method(s): Sampled by Engineering Dept. The results applied to sample as received.
Test Method(s): AS 1289.6.4.2, AS1289.2.1.1

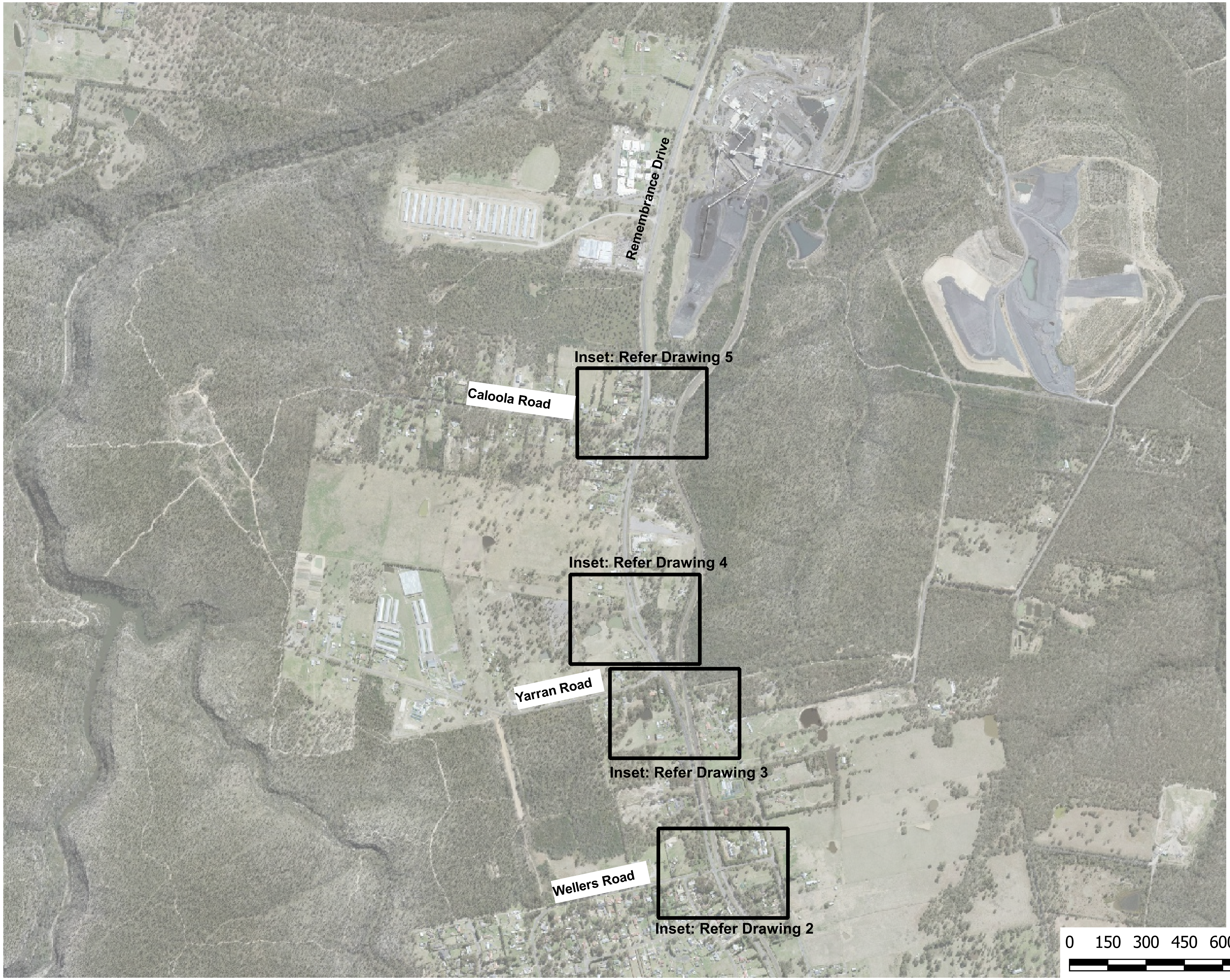
NATA Accredited Laboratory Number: 828
Accredited for compliance with ISO/IEC 17025 - Testing

Tested: AFD/PW
Checked: PW

Peter Chan
Associate

Appendix D

Drawings 1 – 25



Locality Plan

Notes: Aerial photography from Metromap.com

Legend

▭ Study Area

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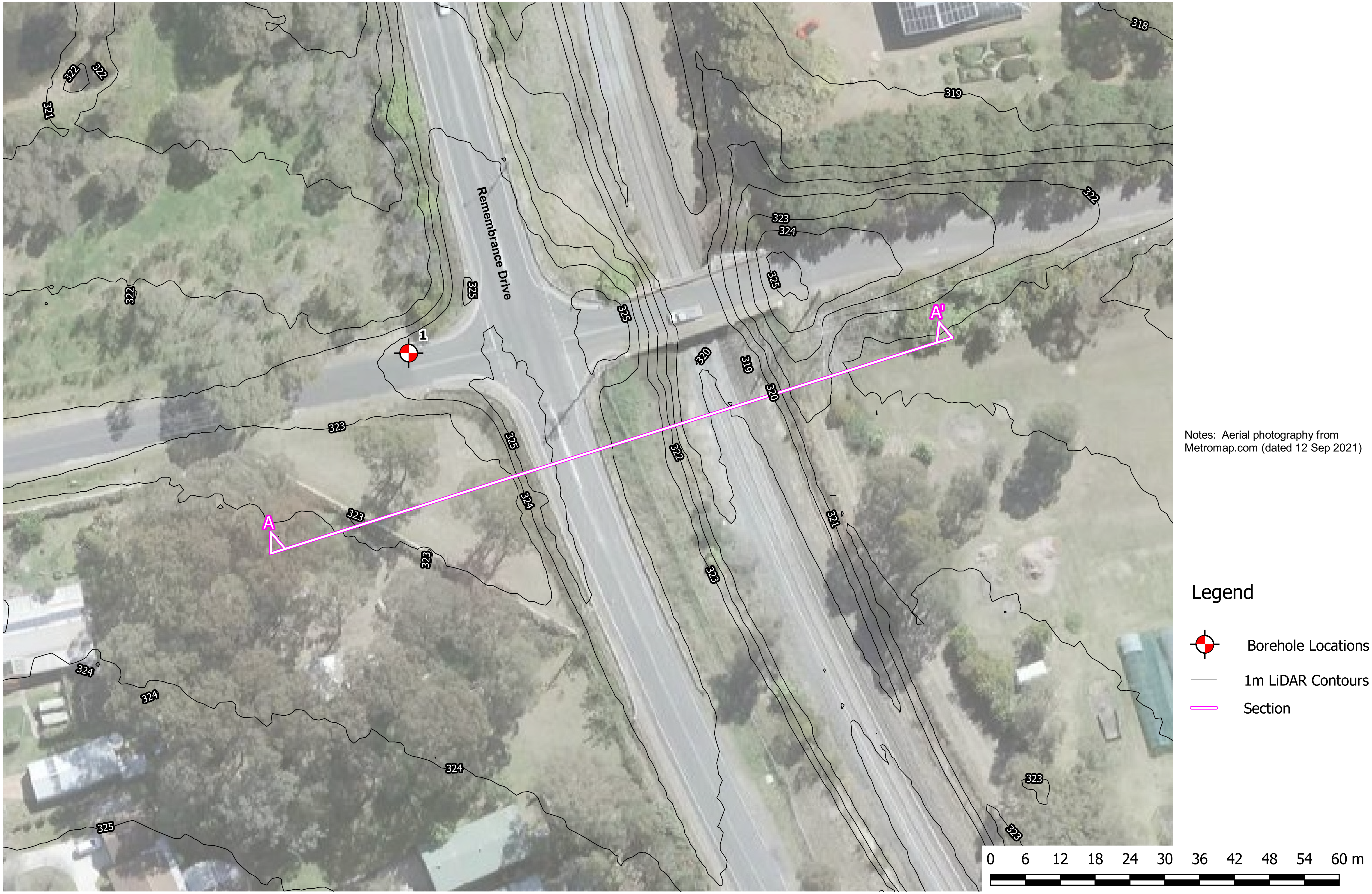
CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	1:15,000 @ A3	DATE:	30 Nov 2021

TITLE: **Test Locations**
Stability Assessment
Remembrance Drive, Bargo

N

PROJECT No:	210597.02
DRAWING No:	1
REVISION:	0



Notes: Aerial photography from Metromap.com (dated 12 Sep 2021)

Legend

- Borehole Locations
- 1m LiDAR Contours
- Section

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	1:600 @ A3	DATE:	27 Jun 2022

TITLE: **Test Locations**
Stability Assessment
Remembrance Drive, Bargo

N

PROJECT No:	210597.02
DRAWING No:	2
REVISION:	0

Notes: Aerial photography from Metromap.com (dated 12 Sep 2021)

Legend

- 🔴 Borehole Locations
- — 1m LiDAR Contours
- ▭ Section

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	1:600 @ A3	DATE:	27 Jun 2022

TITLE: **Test Locations**
Stability Assessment
Remembrance Drive, Bargo

PROJECT No:	210597.02
DRAWING No:	3
REVISION:	0

Notes: Aerial photography from Metromap.com (dated 12 Sep 2021)

Legend

⊕	Borehole Locations
—	1m LiDAR Contours
▭	Section

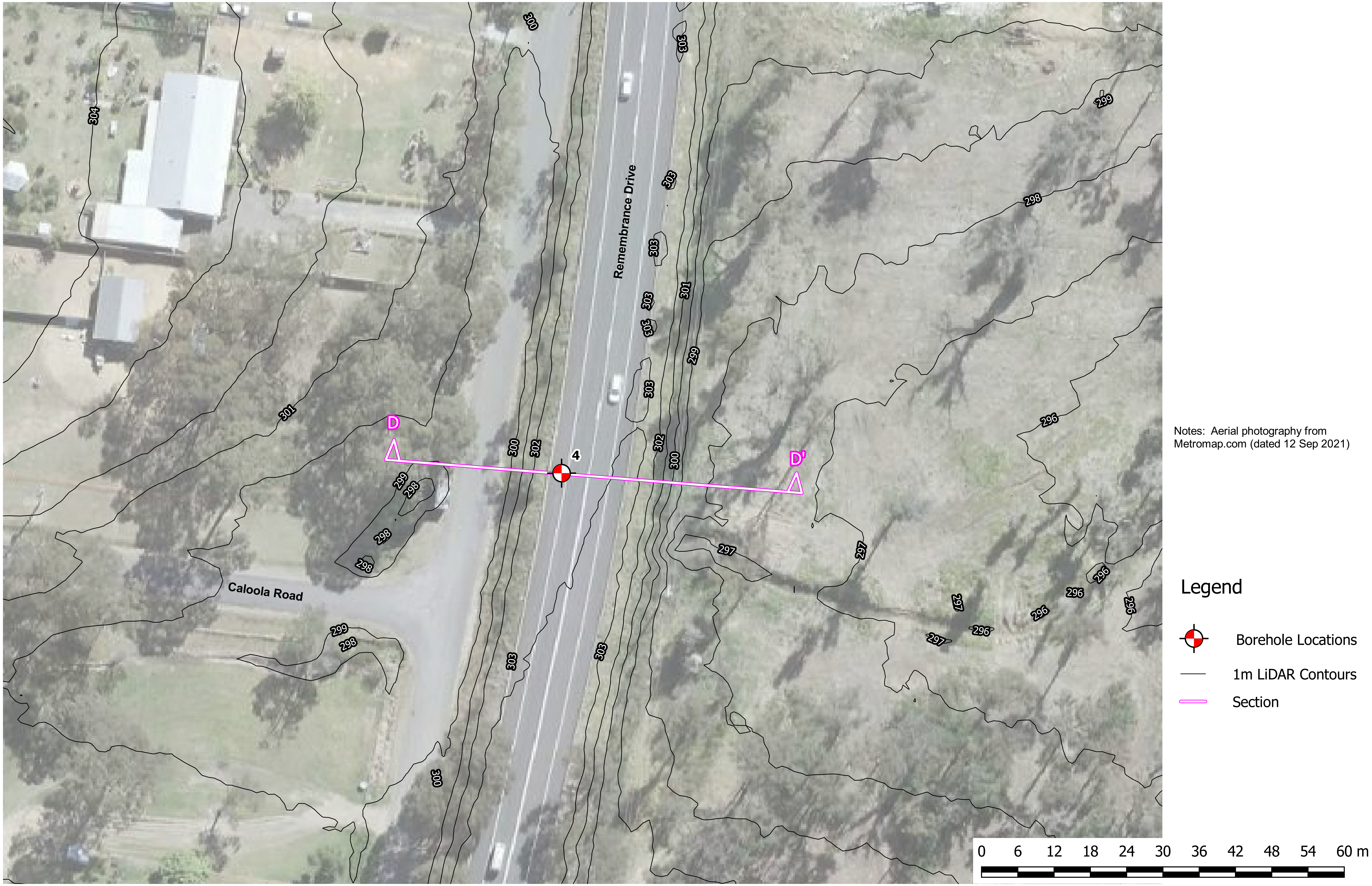
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	1:600 @ A3	DATE:	27 Jun 2022

TITLE: **Test Locations**
Stability Assessment
Remembrance Drive, Bargo

N

PROJECT No:	210597.02
DRAWING No:	5
REVISION:	0



Notes: Aerial photography from Metromap.com (dated 12 Sep 2021)

Legend

⊕	Borehole Locations
—	1m LiDAR Contours
▭	Section

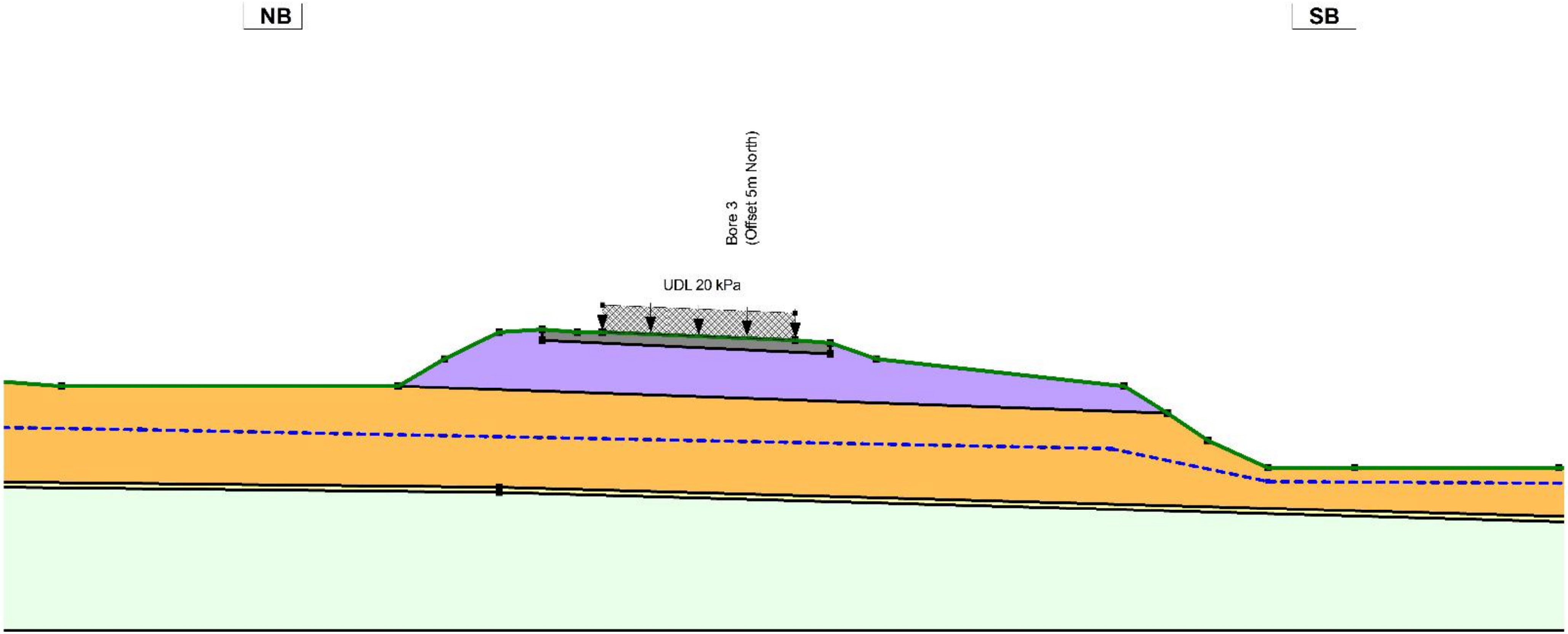
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Tahmoor Coal Pty Ltd		
OFFICE:	Wollongong	DRAWN BY:	RJH
SCALE:	1:600 @ A3	DATE:	27 Jun 2022

TITLE: **Test Locations**
Stability Assessment
Remembrance Drive, Bargo

N

PROJECT No:	210597.02
DRAWING No:	5
REVISION:	0



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

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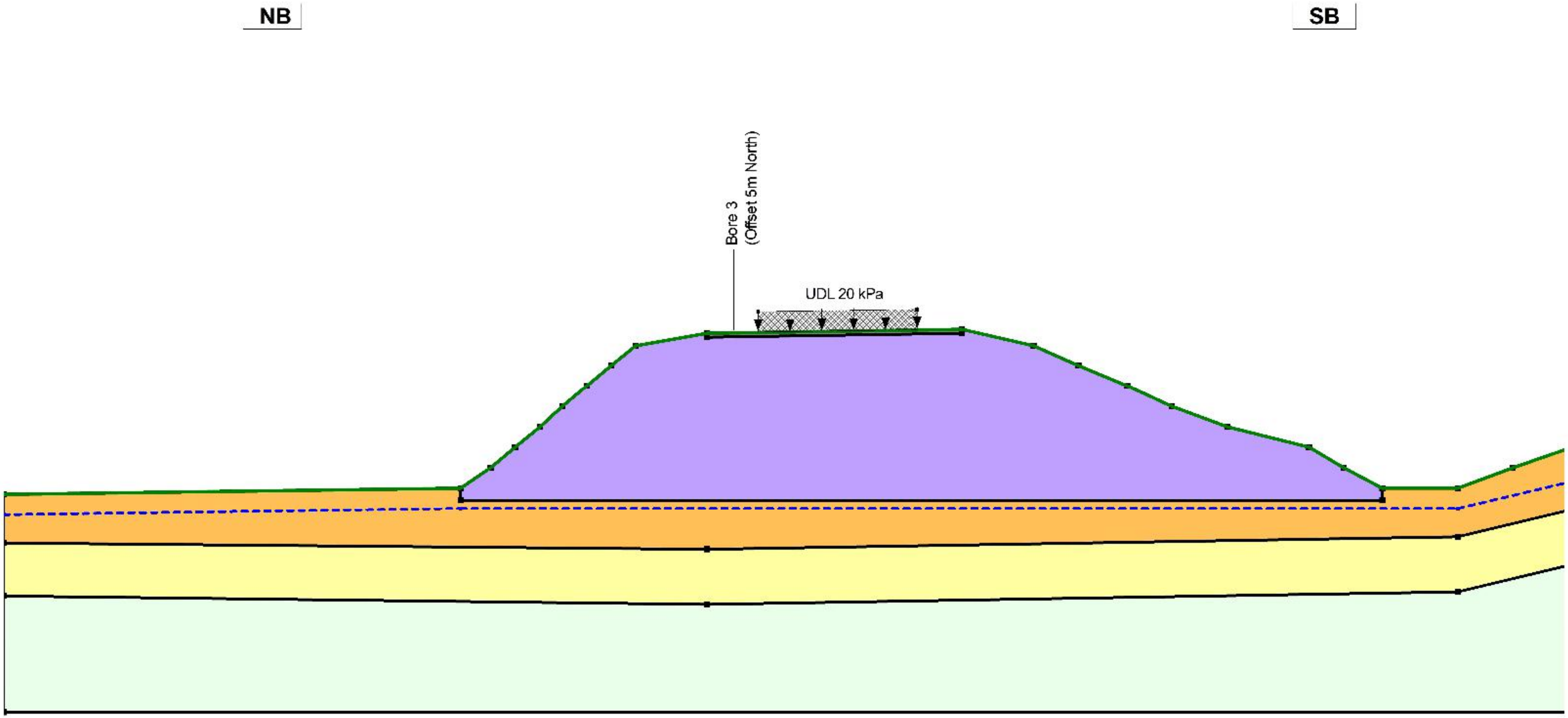
CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:150 @ A3 DATE: 16 Aug 2022

TITLE: **Model - Section A - A'**
Detailed Stability Assessment (Embankment RE1)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 6
REVISION: 0



Color	Name	Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	27	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
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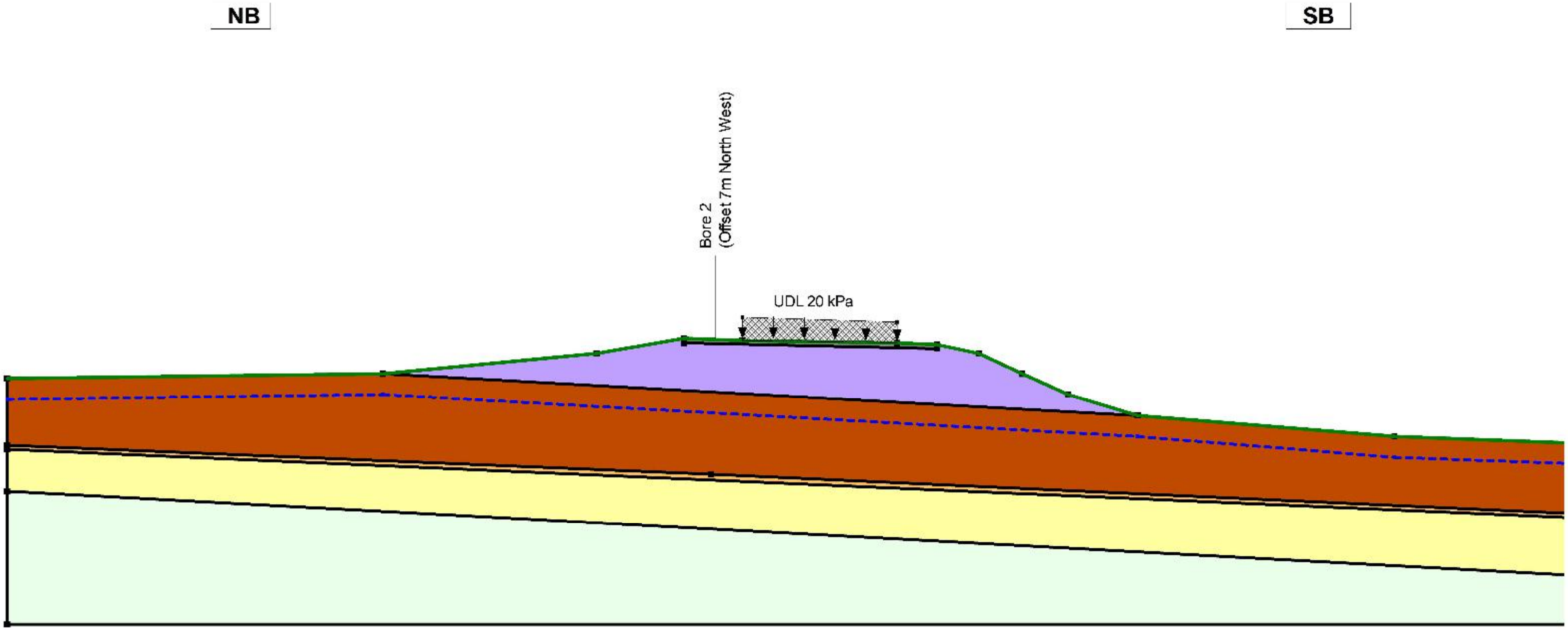
CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:200 @ A3
DATE: 16 Aug 2022

TITLE: **Model - Section B - B'**
Detailed Stability Assessment (Embankment RE2)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 7
REVISION: 0



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟫	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
⬜	7. BEDROCK: M-H	High Strength	24				1

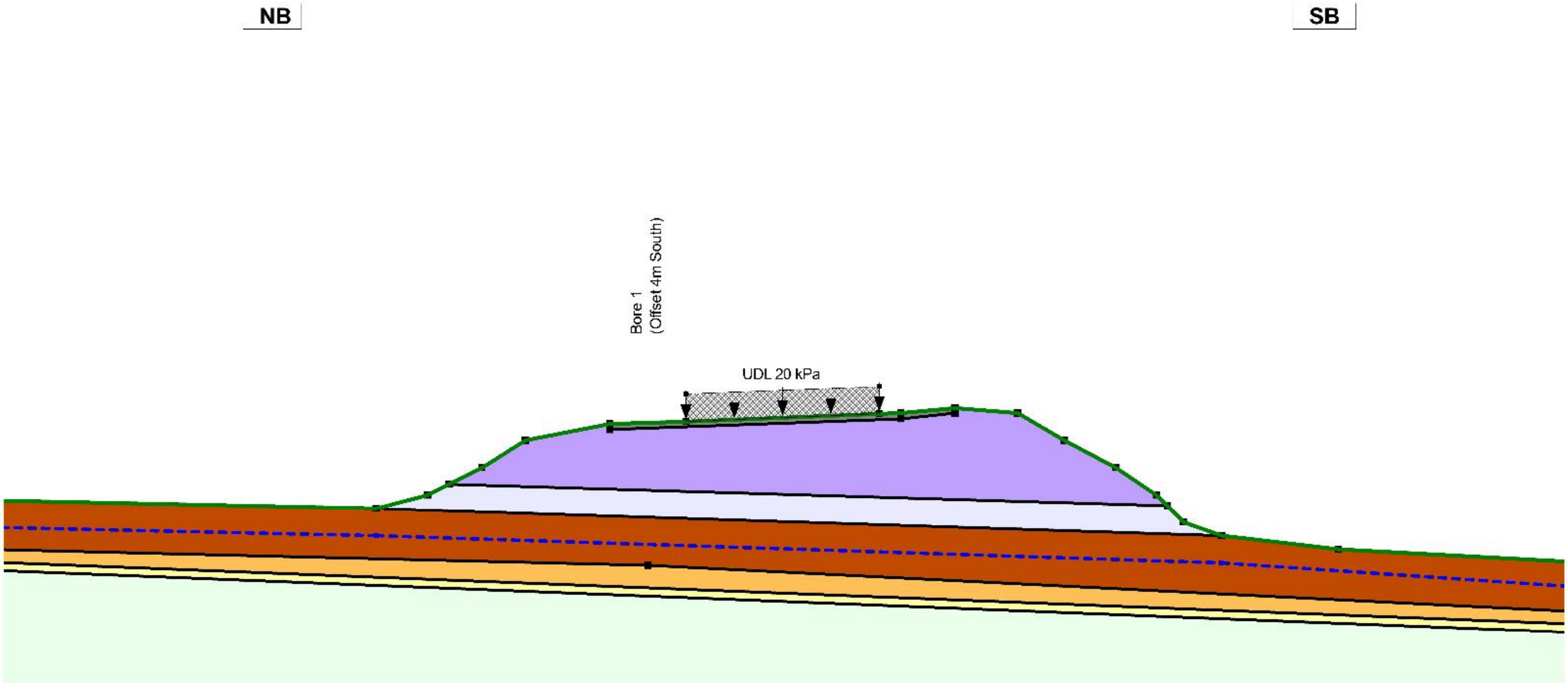
Notes: 1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 0.8m above the level recorded during the investigation)

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:200 @ A3
DATE: 16 Aug 2022

TITLE: **Model - Section C - C'**
Detailed Stability Assessment (Embankment RE3)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 8
REVISION: 0



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	1.5	26	0	1
⬜	3. EMBANKMENT FILL (Crushed Sandstone)	Mohr-Coulomb	20	0	33	0	1
🟫	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

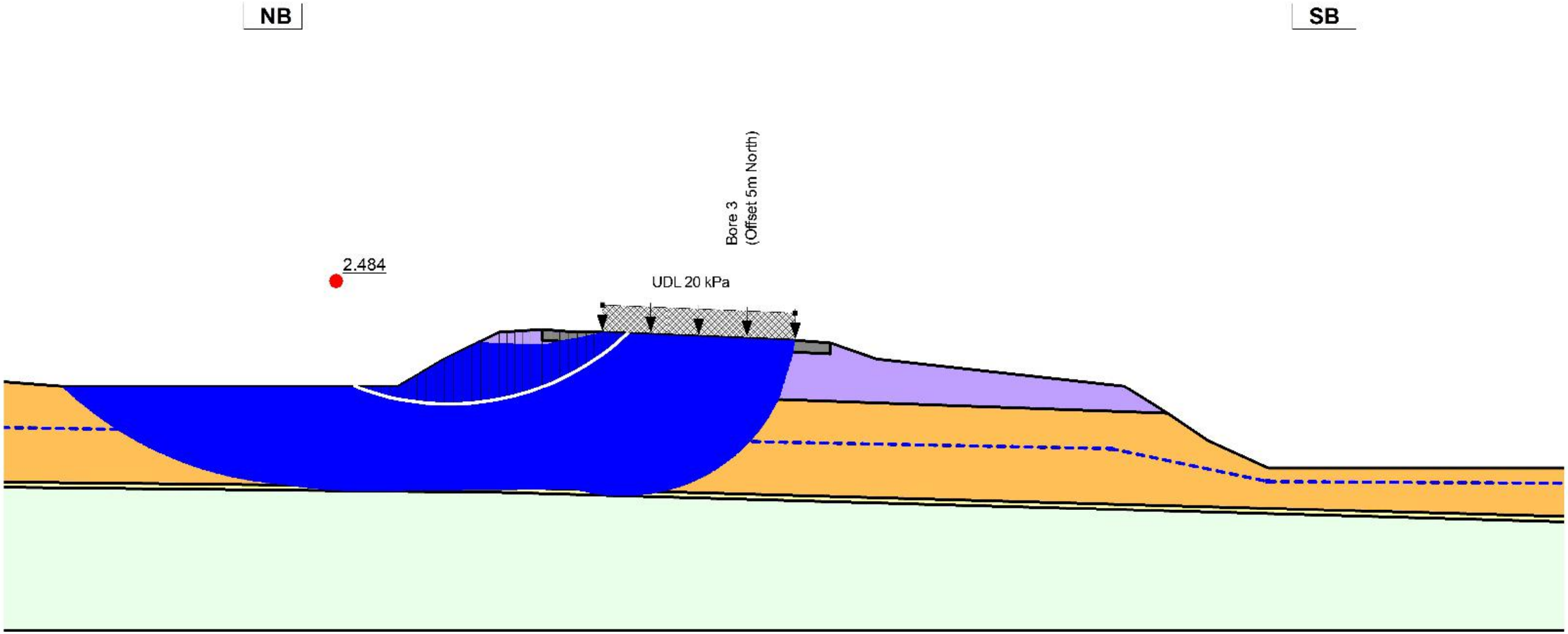
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:150 @ A3
DATE: 16 Aug 2022

TITLE: **Model - Section D - D'**
Detailed Stability Assessment (Embankment RE4)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 9
REVISION: 0



Color	Name	Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

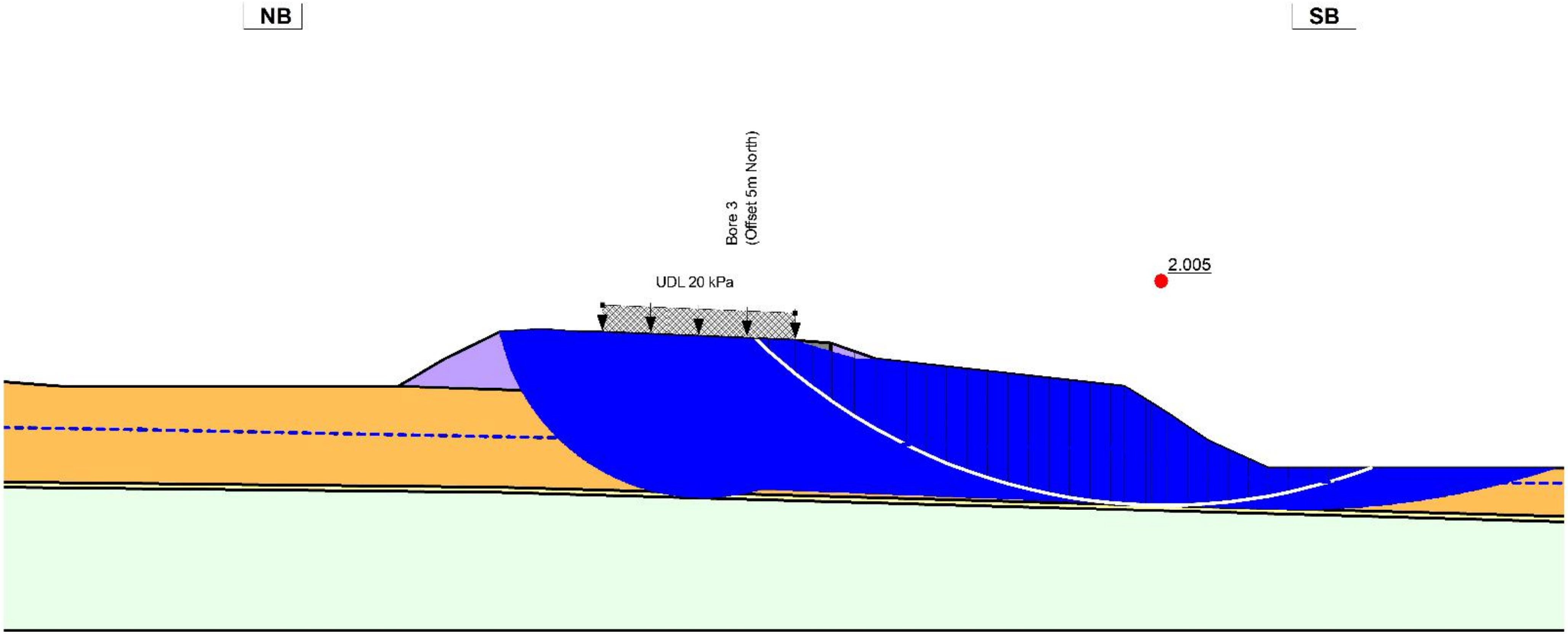
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:150 @ A3 DATE: 16 Aug 2022

TITLE: **1% AEP Flood, North Bound Lane, Section A - A'**
Detailed Stability Assessment (Embankment RE1)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 10
REVISION: 0



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

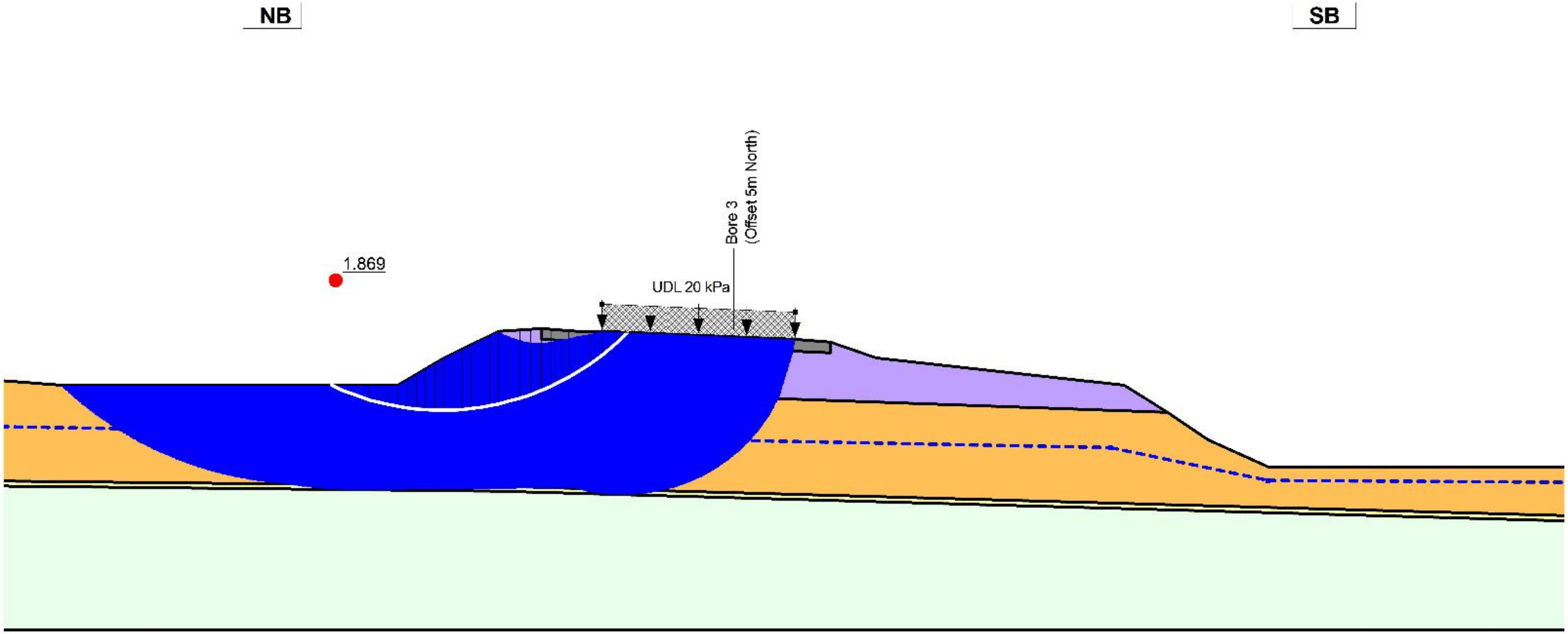
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:150 @ A3 DATE: 16 Aug 2022

TITLE: **1% AEP Flood, South Bound Lane, Section A - A'**
Detailed Stability Assessment (Embankment RE1)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 11
REVISION: 0



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

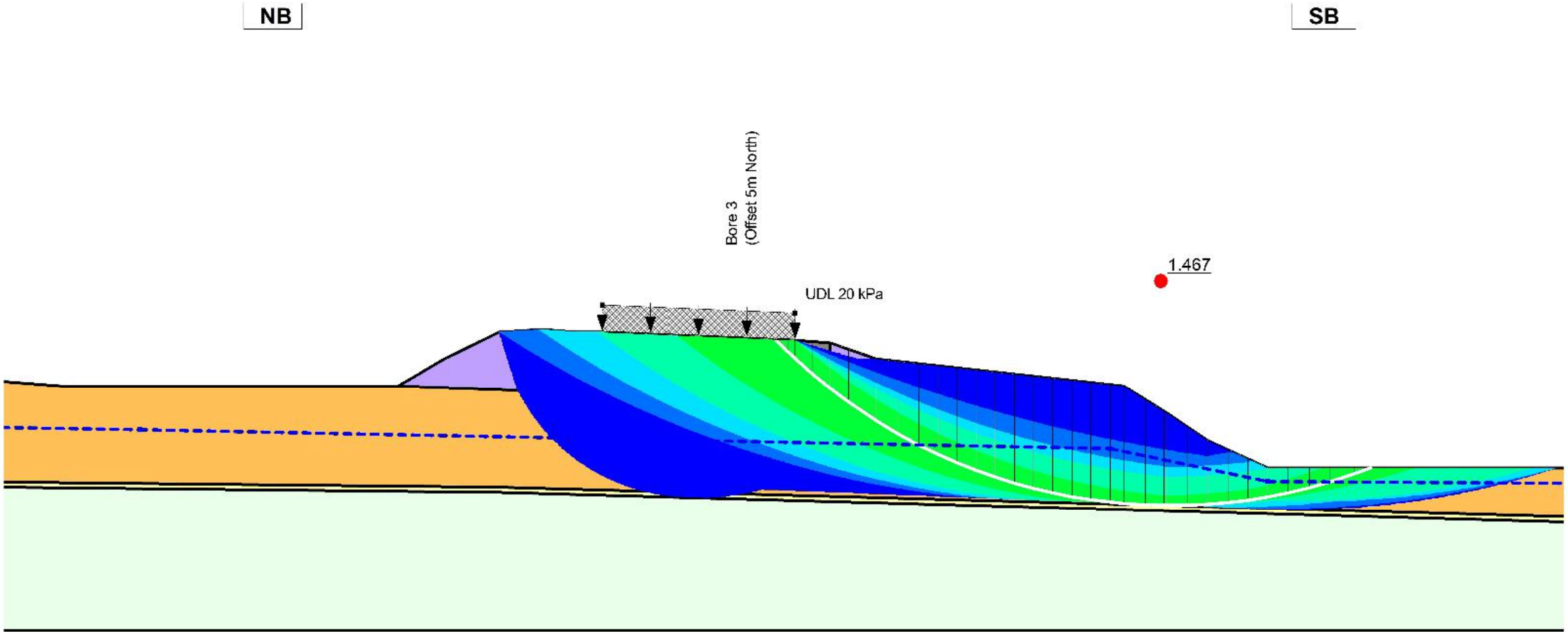
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:150 @ A3
DATE: 16 Aug 2022

TITLE: **Earthquake, North Bound Lane, Section A - A'**
Detailed Stability Assessment (Embankment RE1)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 12
REVISION: 0



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

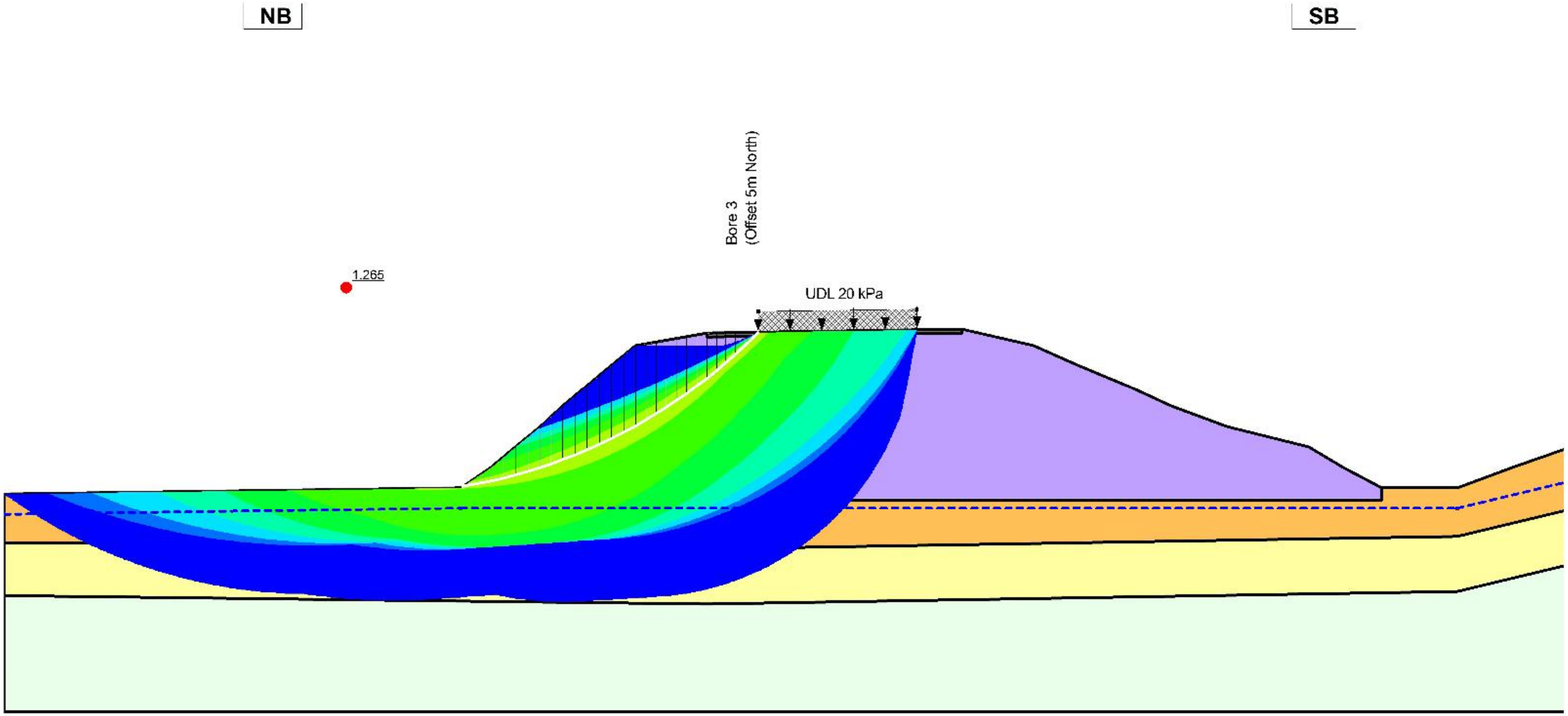
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:150 @ A3 DATE: 16 Aug 2022

TITLE: **Earthquake, South Bound Lane, Section A - A'**
Detailed Stability Assessment (Embankment RE1)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 13
REVISION: 0



Factor of Safety
- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	27	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

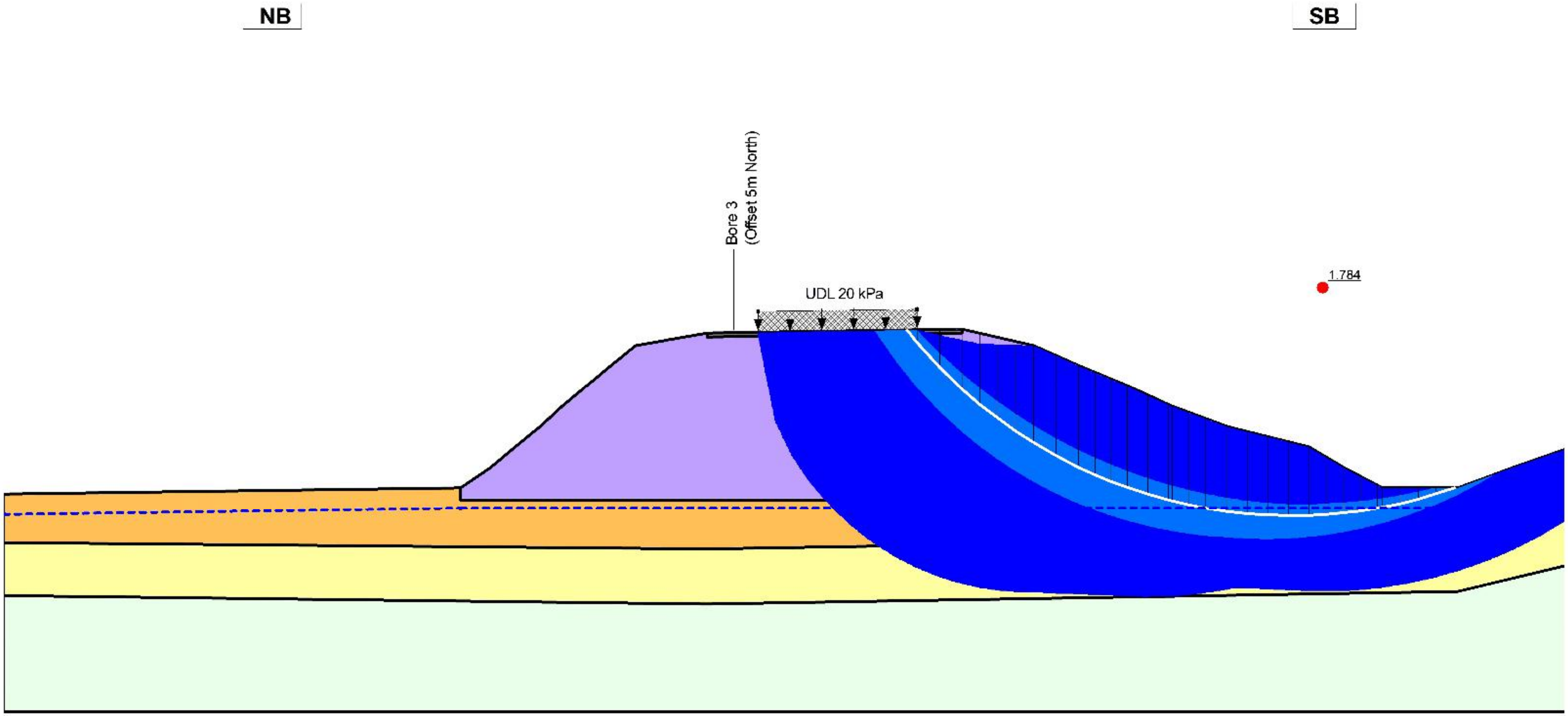
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:200 @ A3 DATE: 16 Aug 2022

TITLE: **1% AEP Flood, North Bound Lane, Section B - B'**
Detailed Stability Assessment (Embankment RE2)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 14
REVISION: 0



Factor of Safety
🟥 ≤ 0.900 - 1.000
🟧 1.000 - 1.100
🟨 1.100 - 1.200
🟩 1.200 - 1.300
🟩 1.300 - 1.400
🟩 1.400 - 1.500
🟩 1.500 - 1.600
🟦 1.600 - 1.700
🟦 1.700 - 1.800
🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

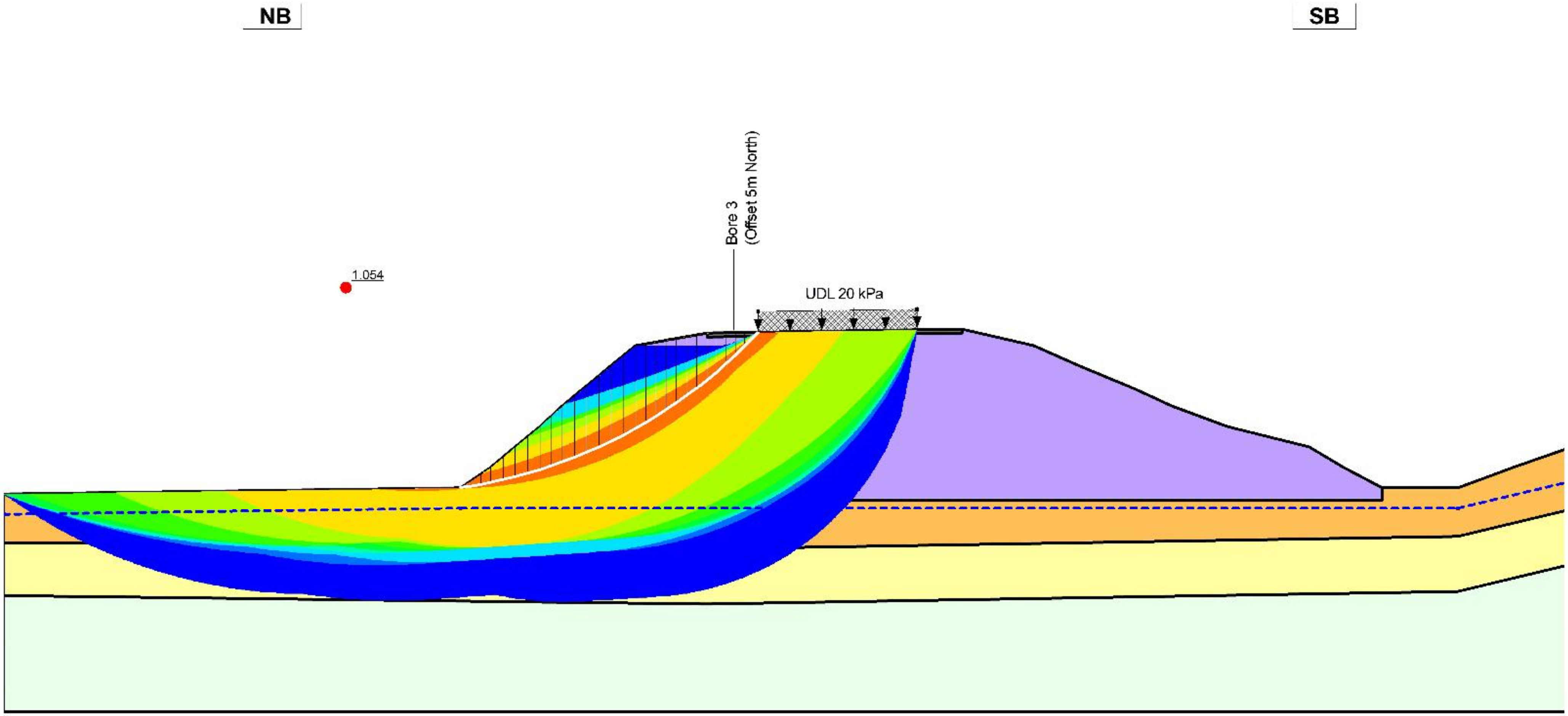
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:200 @ A3
DATE: 16 Aug 2022

TITLE: **1% AEP Flood, South Bound Lane, Section B - B'**
Detailed Stability Assessment (Embankment RE2)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 15
REVISION: 0



Factor of Safety	
🟥	≤ 0.900 - 1.000
🟧	1.000 - 1.100
🟨	1.100 - 1.200
🟩	1.200 - 1.300
🟩	1.300 - 1.400
🟩	1.400 - 1.500
🟩	1.500 - 1.600
🟦	1.600 - 1.700
🟦	1.700 - 1.800
🟦	≥ 1.800

Color	Name	Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	27	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

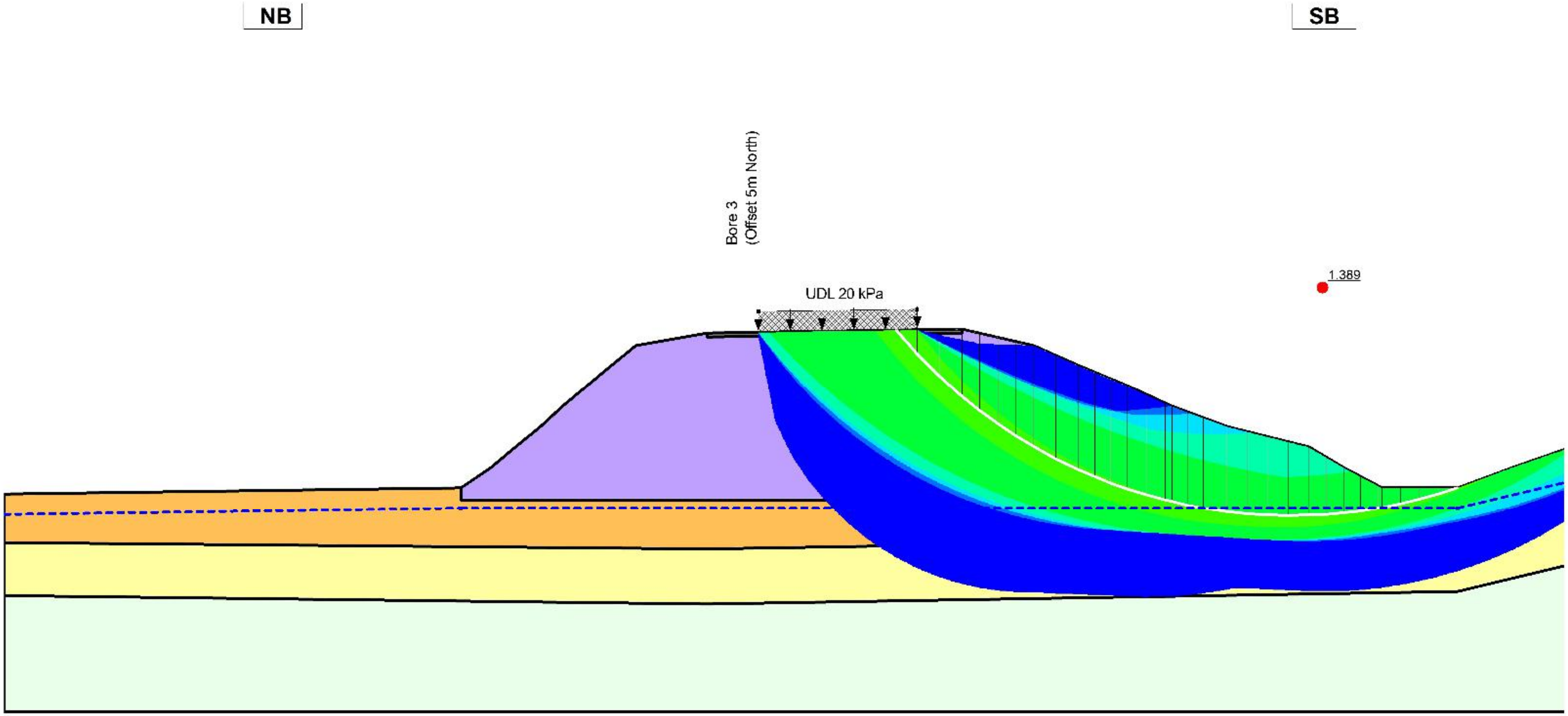
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:200 @ A3
DATE: 16 Aug 2022

TITLE: **Earthquake, North Bound Lane, Section B - B'**
Detailed Stability Assessment (Embankment RE2)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 16
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

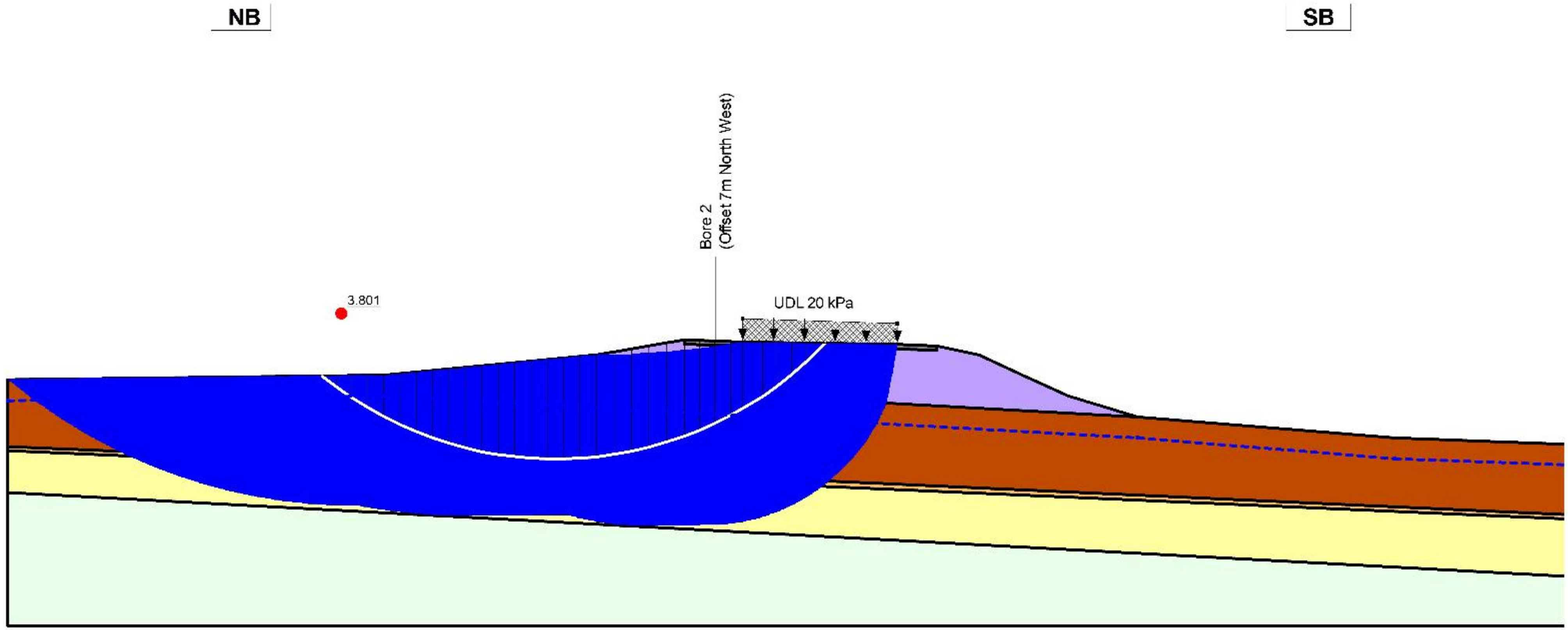
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:200 @ A3
DATE: 16 Aug 2022

TITLE: **Earthquake, South Bound Lane, Section B - B'**
Detailed Stability Assessment (Embankment RE2)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 17
REVISION: 0



Factor of Safety
🟥 ≤ 0.900 - 1.000
🟧 1.000 - 1.100
🟨 1.100 - 1.200
🟩 1.200 - 1.300
🟩 1.300 - 1.400
🟩 1.400 - 1.500
🟩 1.500 - 1.600
🟦 1.600 - 1.700
🟦 1.700 - 1.800
🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
🟫	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

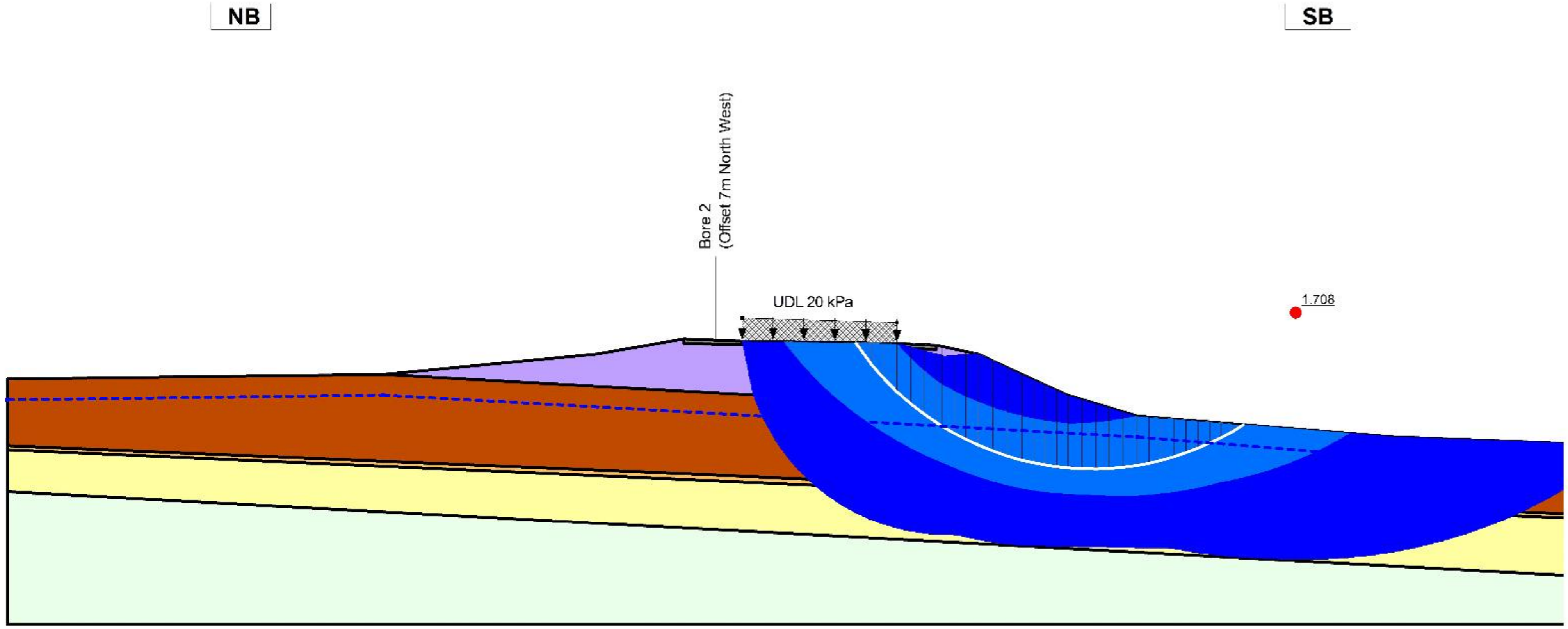
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 0.8m above the level recorded during the investigation)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
SCALE: 1:200 @ A3
DRAWN BY: RJH
DATE: 16 Aug 2022

TITLE: **1% AEP Flood, North Bound Lane, Section C - C'**
Detailed Stability Assessment (Embankment RE3)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 18
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
■	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
■	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
■	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
■	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
□	7. BEDROCK: M-H	High Strength	24				1

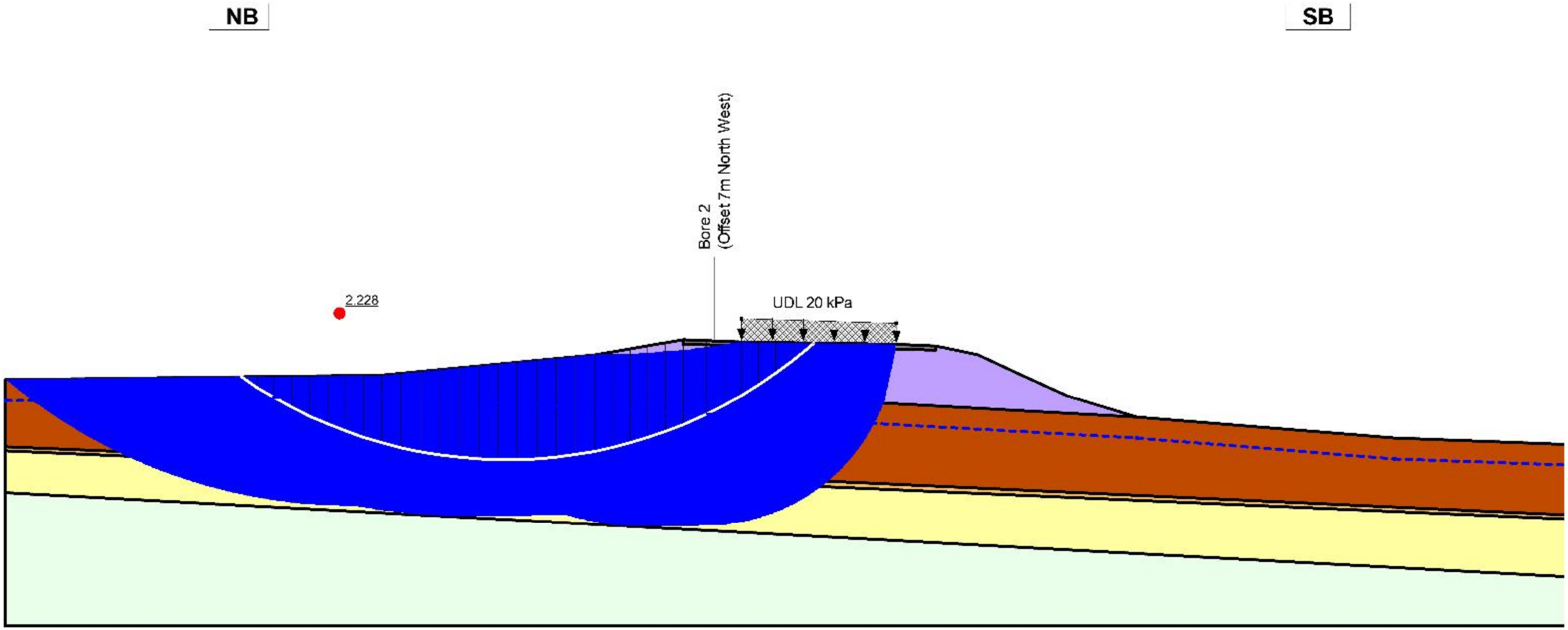
Notes: 1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 0.8m above the level recorded during the investigation)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:200 @ A3 DATE: 16 Aug 2022

TITLE: **1% AEP Flood, South Bound Lane, Section C - C'**
Detailed Stability Assessment (Embankment RE3)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 19
REVISION: 0



Factor of Safety
🟥 ≤ 0.900 - 1.000
🟧 1.000 - 1.100
🟨 1.100 - 1.200
🟩 1.200 - 1.300
🟩 1.300 - 1.400
🟩 1.400 - 1.500
🟩 1.500 - 1.600
🟦 1.600 - 1.700
🟦 1.700 - 1.800
🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
■	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
■	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
■	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
■	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
□	7. BEDROCK: M-H	High Strength	24				1

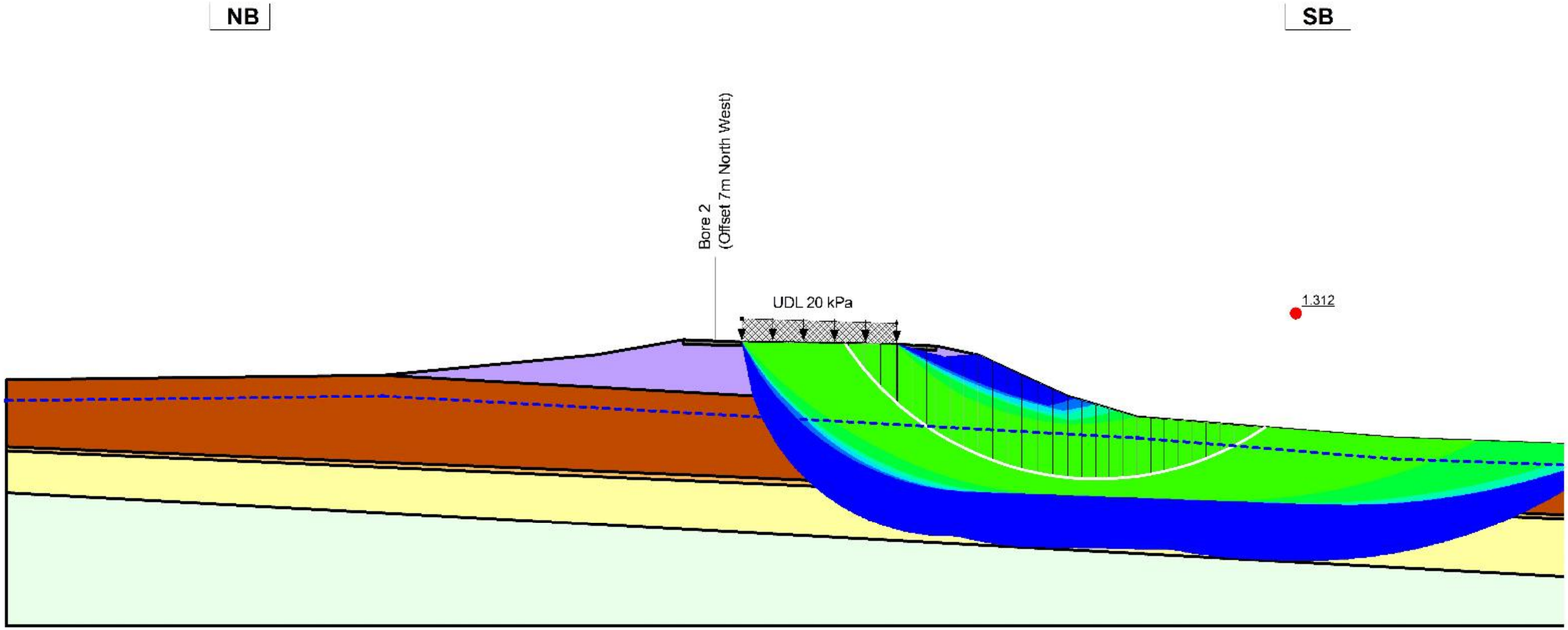
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 0.8m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:200 @ A3
DATE: 16 Aug 2022

TITLE: **Earthquake, North Bound Lane, Section C - C'**
Detailed Stability Assessment (Embankment RE3)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 20
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
■	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	5	26	0	1
■	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
■	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
■	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
■	7. BEDROCK: M-H	High Strength	24				1

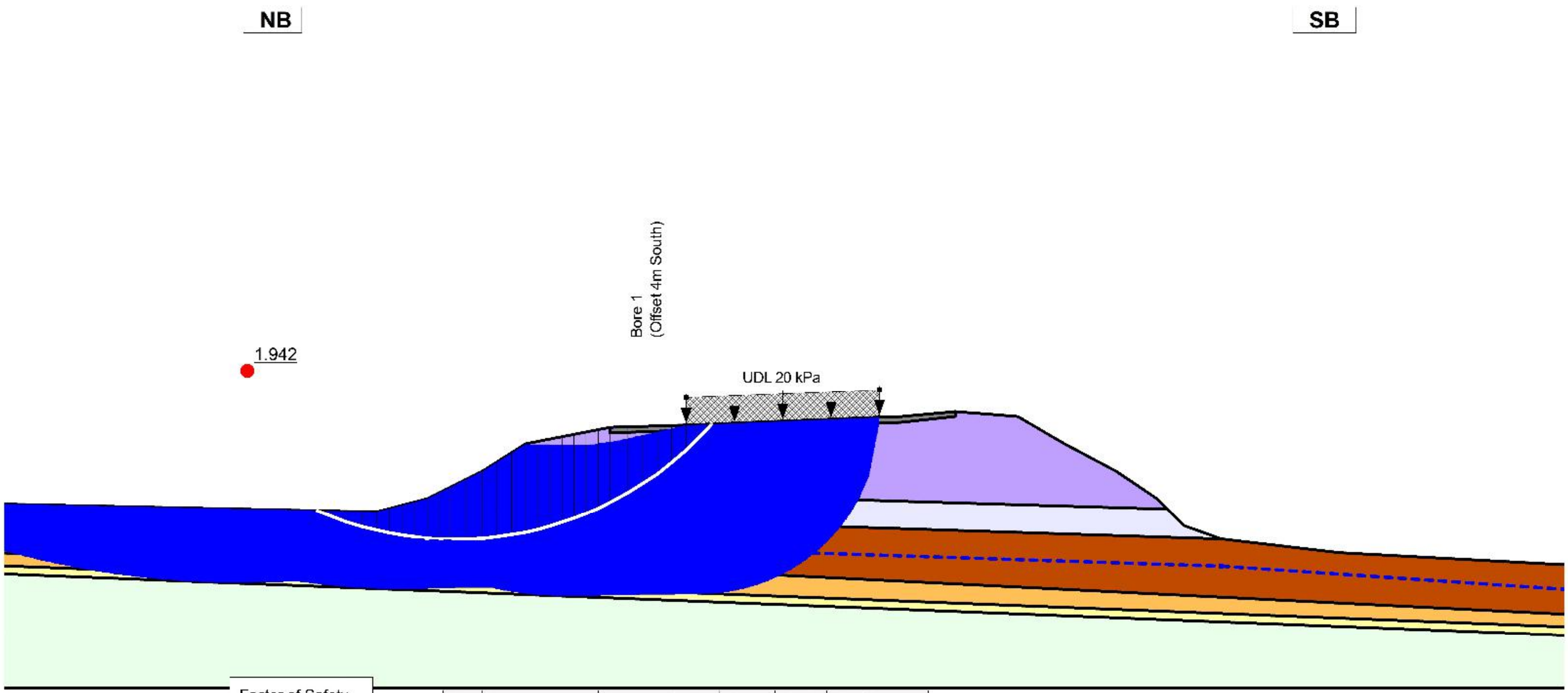
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 0.8m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:200 @ A3 DATE: 16 Aug 2022

TITLE: **Earthquake, South Bound Lane, Section C - C'**
Detailed Stability Assessment (Embankment RE3)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 21
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
■	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
■	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	1.5	26	0	1
□	3. EMBANKMENT FILL (Crushed Sandstone)	Mohr-Coulomb	20	0	33	0	1
■	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
■	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
■	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
□	7. BEDROCK: M-H	High Strength	24				1

Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

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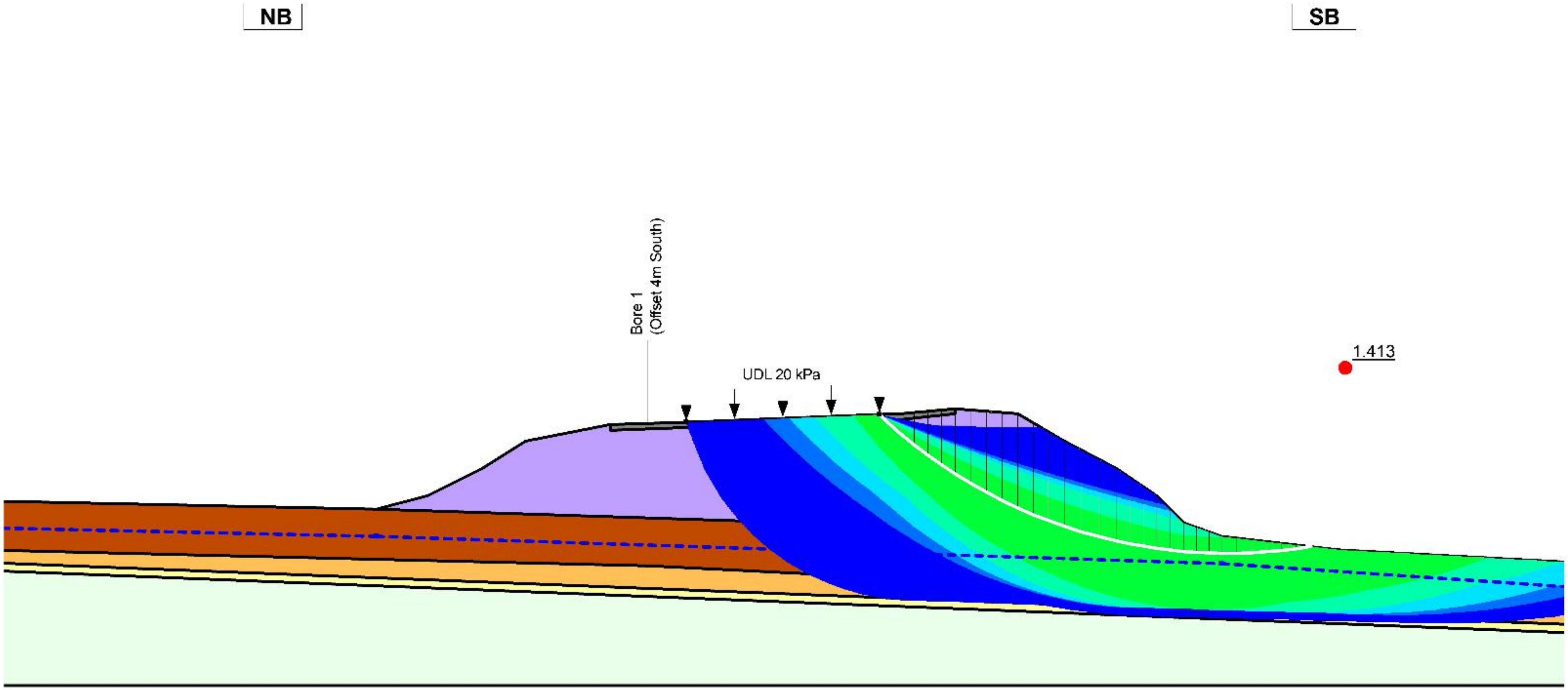
CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:150 @ A3
DATE: 16 Aug 2022

TITLE: **1% AEP Flood, North Bound Lane, Section D - D'**
Detailed Stability Assessment (Embankment RE4)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 22
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	1.5	26	0	1
🟫	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
⬜	7. BEDROCK: M-H	High Strength	24				1

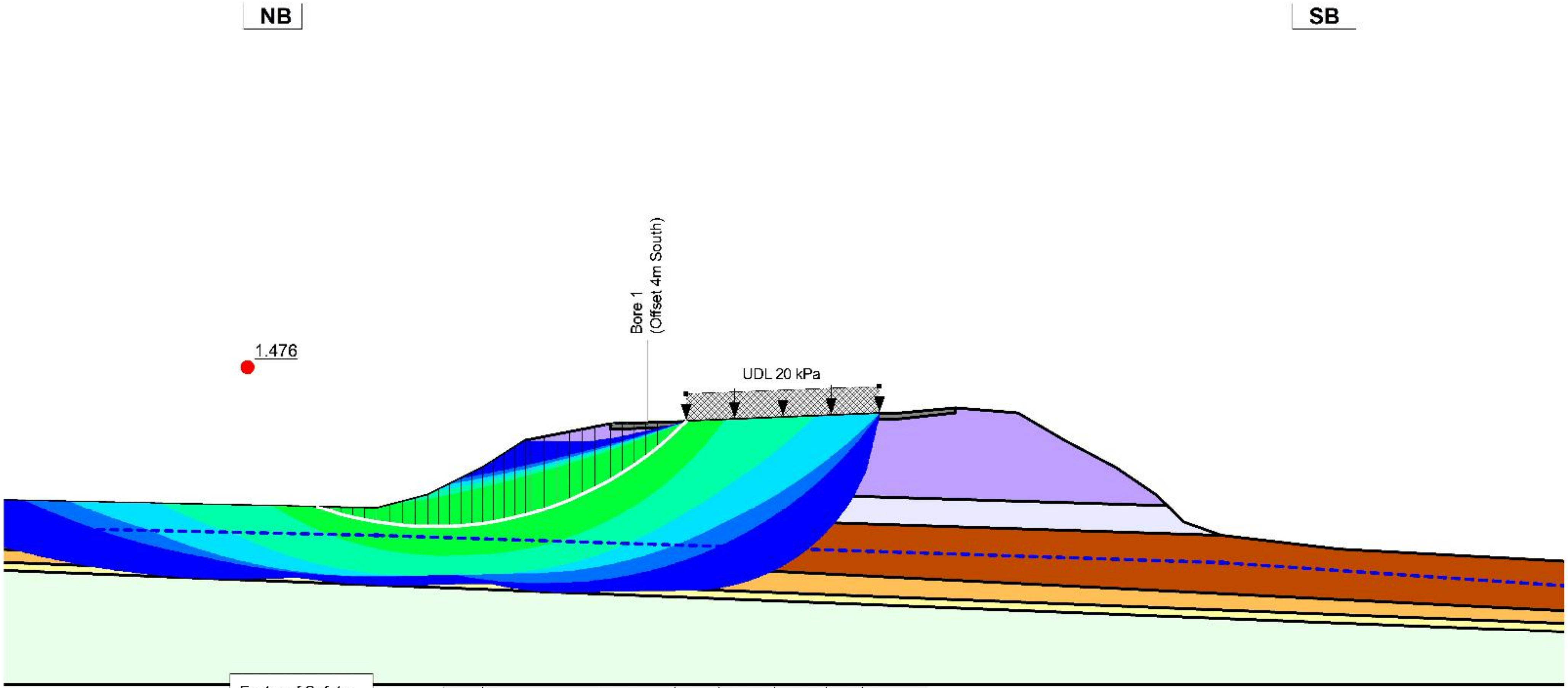
Notes: 1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:200 @ A3 DATE: 16 Aug 2022

TITLE: **1% AEP Flood, South Bound Lane, Section D - D'**
Detailed Stability Assessment (Embankment RE4)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 23
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	1.5	26	0	1
⬜	3. EMBANKMENT FILL (Crushed Sandstone)	Mohr-Coulomb	20	0	33	0	1
🟫	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
🟩	7. BEDROCK: M-H	High Strength	24				1

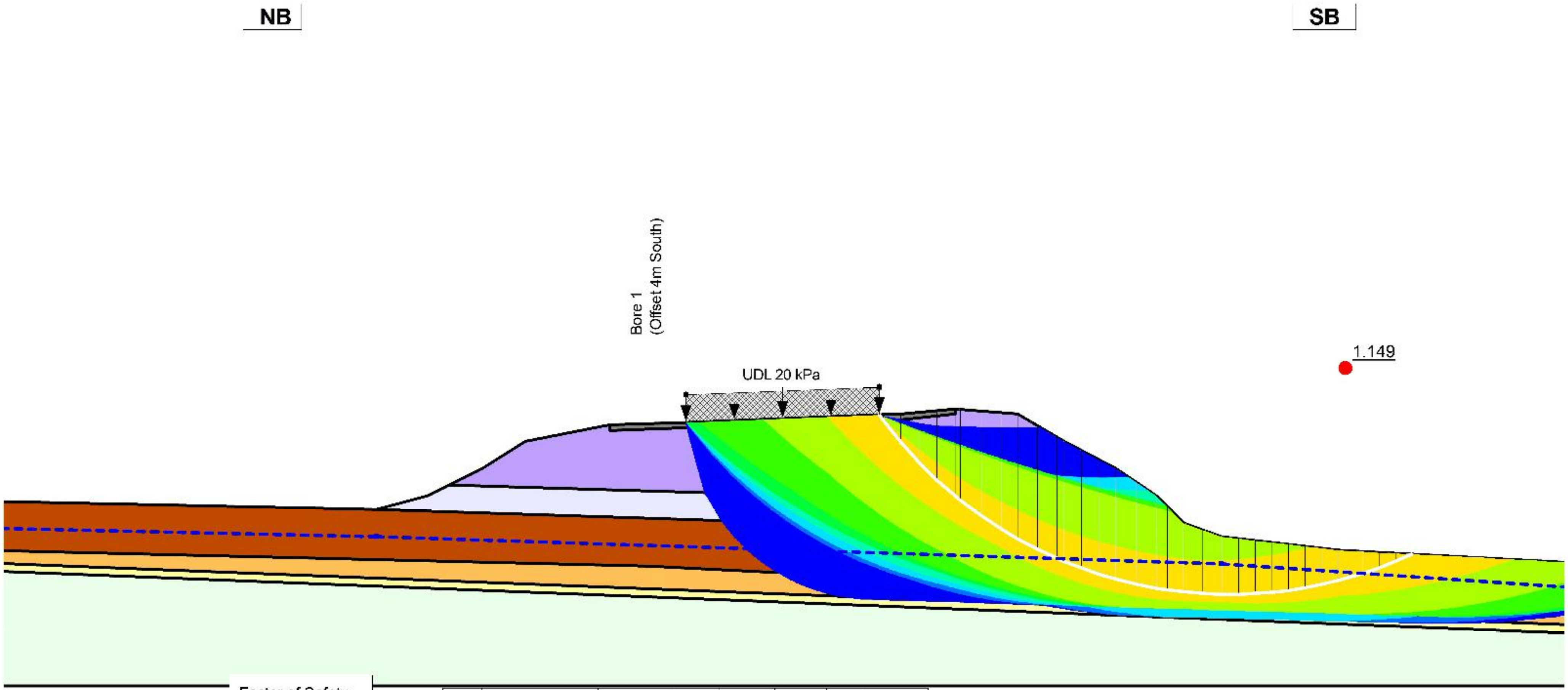
Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong DRAWN BY: RJH
SCALE: 1:150 @ A3 DATE: 16 Aug 2022

TITLE: **Earthquake, North Bound Lane, Section D - D'**
Detailed Stability Assessment (Embankment RE4)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 24
REVISION: 0



Factor of Safety

- 🟥 ≤ 0.900 - 1.000
- 🟧 1.000 - 1.100
- 🟨 1.100 - 1.200
- 🟩 1.200 - 1.300
- 🟩 1.300 - 1.400
- 🟩 1.400 - 1.500
- 🟩 1.500 - 1.600
- 🟦 1.600 - 1.700
- 🟦 1.700 - 1.800
- 🟦 ≥ 1.800

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
⬛	1. PAVEMENT	Mohr-Coulomb	22	0	40	0	1
🟪	2. EMBANKMENT FILL (CLAY)	Mohr-Coulomb	20	1.5	26	0	1
⬜	3. EMBANKMENT FILL (Crushed Sandstone)	Mohr Coulomb	20	0	33	0	1
🟫	4. ALLUVIAL CLAY	Mohr-Coulomb	18	0	25	0	1
🟧	5. RESIDUAL CLAY	Mohr-Coulomb	20	2	25	0	1
🟨	6. BEDROCK: VL-M	Mohr-Coulomb	24	20	35	0	1
⬜	7. BEDROCK: M-H	High Strength	24				1

Notes:
1) Stability analysis carried out using the Morgensterm-Price Method
2) Phreatic surface 1m below the natural ground surface (ie 1m above the level recorded during the investigation)
3) Horizontal seismic coefficient of 0.09

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Tahmoor Coal Pty Ltd
OFFICE: Wollongong
DRAWN BY: RJH
SCALE: 1:150 @ A3
DATE: 16 Aug 2022

TITLE: **Earthquake, South Bound Lane, Section D - D'**
Detailed Stability Assessment (Embankment RE4)
Remembrance Drive, Bargo

PROJECT No: 210597.02
DRAWING No: 25
REVISION: 0