Central Queensland Coal Project

Appendix 4b – Geotechnical Assessment

Central Queensland Coal

CQC SEIS, Version 3

October 2020

Detailed Geotechnical Assessment and Stability Report

Central Queensland Coal Project

M30863

Prepared for
Waratah Coal

25 August 2020

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Our report is based on information made available by the client. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Cardno is both complete and accurate. Whilst, to the best of our knowledge, the information contained in this report is accurate at the date of issue, changes may occur to the site conditions, the site context or the applicable planning framework. This report should not be used after any such changes without consulting the provider of the report or a suitably qualified person.

Executive Summary

This report presents a study on the feasibility of open cut mining operations on the north eastern side of the Bruce Highway. Measures will be taken to ensure the safety of the road users and to avoid damage to road assets. The study area is located approximately 25 km northwest of Marlborough, Central Queensland.

This report does not constitute a pit design.

Project Details

The proposed development comprises the opening of a pit wall parallel to the highway on the north-eastern side (Pit 2) with a pit wall length of approximately 3.5 km. The maximum depth of the portions of the pit near the highway is approximately 150m.

It is understood that initial mining operations will begin further from the highway from Years 1 to 10 with excavations 500m from the highway and with planned operations adjacent to the highway not proceeding until 2032-2033.

The pit will be backfilled with spoil once the coal has been extracted.

Overburden (surficial soils and weathered rock) will be excavated using standard earthmoving plant with a batter slope of 1H:1V. Rock cuts will be excavated with 45m deep batters and 10m berms with appropriate blasting techniques including pre-splitting and vibration monitoring to reduce disturbance.

Geotechnical Information

Geotechnical information is based on two cored boreholes advanced to full pit depth adjacent to the highway. These holes were logged by a Cardno engineering geologist and sampled extensively for laboratory testing. Additional shallow boreholes were drilled for in situ permeability testing.

A comprehensive laboratory testing programme was carried out to provide rock strength and deformation parameters for slope stability and finite element deformation analysis. Hoek-Brown procedures were used to determine rock strength parameters.

This information was supplemented and compared with earlier strength data derived from coal exploration boreholes and down-hole geophysical testing AMEC (2018).

Geotechnical Analysis Slope Stability

Slope stability analyses were undertaken using GeoStudio software. This software package is preferred by DTMR and availability and expertise with package is a requirement for GE2 and GE3 certification. Two basic slope stability models were constructed using stratigraphy derived from the cored boreholes and down-hole ATV investigation.

The analyses produced the following results using probable lower bound strength values

- Factors of safety in excess of 1.5 for circular failure surfaces provided that blasting damage is minimised
- Factors of safety in excess of 1.4 for planar failure surfaces provided that blasting damage is minimised
- Seismic stability is not critical
- 3D wedge failures not analysed but not considered plausible; and
- Analyses were done with pore pressure coefficient (Ru) = 0.15 as per DTMR requirements (this is considered to be conservative).

Factors of safety in excess of 1.5 were obtained for all analyses using mean parameters.

Geotechnical Analysis Deformation

Finite element deformation analyses were performed using Plaxis software. This software package is preferred by DTMR and availability and expertise with package is a requirement for GE2 and GE3 certification. Mohr Coulomb modelling was used for overburden and spoil and Hoek-Brown modelling for rock and coal seams.

The analysis showed maximum horizontal and vertical deflections at the highway centreline of 15mm and 5mm respectively for pit edges 100m from the highway with safety berms as per the proposed pit design. These results indicate that horizontal movement and settlement of the highway alignment is not likely to be significant.

Construction Recommendations

Careful attention to blasting techniques including pre-splitting and limitation of peak particle velocities with vibration monitoring will be required.

Pits are to be backfilled immediately following completion of coal extraction.

Slope Monitoring

A slope monitoring programme including instrumentation would be required prior to commencement of excavations. This will most likely include installation of inclinometers. Details on instrumentation and geological mapping procedure during the excavation of pits in order to validate the geological model will be presented in future geotechnical assessments.

Conclusions

The desktop study has shown that excavation of coal mining pits on either side of the highway is feasible without disruption to the highway to a maximum depth of 150m with provision of setback and safety berms. Bi-annual Geotechnical assessments will be presented, starting six months from the commencement of the project operations to ensure that there are no impacts of project blasting on the state-controlled road.

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Appendices

Tables

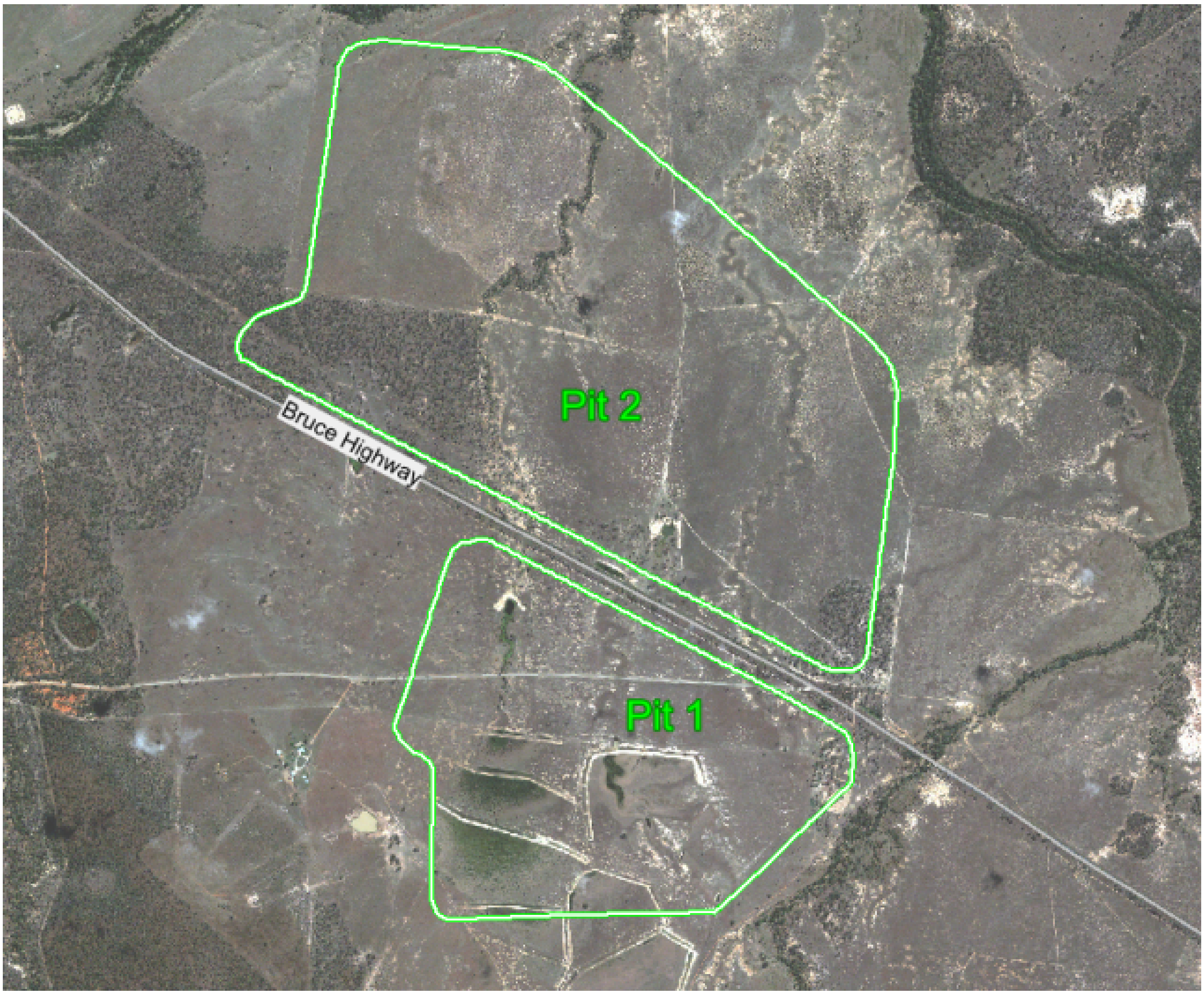
Figures

1 Introduction

1.1 Project Location

This report presents the results of a report on pit stability and likely ground movements associated with proposed mining works approximately 25km northwest of Marlborough, Central Queensland (Refer Figure 1-1). The proposed works comprise the excavation and backfilling of coal mine pits on either side of the Bruce Highway, however, this report is concerned with pit excavations on the northeast side of the highway only.

Figure 1-1 Project Location



1.2 Previous Report

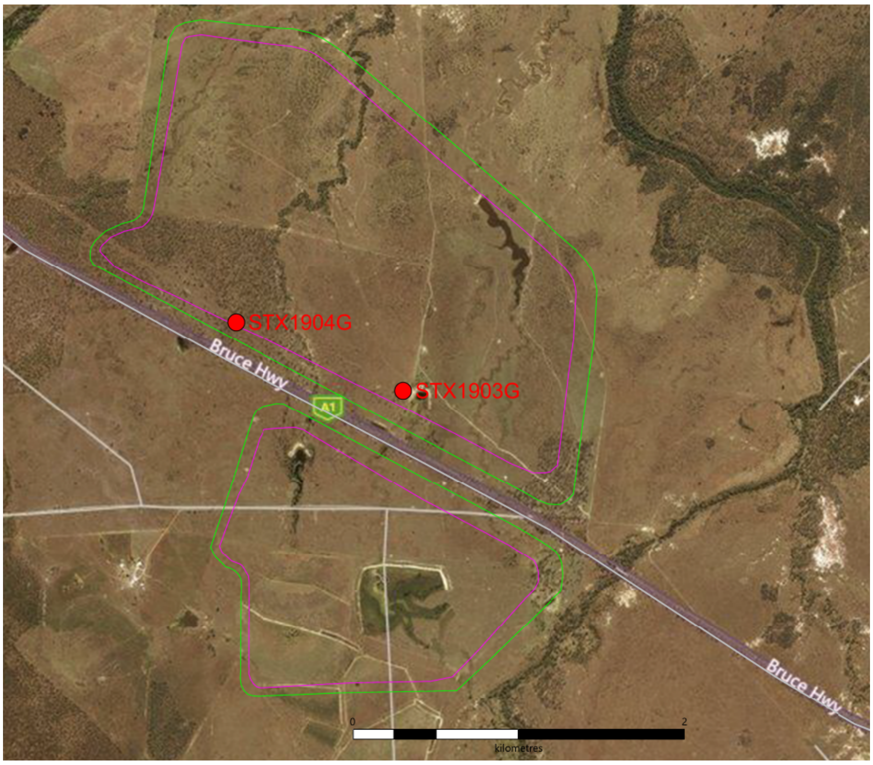
This report was commissioned based on the recommendations of an earlier Cardno report (Refer Appendix A). The stability and deformation analyses presented in the earlier report were based on geotechnical information was largely derived from coal exploration boreholes which were drilled to determine the spatial distribution and quality of coal seams. Selected boreholes were re-logged to provide geotechnical information and these logs together with geological commentary are presented in Appendix B.

1.3 Current Report

This current report is based on geotechnical strength parameters derived from an extensive laboratory testing programme using samples obtained from two new cored boreholes drilled adjacent to the Highway. Details are provided in Section 4.

The location of the boreholes is shown in Figure 1-2.

Figure 1-2 Borehole Locations



Preliminary details of the pits are provided in Section 2.

The information used in the preparation of this report is summarised in Section 3.

Geotechnical Conditions are described in Section 4.

Slope stability and deformation modelling are described in Sections 5 and 6.

Recommendations on construction sequencing are provided in Section 7.

2 Pit Configuration

The draft pit designs comprise:

- Box cut in overburden 1H:1V
- Rock excavation with 0.5H:1V cut slopes and 10m berms at maximum 45 m intervals.

Rock slopes along the road alignment are to be excavated using pre-splitting techniques. The configuration was adopted based on likely available drilling equipment and the requirement to minimise ground disturbance. Slope stability and deformation analyses were performed using geometries based on the concept sketches shown in Figure 2-1 to Figure 2-4.

The following sequence will be followed:

- Excavate pit 2 on north-east side
- Maximum length of batter exposed is 200m
- Immediate backfilling after coal extraction

Figure 2-1 Site Plan

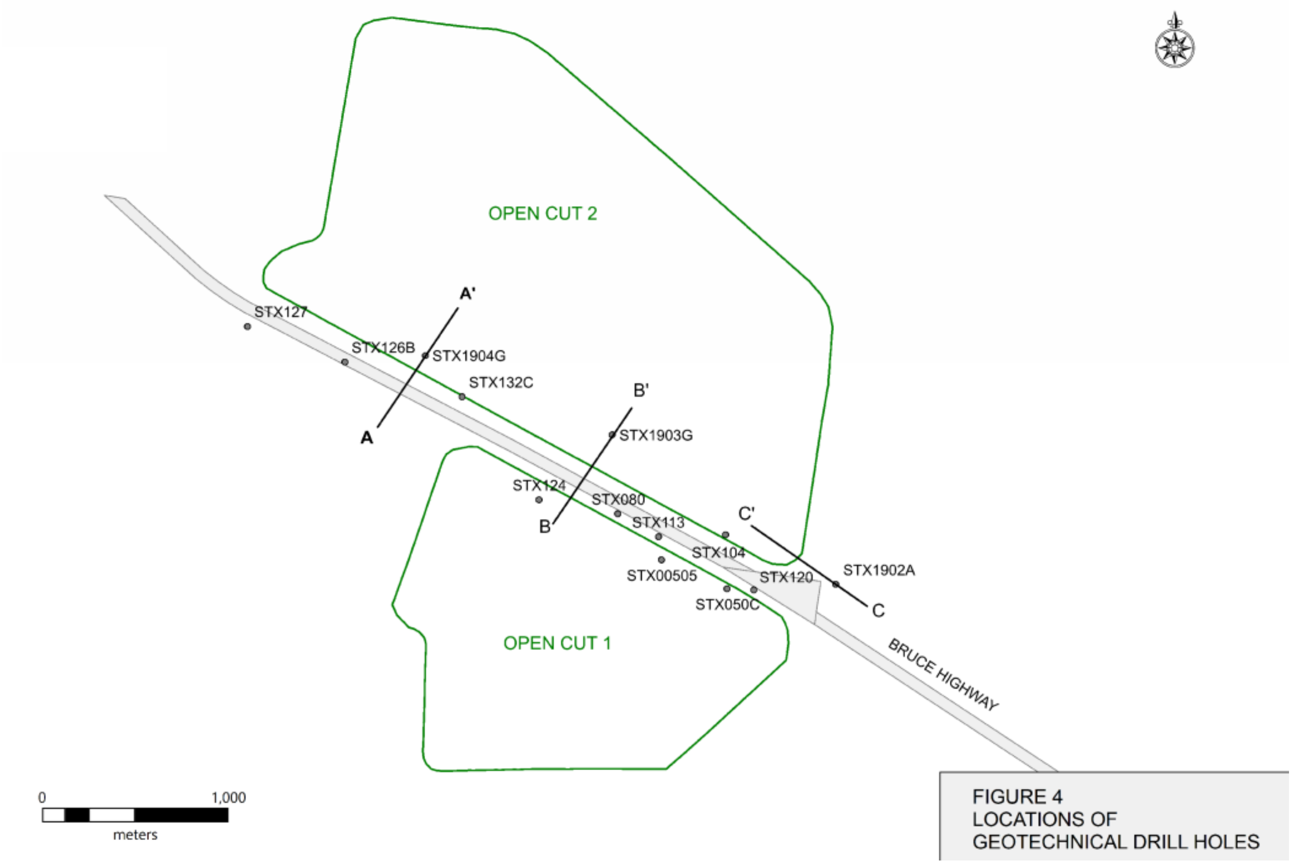


Figure 2-2 Section A-A’

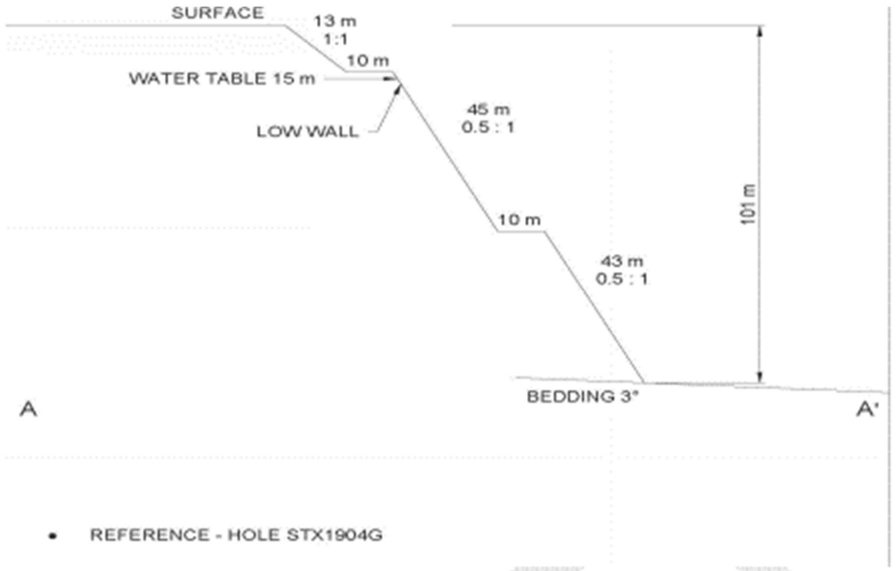


Figure 2-3 Section B-B’

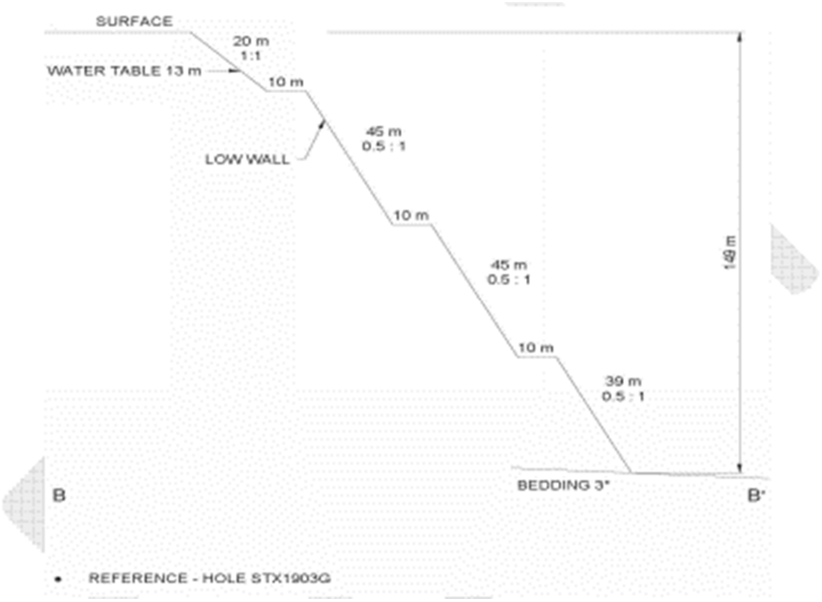
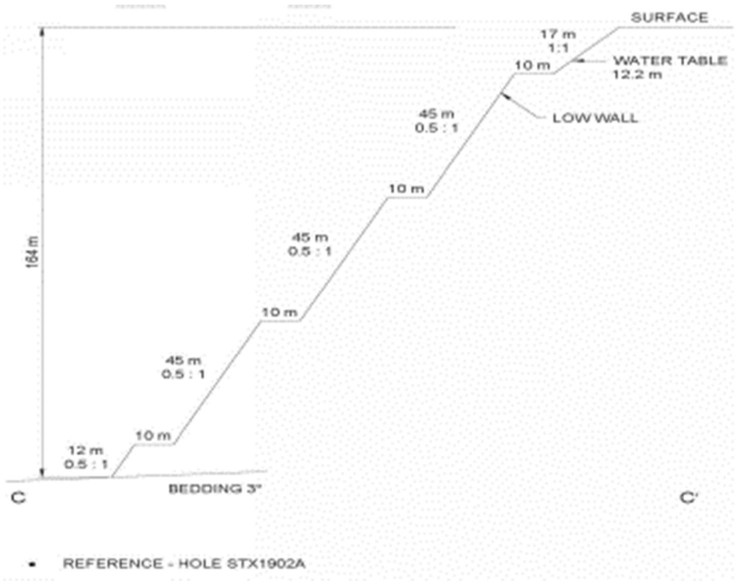


Figure 2-4 Section C-C'



3 Information Available

3.1 Historical Information

3.1.1 Reports

The following reports have been supplied:

- Geotechnical Assessment of Bruce Highway (AMEC 2018)
- Geotechnical Assessment of Open Cut Mining Adjacent to the Bruce Highway, STYX Project (AMEC 2017 a)
- Groundwater Investigations for the Styx Trial Pit (AMEC 2014)
- Geotechnical Report for the Styx Coal Project (AMEC 2017 b)
- Preliminary Investigations for Sediment Dam, Water Storage Dam, Train Loadout and Haul Road, Styx Coal Project (AMEC 2017 c)
- Pits adjacent to Bruce Highway - Slope Stability Assessment, Central Queensland Coal Project (Cardno 2018)

3.1.2 Boreholes

A large number of exploration boreholes have been drilled across the project, however these provide limited geotechnical information due to the absence of detailed geotechnical logging and the distance of the boreholes from the highway. A total of 10 boreholes near the highway were re-logged by an engineering geologist; the re-worked logs are presented in AMEC 2018 (Refer Appendix B). Detailed logging of discontinuities was not provided, however some core photos were provided although these do not cover the full cored depth of the boreholes.

Unconfined Compressive strength values derived from downhole sonic velocity logging were provided on some logs.

3.1.3 Pit Cross Section

Pit geometries were provided in three stages:

1. Initial sketches provided by AMEC (Refer Figure 2-1)
2. Cross Sections with mapped coal layers provided by Central Queensland Coal and AMEC
3. Cross Sections with revised coal layers provided by Central Queensland Coal (Refer Figure 3-1)

A total of five cross sections were provided as shown in Figure 3-1. Stability and deformation models were prepared for Cross Section 5 which had the deepest proposed excavation (Refer Figure 3-2 and Figure 3-3).

Figure 3-1 Initial Cross Sections

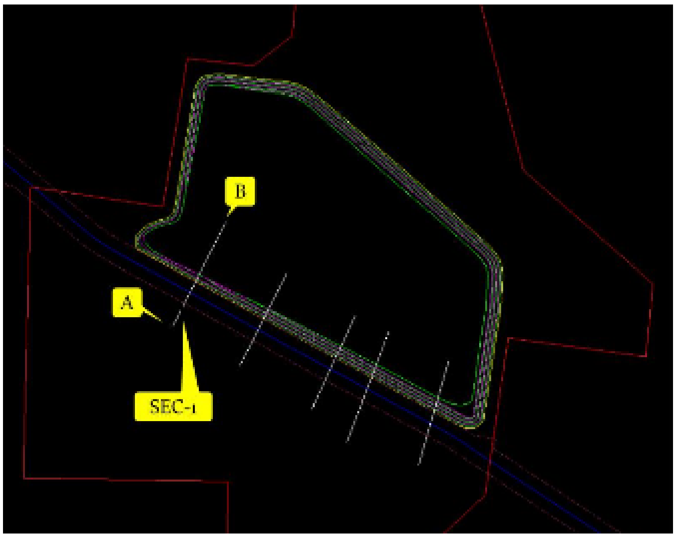


Figure 3-2 Cross Section 5 NE (Right) Side

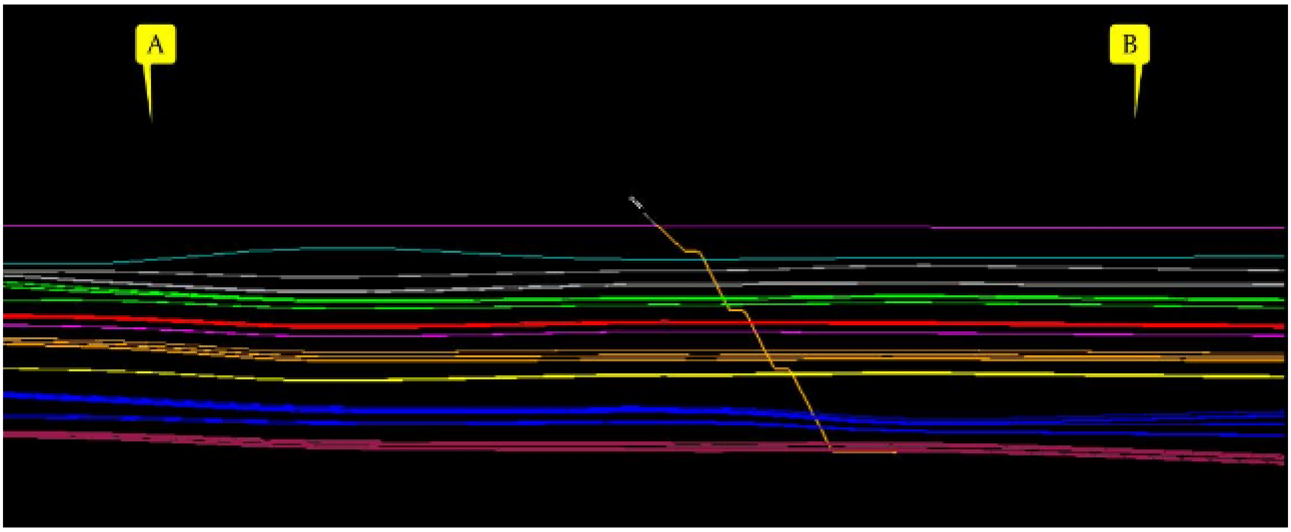
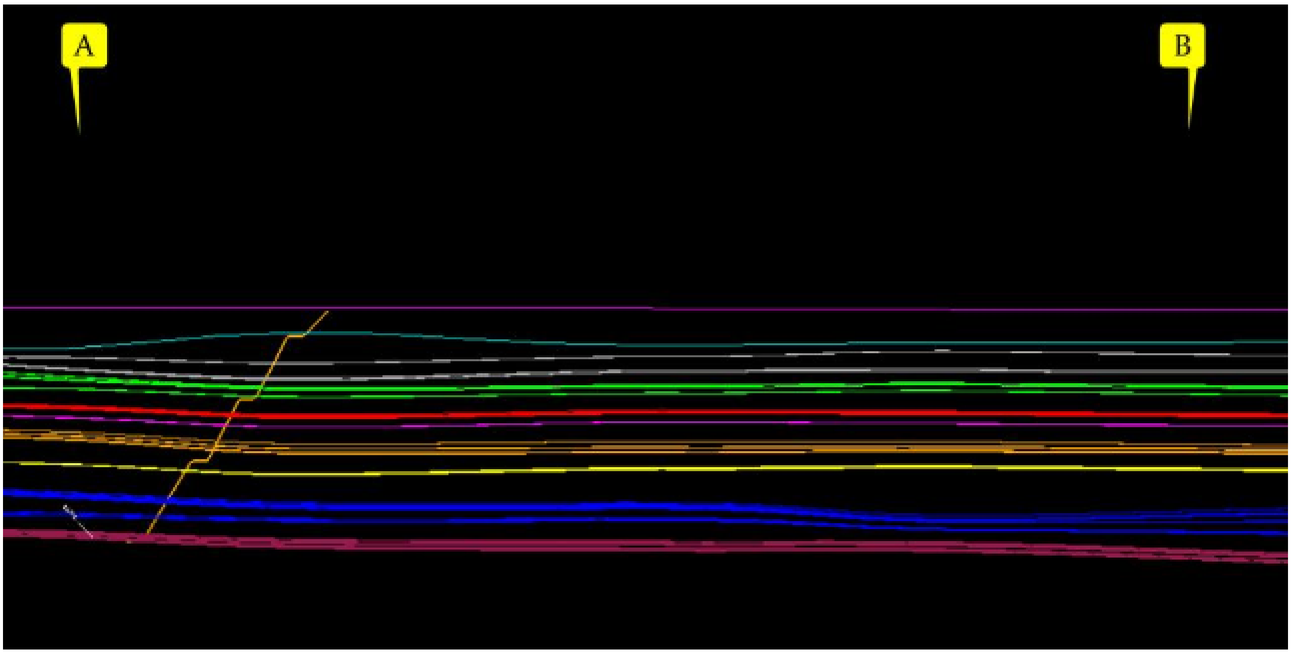


Figure 3-3 Cross Section 5 SW (Left) Side



3.2 Current Study

3.2.1 Geotechnical Boreholes

Two cored boreholes (STX1903G and STX 1904G) were drilled with core logged and sampled by a Cardno engineering geologist in August-September 2019. Detailed borehole logs are presented in Appendix C. These holes were drilled to the bottom of the proposed pit. The depth of the pit floor reduces from 150m at borehole STX1903G to 100m at borehole STX1904G.

Core samples from these boreholes were retrieved for laboratory testing as described in Section 3.2.2.

Two boreholes (STX1901 and STX1902) were drilled for water permeability testing in the overburden and packer tests for the full stratigraphic column.

Detailed borehole logs and core photos are provided in Appendix C.

3.2.2 Laboratory Testing

Laboratory test data is presented in Appendix D and summarised below:

Table 3-1 Lab Tests Overburden

Test Type	No of Tests
CU Triaxial	3

Table 3-2 Lab Tests Rock Core

Test Type	No of Tests
Point Load Axial	110
Point Load Diametral	110
Unconfined Compressive Strength	32
Rock Triaxial	8
Rock Direct Shear	17
Slake Durability	5

3.2.3 Downhole Logging

Downhole Acoustic Televiewer logging (ATV) was performed in borehole STX1904G only. Useable data was not obtained from Borehole STX1903G. Results are presented in Appendix E.

An analysis of the results and recommendations on material parameters is presented in Section 4.

4 Geotechnical Conditions

4.1 Geology

The local geology is described in Appendix B. A summary is presented below.

4.1.1 Introduction

The Central Queensland Coal Project lies within the Styx Coal Measures. Unconsolidated overburden comprises soil, colluvium and Tertiary Clay. Depth of weathering adjacent to the Bruce Highway ranges from 11.86 m to 28.50 m.

4.1.2 Geological Setting

The Project area is in the Styx Basin, a small, Early Cretaceous, intracratonic sag basin which covers an area of about 300 km2 onshore and 500 km2 offshore. The coal bearing strata are known as the Styx Coal Measures and consist of quartzose, calcareous, lithic and pebbly conglomerate, sandstone, siltstone, mudstone, carbonaceous shale and coal seams. Figure 4-1 shows the typical coal seams stratigraphy. The depositional environment was freshwater, deltaic to paludal, with occasional marine incursions.

The Styx Coal Measures occur as basin infill in a half graben geometry which has a plunge to the north. The deposit has north and east dipping components.

The full sequence of coal is about 6 m occurring within a sequence of about 120 m of coal bearing strata. Typical sections across the Bruce Highway showing the mining area are shown in Figure 4-1 and Figure 4-2.

Figure 4-1 Schematic section across the Bruce Highway

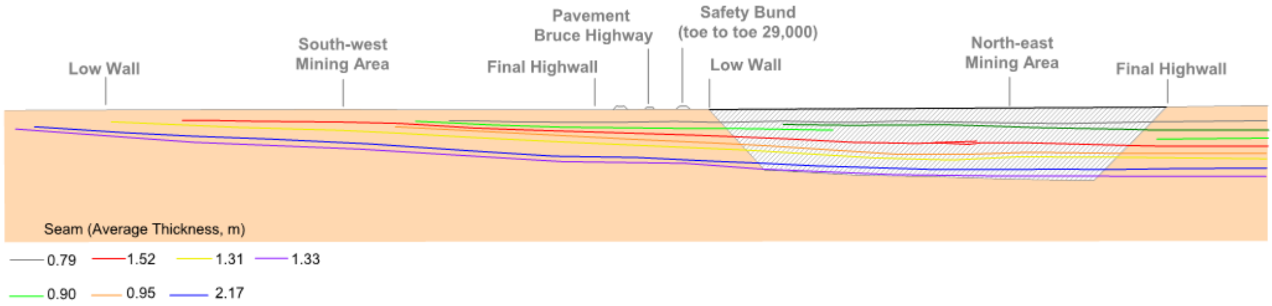
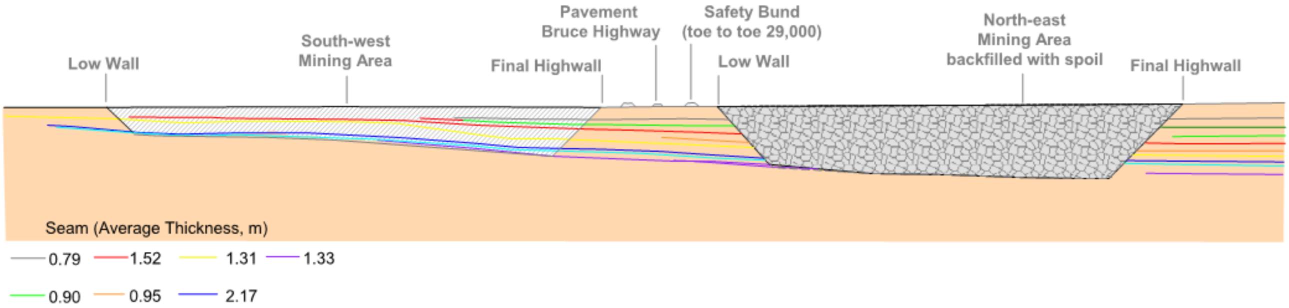


Figure 4-2 Schematic section across the Bruce Highway



4.1.3 Stratigraphy

The Styx Coal Measures comprise multiple coal seams which are generally interbedded with sandstone, siltstone and mudstone. Bedding thickness varies. Partings are present along bedding planes. Lensing of coal seams also occurs.

Multi-seam mining will be required with parting operations which minimise dilution.

4.1.4 Geological Structure

Bedding is generally uniform with an average dip of 3°. Maximum dip is about 7°. Partings occur along bedding planes. Jointing is generally widely spaced.

To date no significant faults or dykes have been encountered during geological investigations.

4.2 Material Properties

4.2.1 Overburden

Three CU triaxial tests were performed on the overburden material, results are summarised in Table 4-1.

Table 4-1 Overburden Triaxial Test Results

Borehole and Depth	c' (kPa)	Φ' (Degrees)
STX1903 11.48-11.63m	45	24
STX1904 2.27-2.37m	35	18
STX1904 3.70-3.89	52	18

Because of the drilling process, the ability to retrieve undisturbed sample suitable for testing was limited. The test results for the deeper sample are broadly in line with the values used in the previous study, ie:

c'=40 kPa, Φ' = 25°

These values have been used in the slope stability analysis.

4.2.2 Spoil

No test data is available, the following strength values have been assumed:

c'=0 kPa, Φ' = 34°

Spoil will be used to construct safety bunds and for backfilling of the pits. These applications are not critical.

4.2.3 Rock

Initial rock strength parameters were supplied by AMEC (2018) and are summarised in below. These parameters were used in the initial stability model

Table 4-2 Initial Material Properties

Material	Density (kN/m3)	Angle of Internal Friction φ (degrees)	Cohesion (kPa)
Overburden (clay and XW rock)	19.6	25	40
Spoil	18.6	34	0
Mudstone XW	18.6	24	60
Mudstone MW	18.6	25	200
Mudstone Fr	19.6	38	200
Siltstone CW	24.5	43	60
Shale Fr Competent	24.5	15	38 400
Sandstone HW	19.6	38	60
Sandstone Fr Weak	24.5	40	200
Sandstone Fr, Competent	24.5	28	27 200
Coal Fr	14.7	35.5	420
Coal XW	11.8	22	0
Soot	11.8	9	0
Intraformational Shear Zone	-	25	9

Revised parameters were prepared using Hoek-Brown procedures using core logs, laboratory tests and ATV tests as described in the following sections. The Hoek-Brown model takes into account both intact rock strength and the strength and nature of discontinuities including bedding planes joints and shear zones. Mean and moderately conservative strength parameters were derived and are summarised in Section 4.5.2.

4.3 Rock Discontinuities

4.3.1 All Discontinuities

Downhole Acoustic Televiewer logging (ATV) was performed in borehole STX1904G. The results are presented in Appendix E. The following discontinuity types were logged

> Bedding Planes	(26 No)
> Fractures	(166 No)
> Intrusions	(3 No)

A lower hemisphere contour plot of all discontinuities is presented in Figure 4-3.

4.3.2 Bedding Planes

Figure 4-4 shows a contour plot of all bedding planes. The highest concentration of bedding planes equates to a pole with trend/plunge of 185/83 (dip 7°, dip direction 005°) (Refer Figure 4-5).

For two dimensional planar failure an apparent dip of 5° out of the RHS face is recommended. This corresponds approximately with stratigraphy based on coal exploration boreholes.

Figure 4-3 Lower hemisphere plot all discontinuities

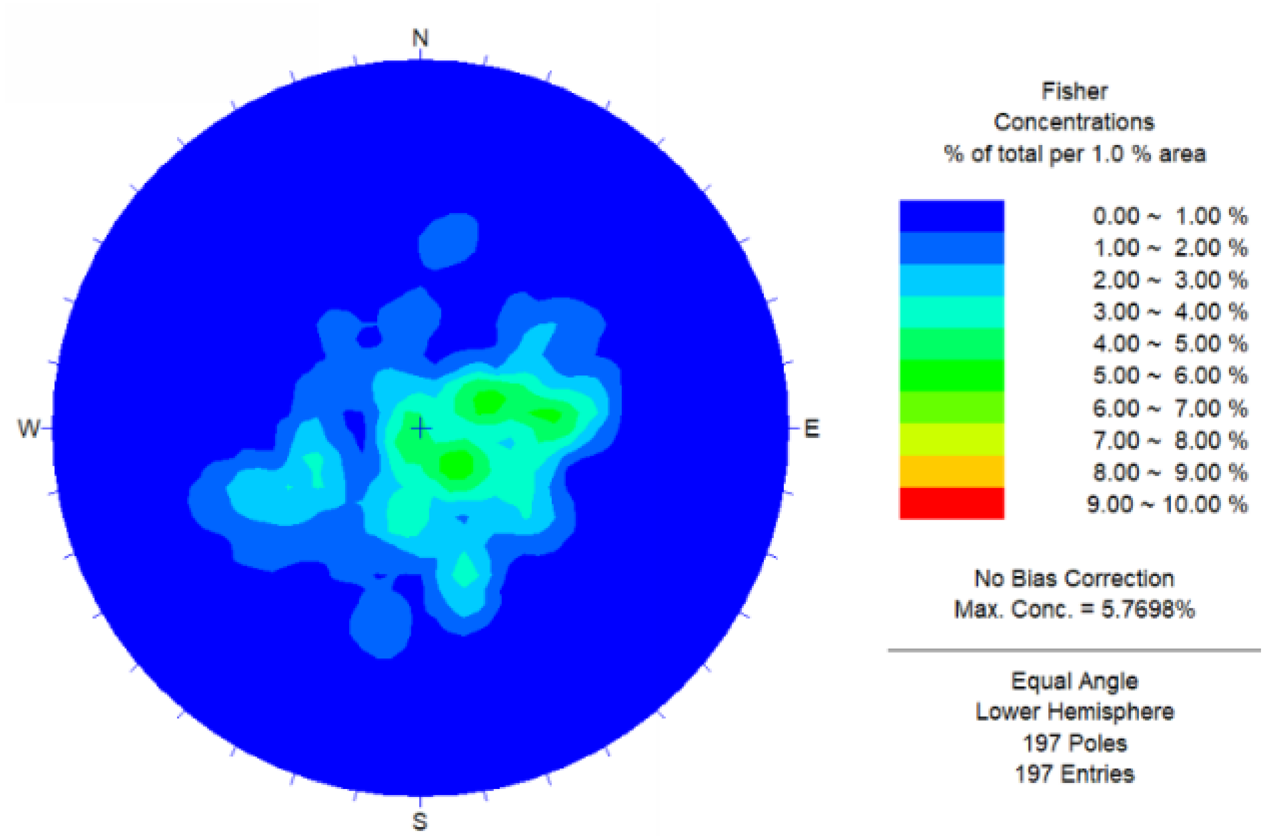


Figure 4-4 Lower hemisphere plot bedding planes

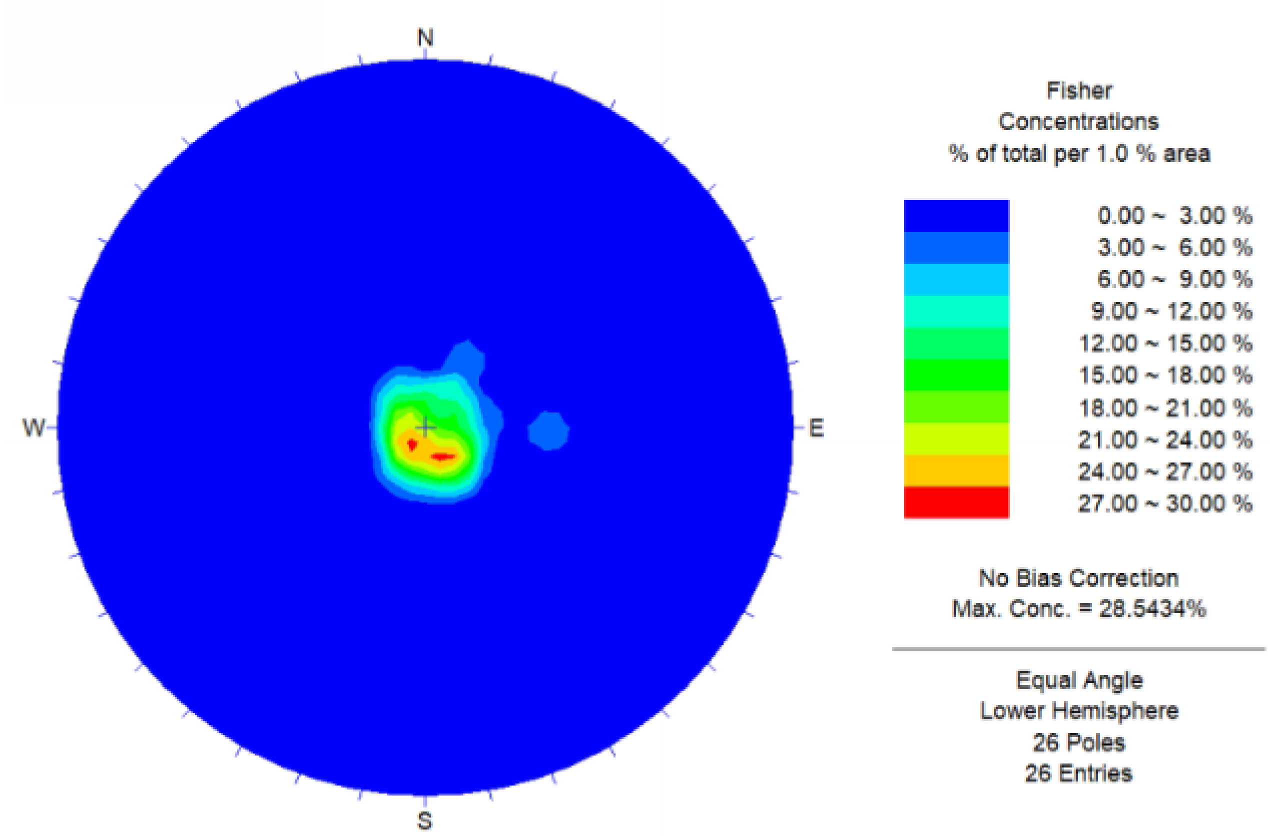
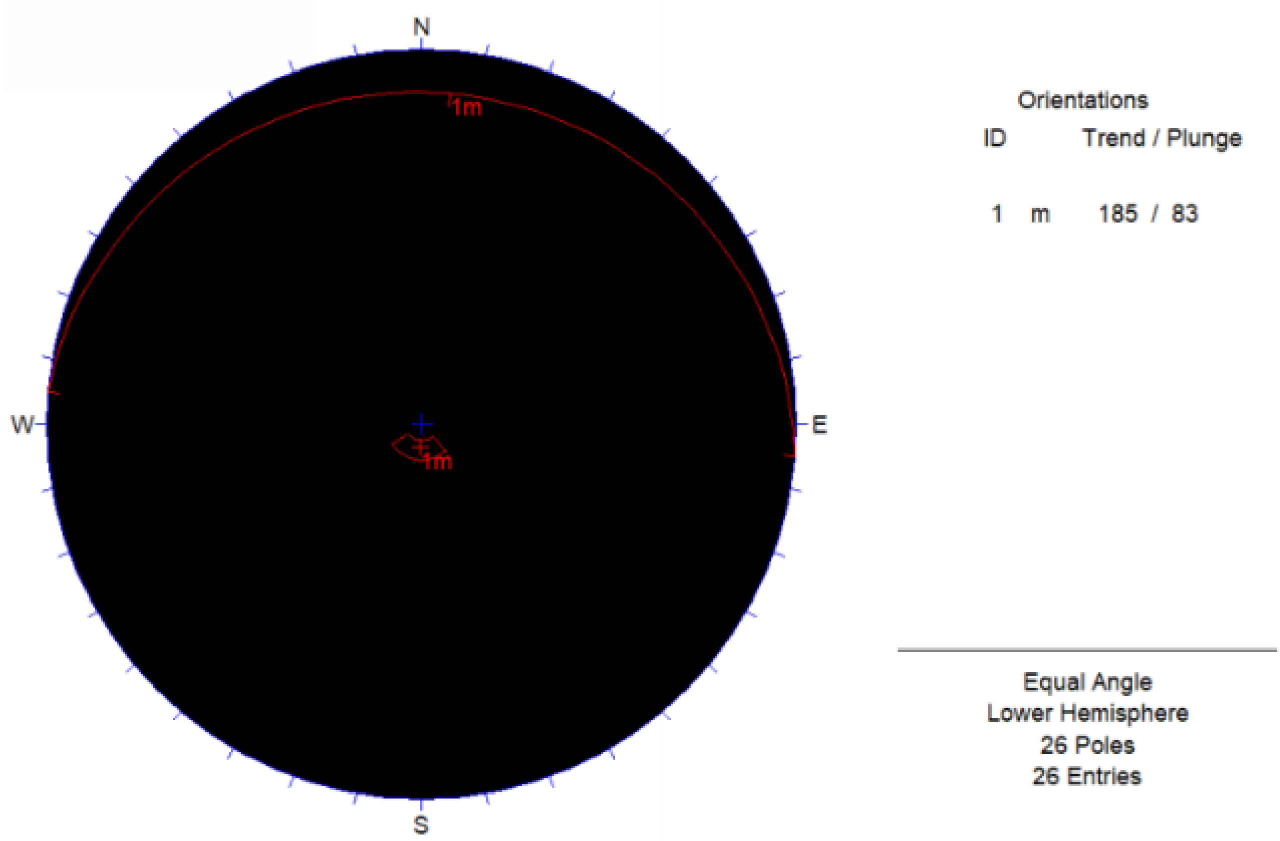


Figure 4-5 Major bedding plane

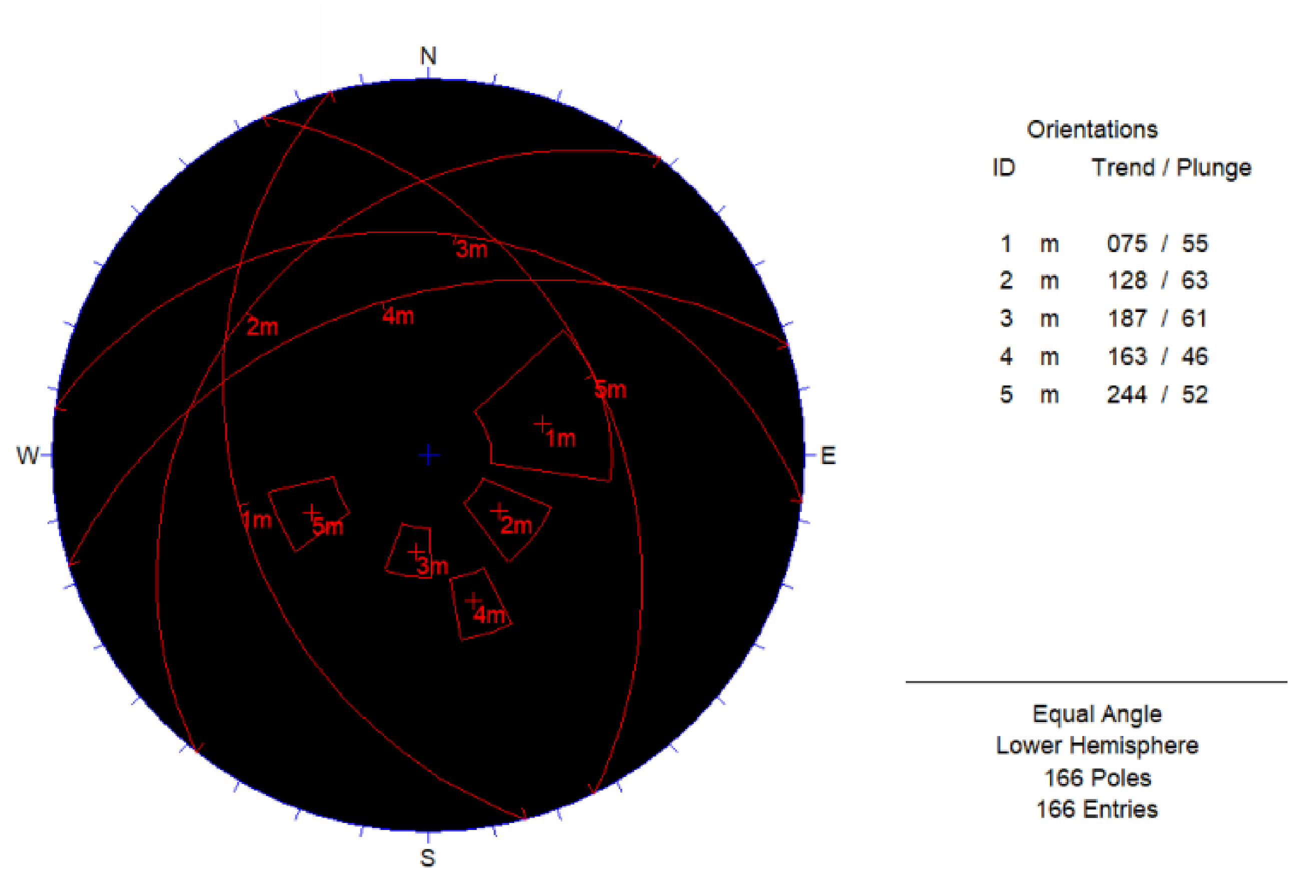


4.3.3 Fractures/Joints

A total of five major discontinuity sets were identified as shown in Figure 4-6. Dips range from 27° to 44°. Joints in these formations are known to be widely spaced and discontinuous between beds, the formation of significant wedge failures is considered to be infeasible. Refer Section 5.3.

Strengths measured on bedding planes and joints using direct shear tests have been used to determine appropriate Hoek-Brown rock mass strength parameters for use in 2D modelling.

Figure 4-6 Fracture Planes



Orientations

ID		Trend / Plunge
1	m	075 / 55
2	m	128 / 63
3	m	187 / 61
4	m	163 / 46
5	m	244 / 52

Equal Angle
Lower Hemisphere
166 Poles
166 Entries

4.3.4 Shear Zones

Discontinuities with large aperture spacing were logged at depths of 58.38m and 58.74m at shallow dip angles. These correlate with a fault/shear zone identified in the core log and core photographs. This has been incorporated in planar failure models (refer Section 5.2.2).

4.3.5 Intrusions

Three items were identified as intrusions. No igneous intrusions were noted on the logs, however at one location thermal alteration was noted.

4.4 Statistical Analysis

4.4.1 Point Load and UCS Tests

Unconfined compressive strength (UCS) testing provides an accurate determination of the strength of the undisturbed rock mass, point load tests provide a useful strength estimate at lower cost, however the correlation between Point Load and UCS tests must be established for each rock type and geological environment.

Comparisons were performed between adjacent UCS and point load tests on the same rock type; results are summarised in Table 4-3.

Table 4-3 Point Load vs UCS Comparison Mean Values

Rock Type	UCS/Point Load Axial[1]	UCS/Point Load Diametral[2]
All	15.2	30.8
Sandstone	17.7	22.2
Siltstone	12.2	47.9
Carbonaceous Sandstone/Siltstone	10.9	28.2

The diametral tests showed highly variable results and many of the samples split along bedding planes. The diametral test results are not considered representative of the intact rock strength.

4.4.2 Strength vs Depth

Measured strength values were plotted against depth for all rock types (Figure 4-7), for sandstone (Figure 4-8) and siltstone/mudstone (Figure 4-9).

There is a very weak correlation with depth, however this is not considered statistically significant and has not been included in the strength models used for the stability analysis.

There was no obvious correlation between rock triaxial and direct shear results with depth.

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[1] Values less than 5 and greater than 50 excluded
[2] Values greater than 100 excluded

Figure 4-7 Strength vs Depth All Rock Types

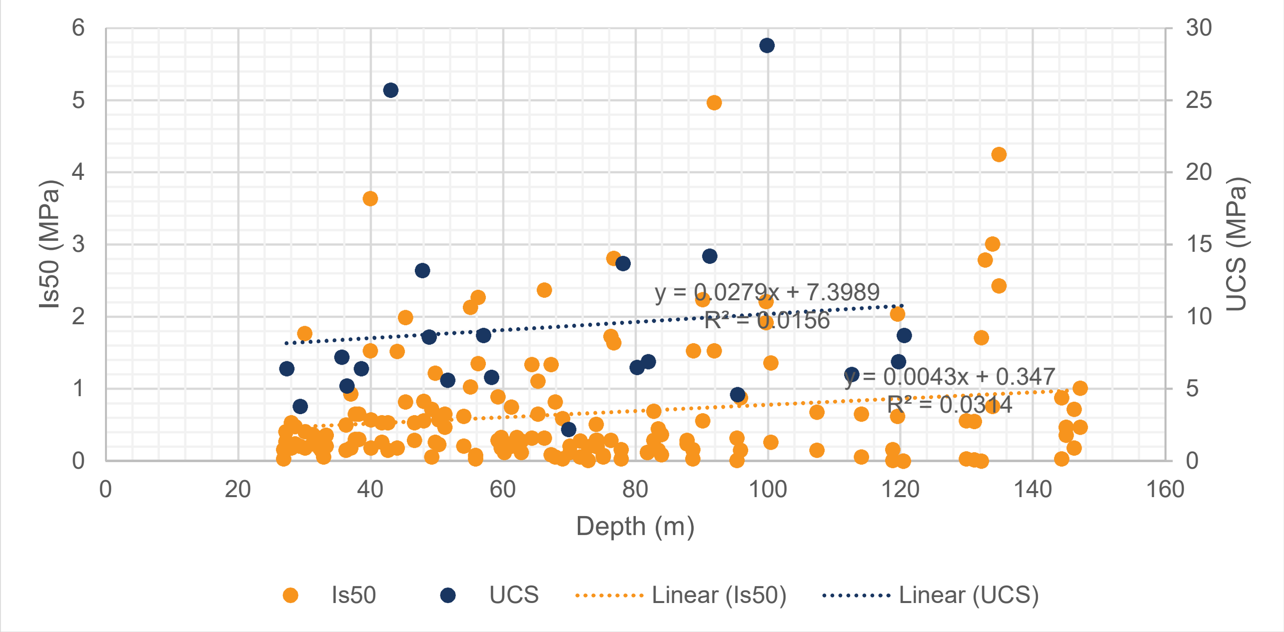


Figure 4-8 Strength vs Depth Sandstone

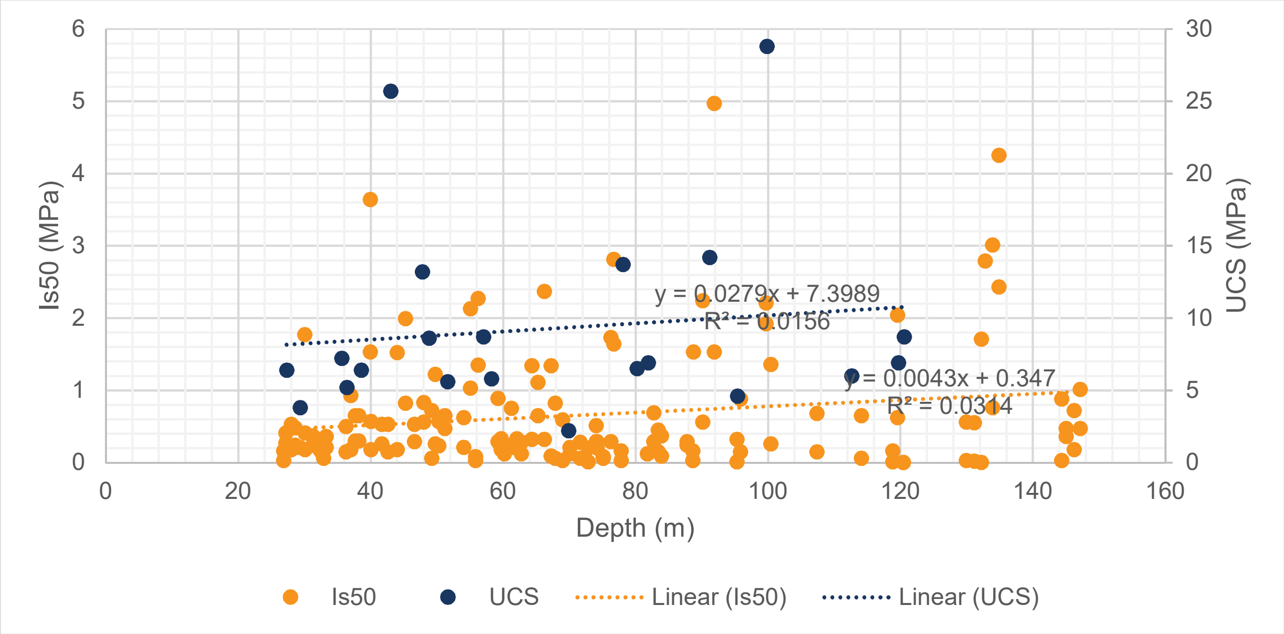
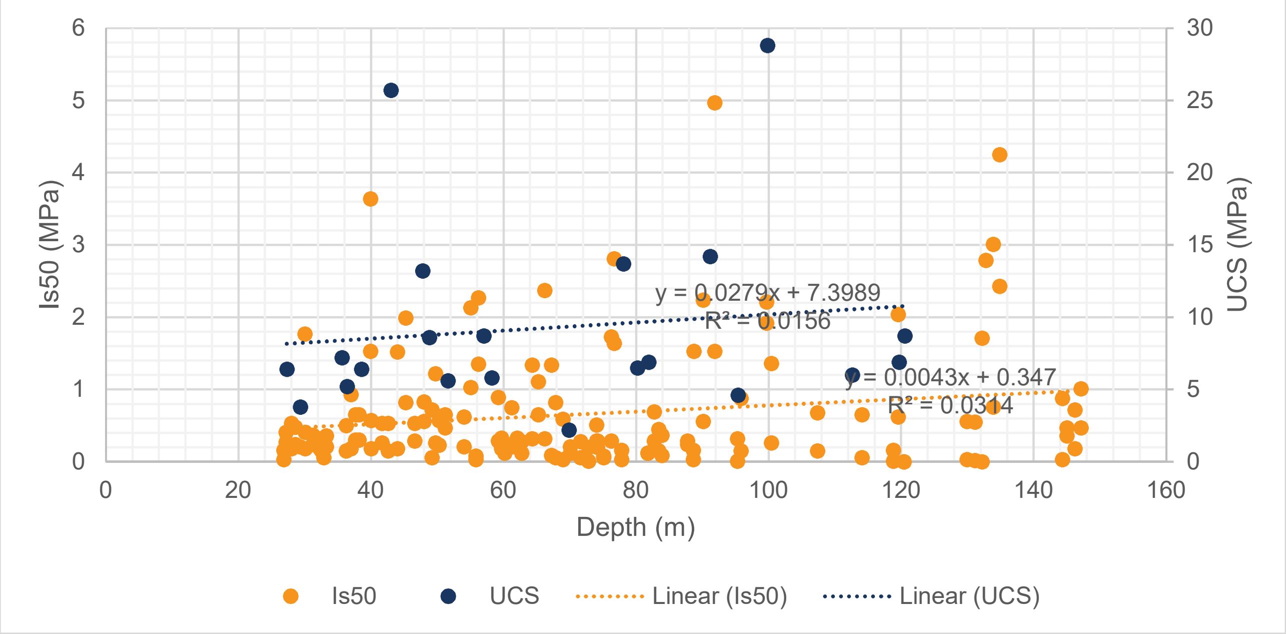


Figure 4-9 Strength vs Depth Siltstone/Mudstone/Carbonaceous Mudstone



4.5 Hoek Brown Parameters

4.5.1 Introduction

Slope stability and deformation modelling was undertaken using Hoek-Brown strength parameters as described in Appendix F.

The basic Hoek-Brown parameters were determined as described in Table 4-4.

Table 4-4 Derivation of Hoek-Brown Parameters

Parameter	Derived
σ_{ci} (UCS)	From UCS, Point Load and Triaxial Tests using RocLab
m_i	From Triaxial Tests using RocLab
GSI Geotechnical Strength Index	Hoek Brown procedures based on RQD from logs and joint conditions from shear box tests and visual observations
D Disturbance Factor	Assume 0.7 based on presplitting and blast monitoring

4.5.2 RocLab Lab Analysis

Roclab software was used to determine Hoek-Brown parameters using mean and lower-bound values for RQD and J_{cond89} (Refer Appendix F). Equivalent Mohr-Coulomb parameters were derived assuming a cut depth of 150m. Mohr Coulomb parameters are required for the Geostudio analysis.

The use of mean strength values is considered appropriate as the critical failure surfaces are steep and cut across multiple flat dipping beds. Recommended parameters for analysis are provided in Table 4-5 and, Table 4-6.

Table 4-5 Recommended Properties Mean Values Good Blasting (Presplit)

Material Type	Sigci (MPa)	mi	RQD (%)	JCond89[3]	GSI	D	C (kPa)[4]	Φ (degrees)	Em (MPa)
Sandstone	13.9	41.5	98	25	86.5	0.7	1470	52.1	19800
Siltstone	8.8	29.2	99	20	79.5	0.7	795	44.9	10260
Carbonaceous	6.5	50	99	10	64.5	0.7	720	38.7	3840
Coal	6.25	10	99	10	64.5	0.7	410	25.4	3740

Table 4-6 Recommended Properties Moderately Conservative Values Good Blasting (Presplit)

Material Type	Sigci (MPa)	mi	RQD (%)	JCond89	GSI	D	C (kPa)	Φ (degrees)	Em (MPa)
Sandstone	3.9	41.5	80	20	70	0.7	1000	45.4	7660
Siltstone	8.8	29.2	80	20	70	0.7	660	40.8	6110
Carbonaceous	6.5	50	80	10	55	0.7	590	34.5	2220
Coal	5	10	70	10	50	0.7	285	19.8	1625

4.5.3 Discussion

RQD values from corelogs were consistently high; this was reflected in the high strength values derived using Hoek Brown procedures.

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[3] Refer Appendix F

[4] C and Φ equivalent Mohr Coulomb parameters for 150m high slope

5 Stability Analysis

5.1 Introduction

Slope stability analyses were carried out using GeoStudio software. Pore pressure conditions were determined as follows:

- Phreatic lines based on earlier drawdown studies
- Minimum Ru 0.15

Effective cohesion and friction angles c’, Φ’ were derived from the Hoek-Brown parameters using RocLab software. This was necessary as GeoStudio does not include a Hoek Brown model which uses a curved failure envelope. Cohesion and friction angle values were derived based on a 150m deep cut slope.

The effect of intraformational shear zones was modelled using a combined circular/planar failure surface as described in Section 5.2.2.

5.2 Two Dimensional Model

Two dimensional slope stability analyses were performed using Geostudio software. Cross sections modelled are described in 5.2.2.

5.2.1 Sections Modelled

Table 5-1 2D Cross Sections New Model

Section	Location/Geometry	Model Type
1A	150m deep pit at Borehole STX1903G Flat Bedding	Morgenstern and Price Circular
1B	As above adverse bedding dip	Morgenstern and Price Circular
1C	As above with nominal coal bed and shear zone.	Morgenstern and Price Circular plus planar failure on shear zone
2A	100m deep pit at Borehole STX1904G Flat Bedding	Morgenstern and Price Circular
2B	100m deep pit at Borehole STX1904G Adverse Bedding	Morgenstern and Price Circular plus planar failure on shear zone

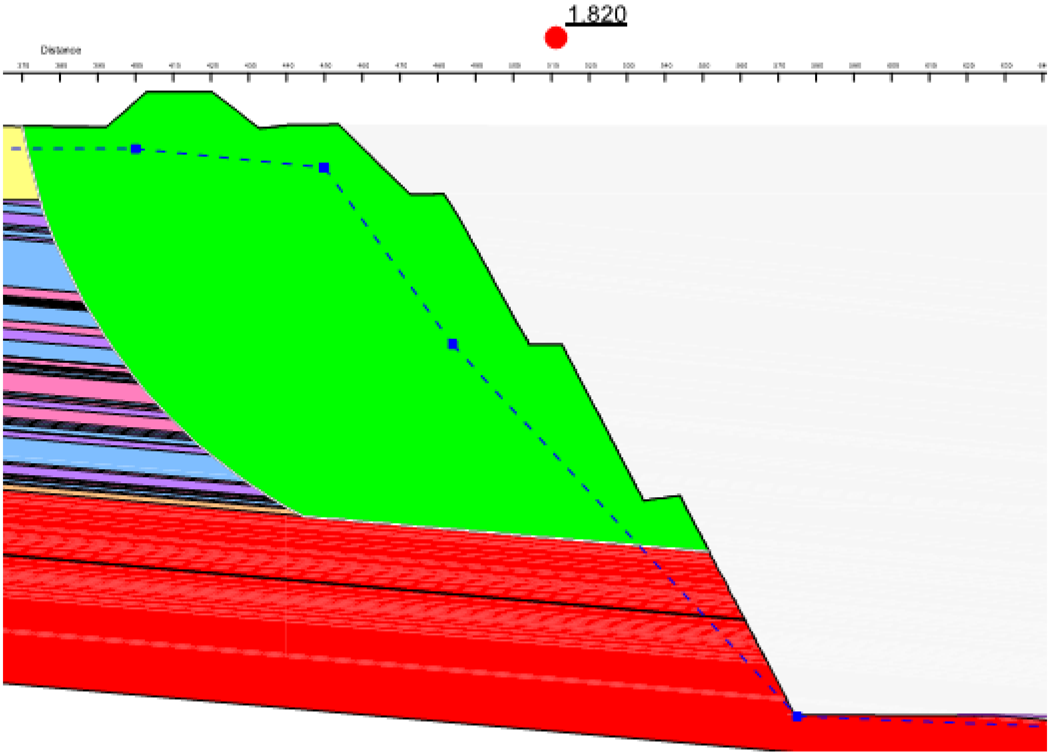
Table 5-2 2D Cross Sections Old Model

Section	Location/Geometry	Model Type
Section 5	150m deep pit RHS	Morgenstern and Price Circular
Section 5	150 m deep pit LHS	Morgenstern and Price Circular

5.2.2 Planar Failures

Geostudio allows analysis of a combined failure surface comprising a circular surface cutting across beds intersecting a pre-defined planar surface. A typical example is shown in Figure 5-1.

Figure 5-1 Typical planar failure surface 150m deep pit



5.2.3 Results of Analysis

The results of the analysis are presented in Table 5-3.

For comparative purposes a limited number of stability checks were undertaken using stratigraphy from the previous study. These results are also presented in Table 5-3. The failure surfaces are illustrated in Figure 5-2 to Figure 5-19.

Further load cases can be analysed if required.

Table 5-3 Stability Analysis Summary of Results New Model

Run	File	Section	Pit Depth	Parameters	Blasting	Case	FOS	Ref Figure	Comments
1	STX1903V6MeanProps	1A	150	Mean	Good D=0.7	Ru=0.15	2.52	Figure 5-2	
2	STX1903V6MeanProps	1A	150	Mean	Good D=0.7	Piez Surf	2.21	Figure 5-3	
3	STX1903V6MeanProps	1A	150	Mean	Good D=0.7	Piez+Seis	2.00	Figure 5-4	Pseudo Static 0.08g
4	STX1903V7MeanProps	1B	150	Mean	Good D=0.7	Ru=0.15	2.63	Figure 5-5	
5	STX1903V7MeanProps	1B	150	Mean	Good D=0.7	Piez Surf	2.29	Figure 5-6	
6	STX1903V7MeanPropsPlanar	1C	150	Mean	Good D=0.7	Piez Surf	1.82	Figure 5-8	Planar Failure High Level
7	STX1904V5MeanProps	2A	100	Mean	Good D=0.7	Ru=0.15	3.67	Figure 5-9	
8	STX1904V5MeanProps	2A	100	Mean	Good D=0.7	Piez Surf	3.41	Figure 5-10	
9	STX1904V5MeanProps	2A	100	Mean	Good D=0.7	Piez Surf	3.18	Figure 5-11	Planar Failure
10	STX1903V7MeanPropsPlanar	1B	150	Mean	Good D=0.7	Ru=0.15	2.63	Figure 5-12	
11	STX1903V7MeanPropsPlanar	1B	150	Mean	Good D=0.7	Piez Surf	2.29	Figure 5-13	
12	STX1903V7MeanPropsPlanar	1B	150	Mean	Good D=0.7	Piez Surf	1.73	Figure 5-14	Planar Failure
13	STX1903V6LowProps Good Blasting	1A	150	Lower	Good D=0.7	Piez Surf	1.73	Figure 5-15	
14	STX1903V7LowPropsGoodBlasting	1C	150	Lower	Good D=0.7	Piez Surf	1.79	Figure 5-16	
15	STX1903V7LowPropsGoodBlasting	1C	150	Lower	Good D=0.7	Piez Surf	1.46	Figure 5-17	Planar failure
16	STX1903V7LowPropsGoodBlasting	1C	150	Lower	Good D=0.7	Piez Surf	2.64	Figure 5-18	As above partial pit fill
17	CQCoalSect5d2020a	5	150	Mean	Good D=0.7	Ru=0.15	2.44	Figure 5-19	

Figure 5-2 Failure Surface Section 1a Ru=0.15 150m deep pit

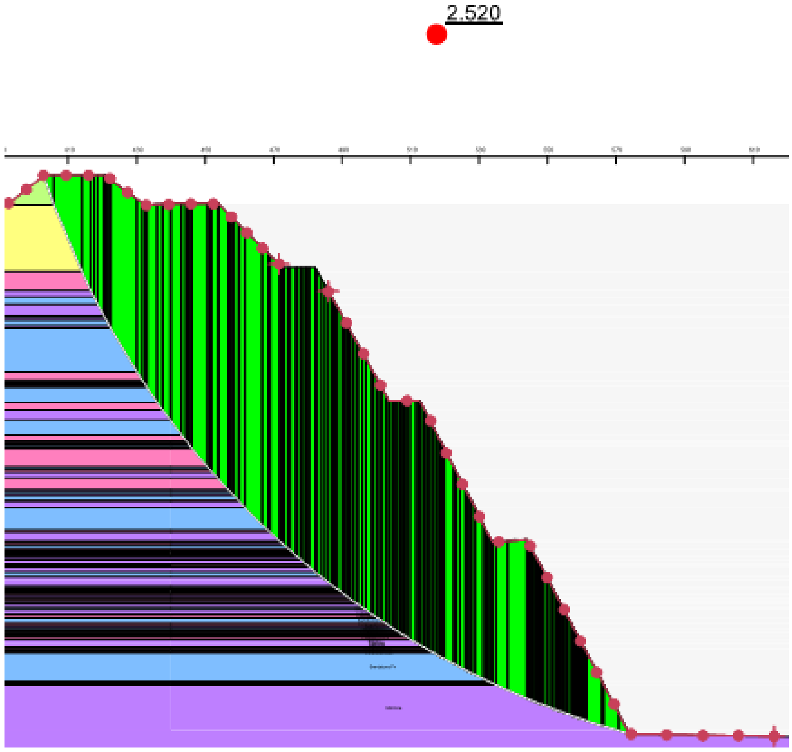


Figure 5-3 Failure Surface Section 1a Piez Line 150m deep pit

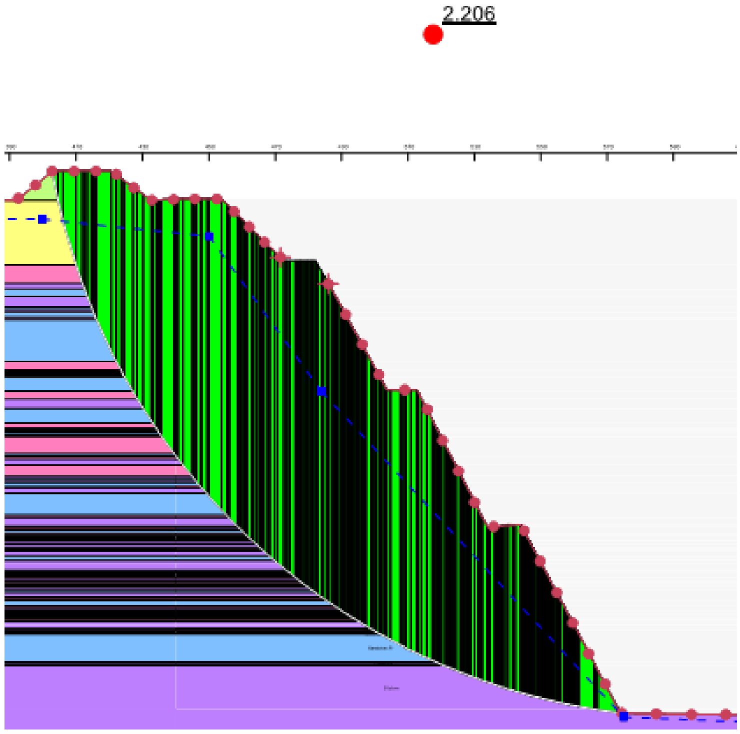


Figure 5-4 Failure Surface Section 1a Seis 150m deep pit

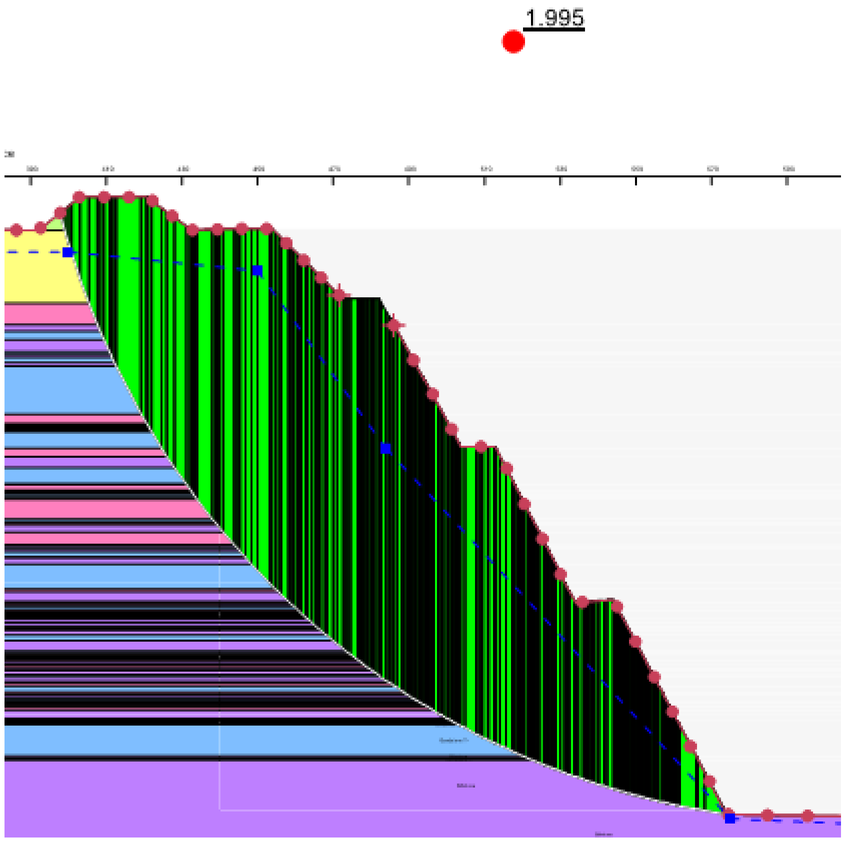


Figure 5-5 Failure Surface Section 1b Ru=0.15 150m deep pit

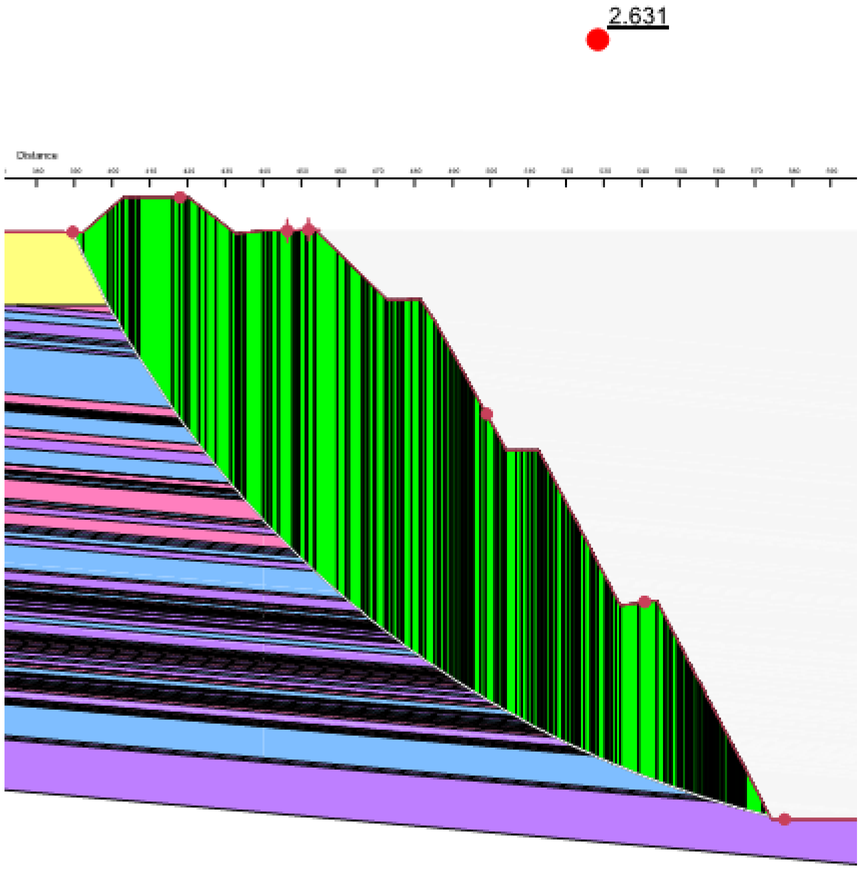


Figure 5-6 Failure Surface Section 1b Piez Line 150m deep pit

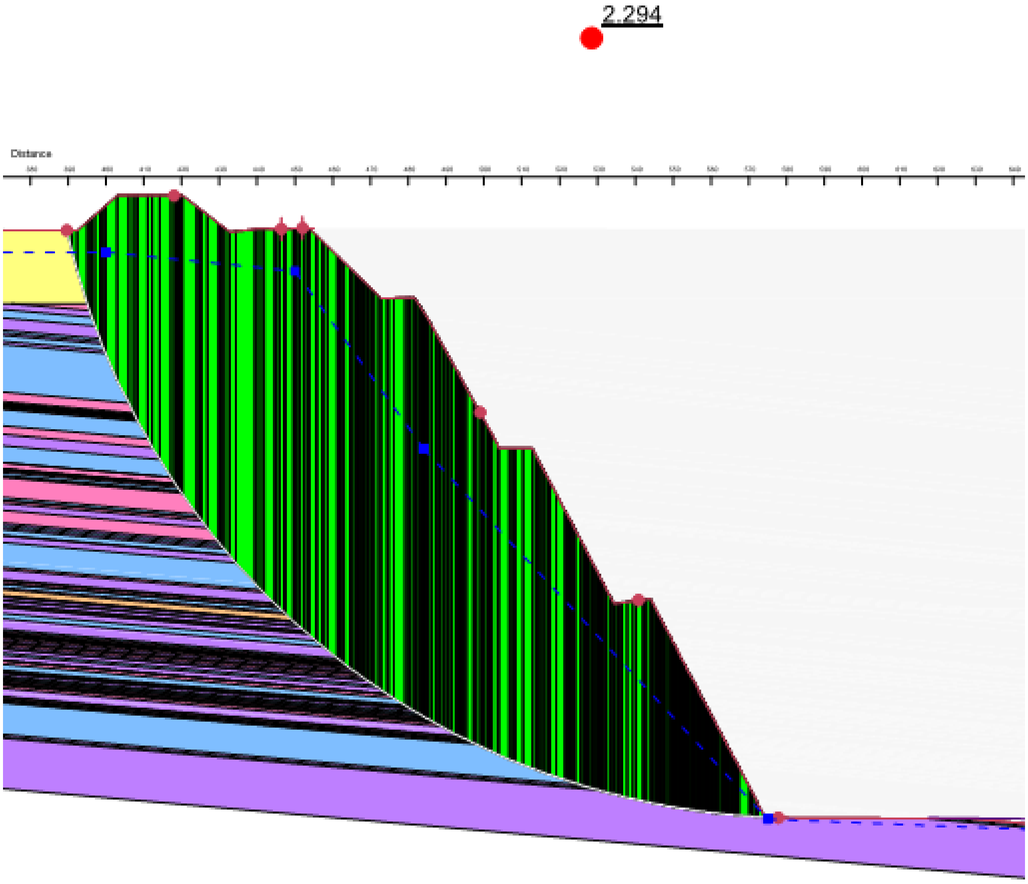


Figure 5-7 Failure Surface Sect 1B Planar Low Level 150m deep pit

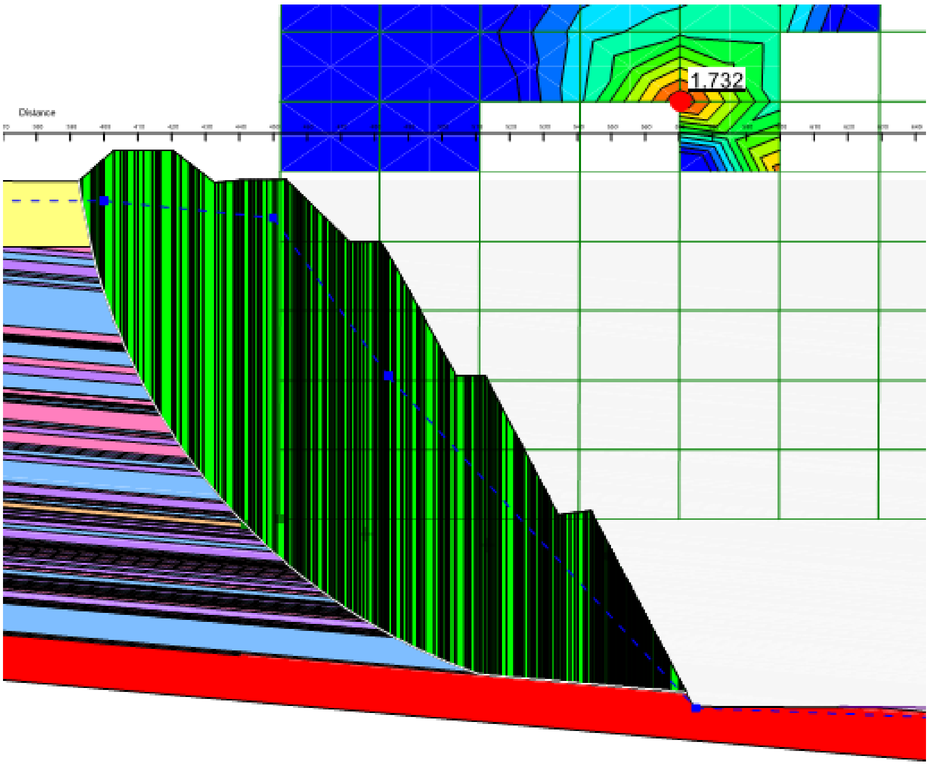


Figure 5-8 Failure Surface Sect 1B Planar High Level 150m deep pit

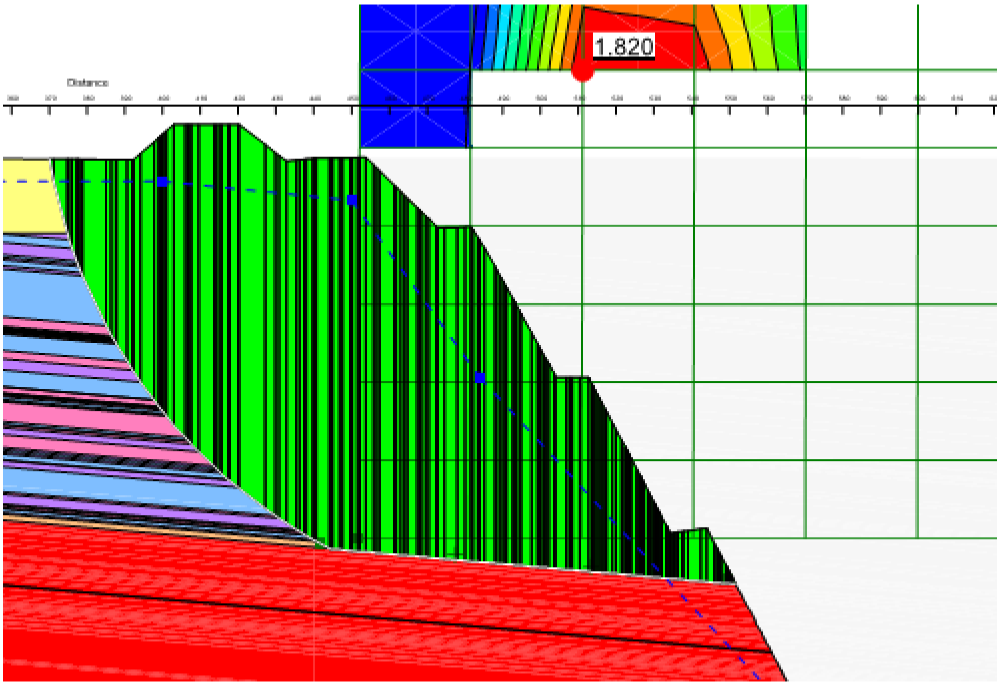


Figure 5-9 Failure Surface Section 2A Ru=0.15 100m deep pit

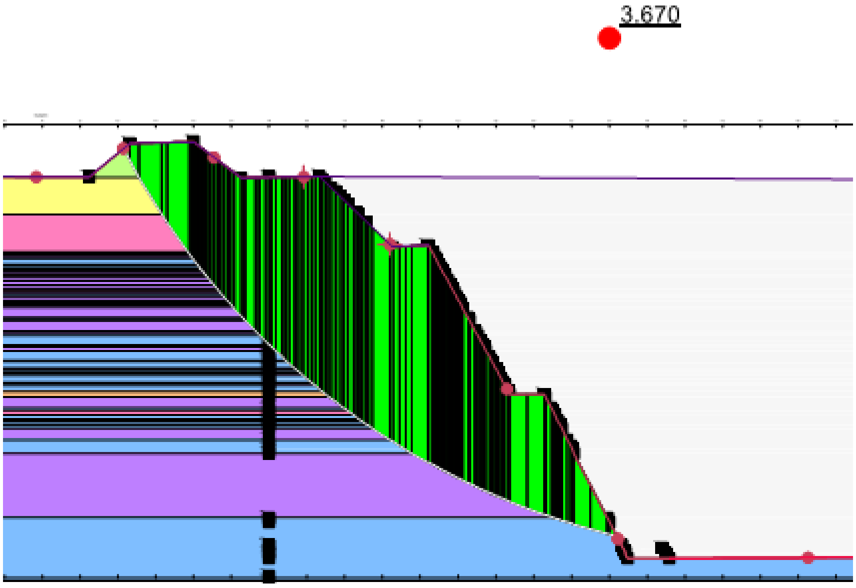


Figure 5-10 Failure Surface Section 2A Piez Line 100m deep pit

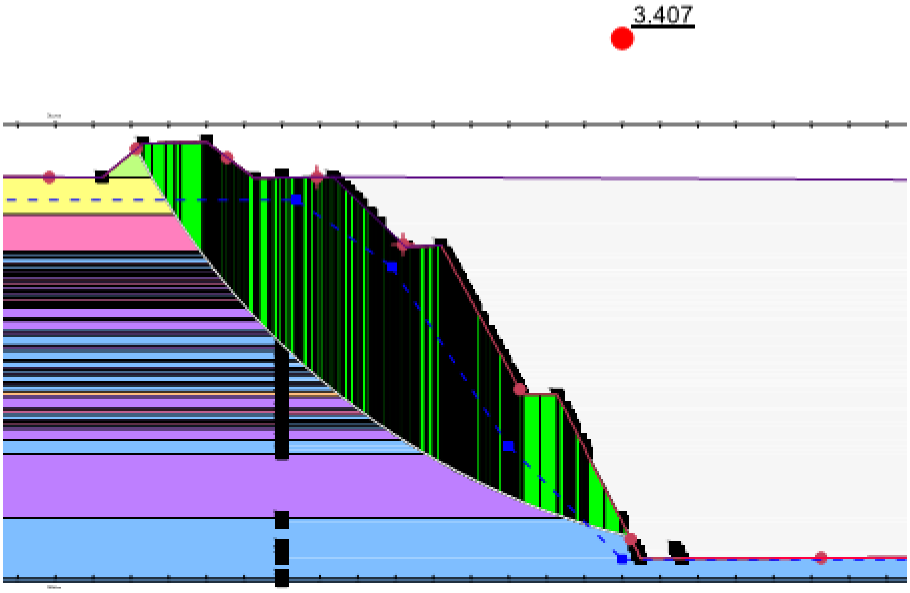


Figure 5-11 Failure Surface Sect 2A Planar 150m deep pit

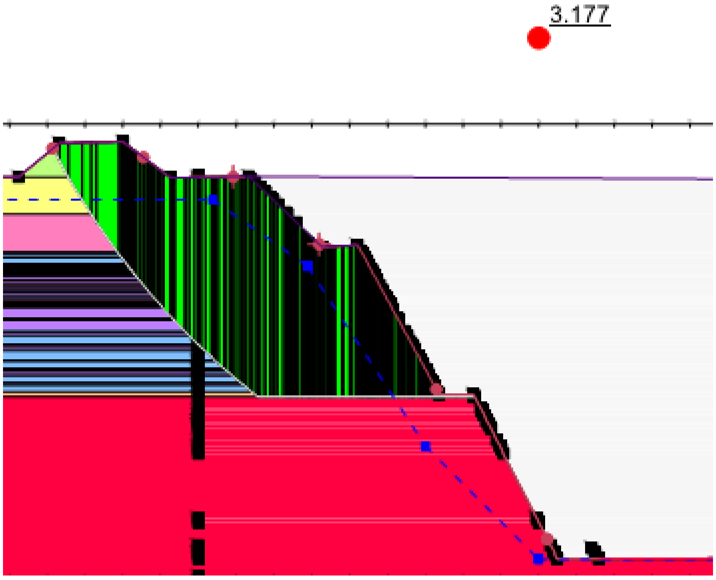


Figure 5-12 Failure Surface Section 1B Ru=0.15 150m deep pit

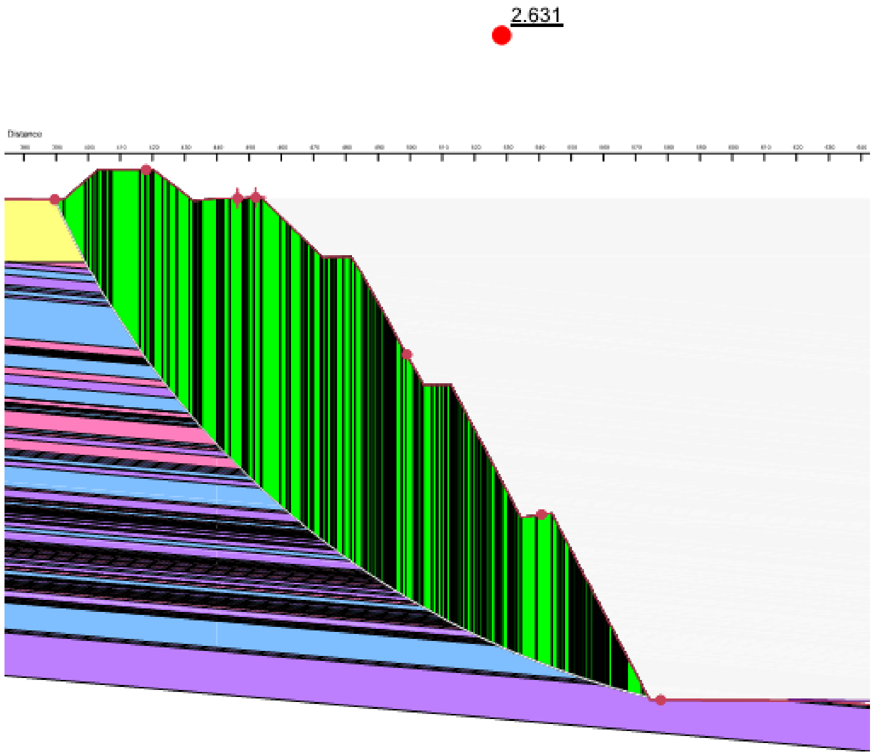


Figure 5-13 Failure Surface Section 1B Piez Line 150m deep pit

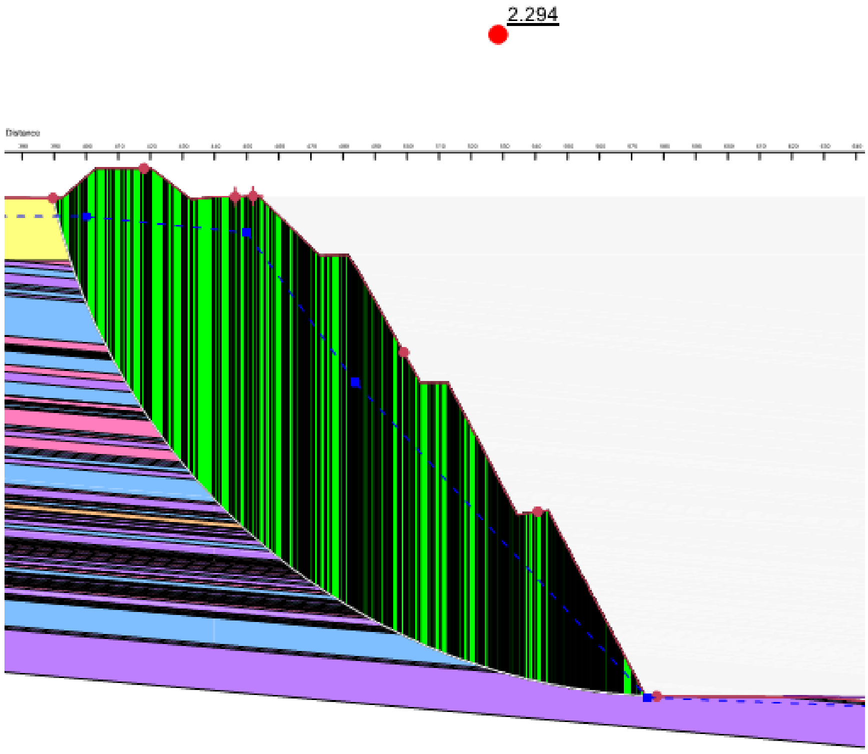


Figure 5-14 Failure Surface Sect 2B Planar

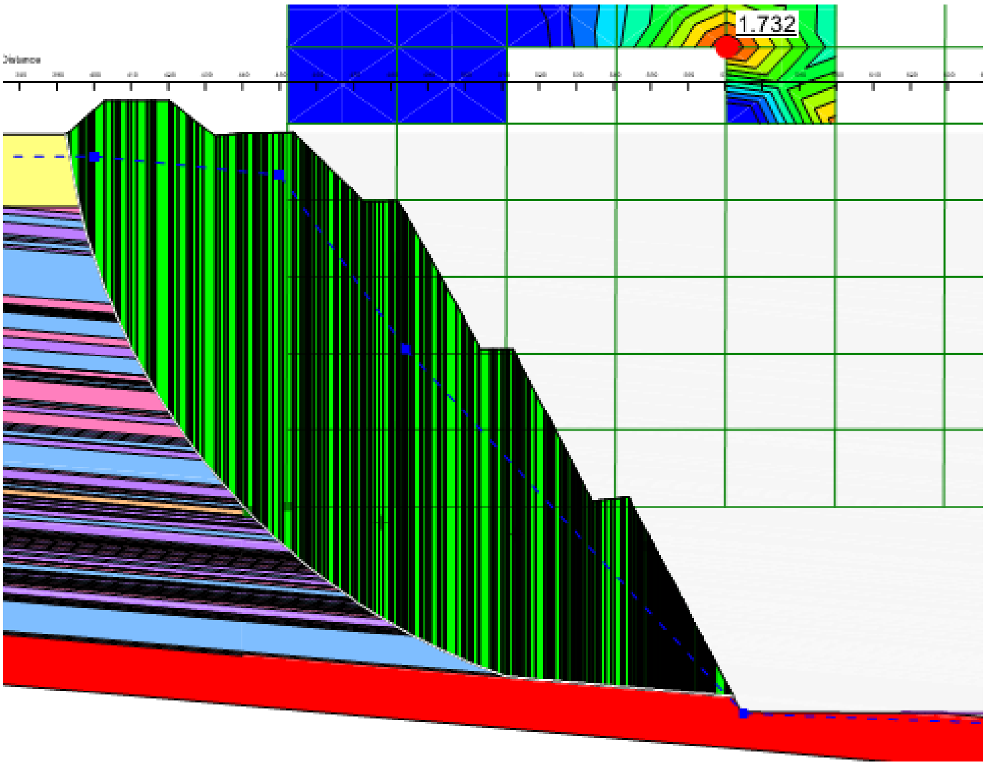


Figure 5-15 Failure Surface Sect 1A Lower Bound Good Blasting

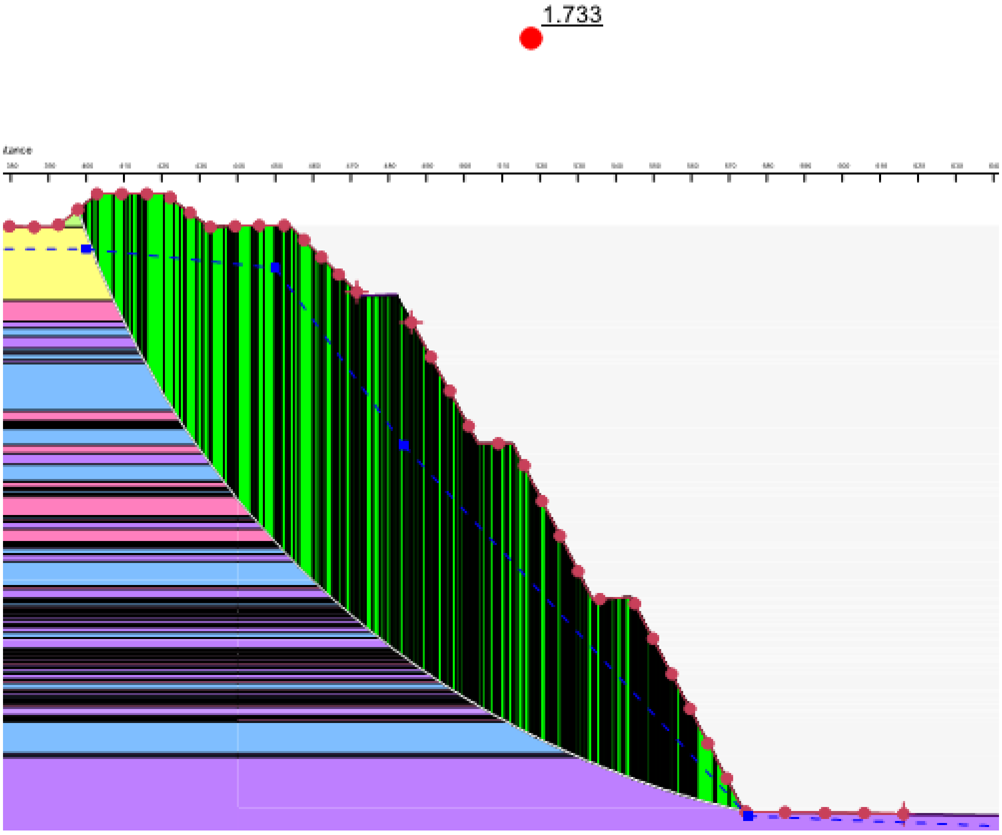


Figure 5-16 Failure Surface Sect 1C Lower Good Blasting Piez Surface

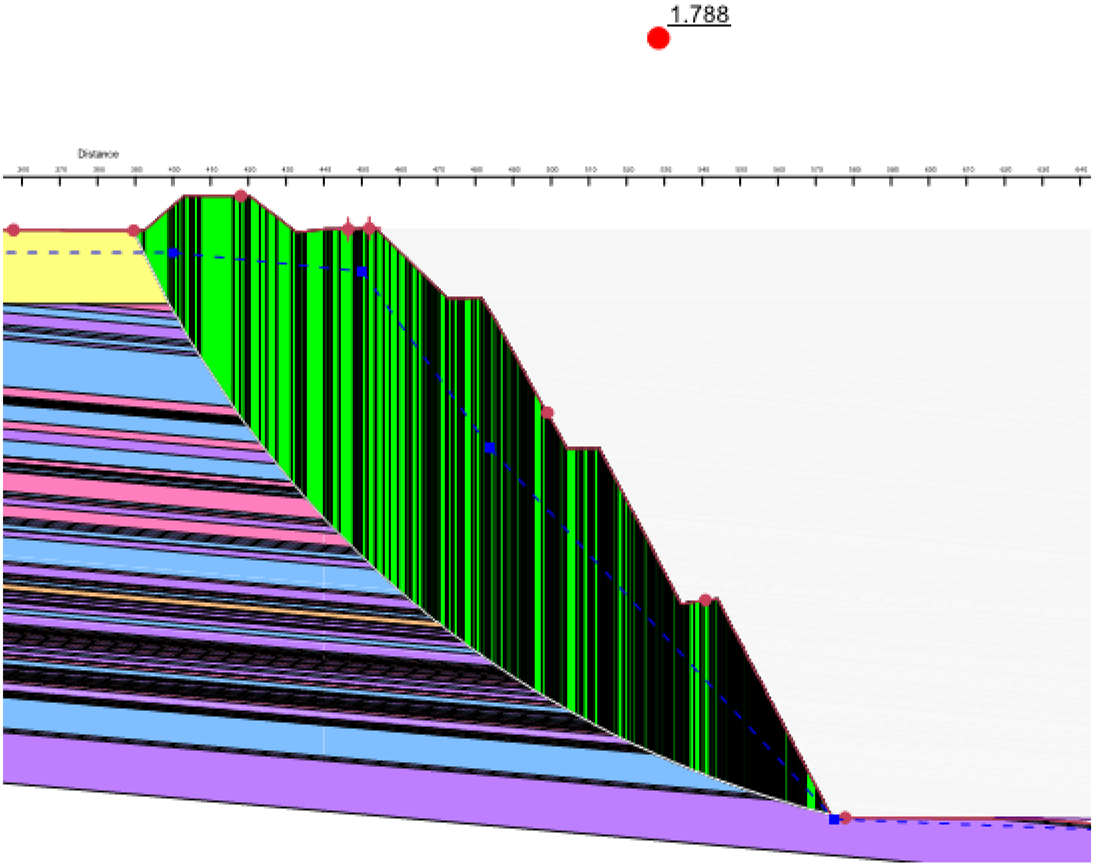


Figure 5-17 Failure Surface Sect 1C Lower Good Blasting Piez Surface Planar

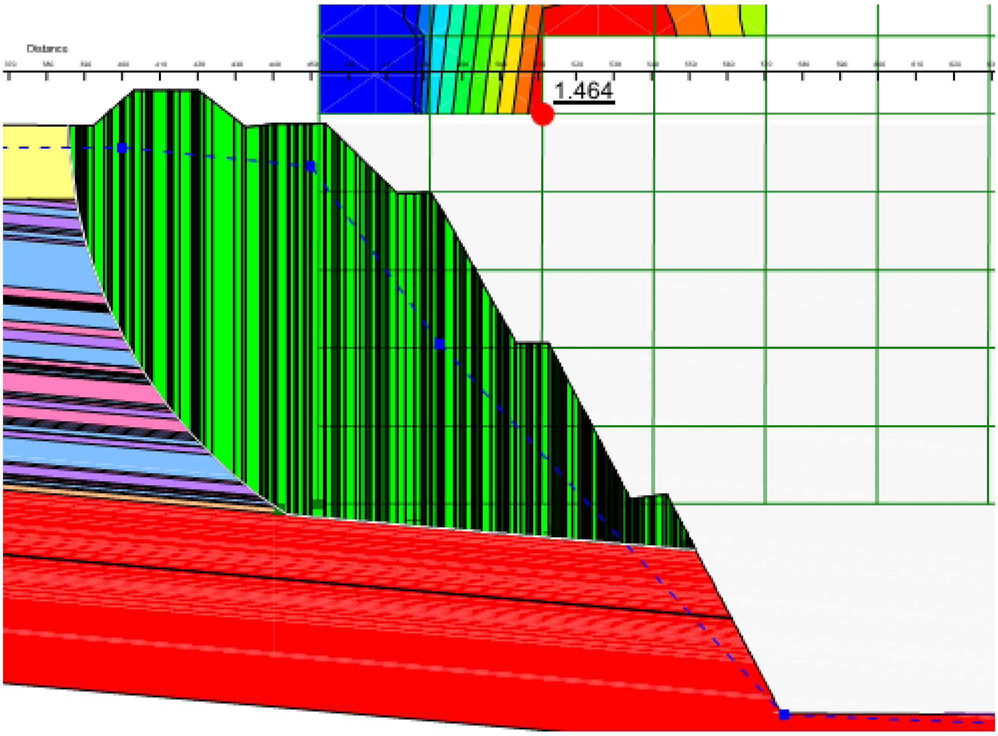


Figure 5-18 Partial Pit Fill

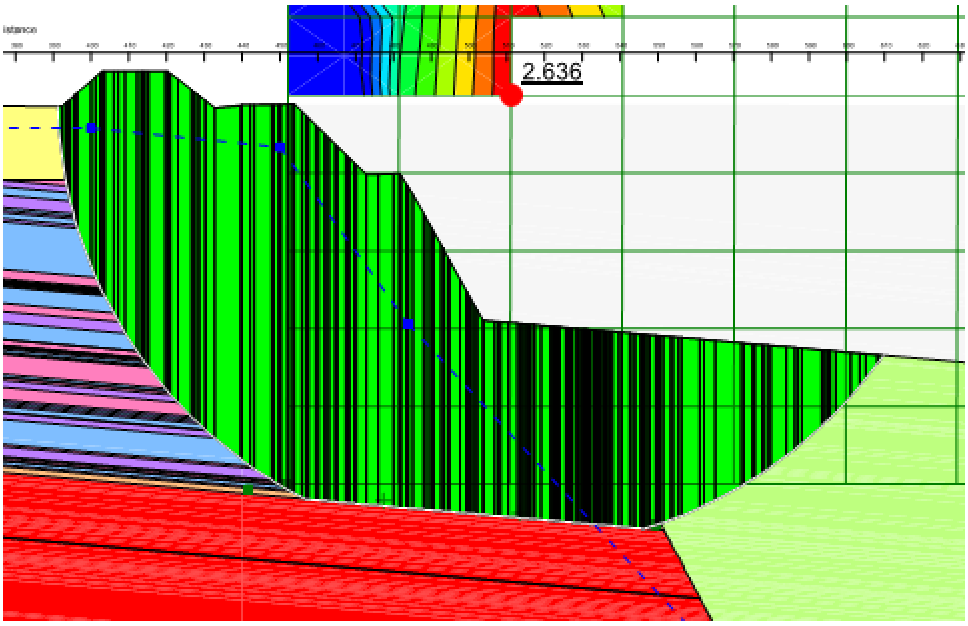
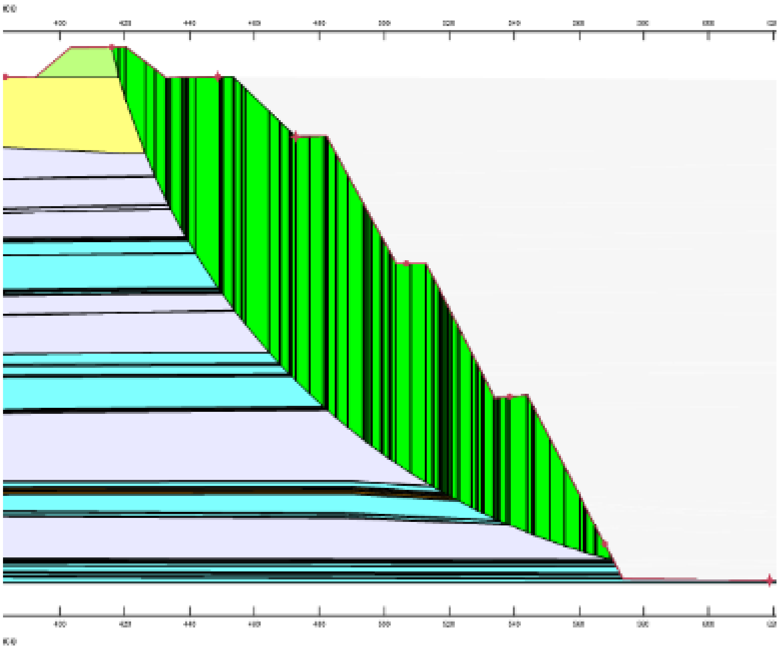


Figure 5-19 Old Model Section 5 RHS Ru=0.15 150m deep pit

2.438



5.3 Three Dimensional Modelling

An ATV survey was undertaken in borehole STX1904G and a number of discontinuity sets were identified in addition to the flat dipping bedding. Some combinations of discontinuities do produce wedges where failure is kinematically possible, however as the joints are known to be discontinuous across beds, 3D wedge stability analyses have not been undertaken.

2D planar failure has been considered as described in Section 5.2.2. This approach is believed to be conservative.

5.4 Discussion and Conclusions

5.4.1 Required Factor of Safety

Minimum acceptable factors of safety for cut slopes are specified in the current DTMR Geotechnical Design Standards (DTMR 2020) as follows:

> Short Term (During Construction)	1.30
> Long Term (In Service)	1.50
> Seismic Loading	1.10

In service analyses are required to be undertaken with a representative ground condition and as a minimum a pore pressure coefficient of 0.15 shall be used.

A minimum FoS of 1.3 is typically used for the design of mine pit slopes. Slope behaviour for a variety of different strength models is discussed in the sections below.

5.4.2 Sensitivity to Material Properties and Failure Mechanism

Table 5-4 shows a summary of lowest factors of safety for combinations of pit geometry and material properties. The following conclusions may be made from these results.

- Acceptable factors of safety for short term conditions (FoS 1.3) are obtained for pit depths of up to 150m and with adverse bedding plane dip.
- Acceptable factors of safety are obtained using moderately conservative strength parameters
- Acceptable factors of safety are obtained for seismic conditions based on pseudo static analysis at 0.08g

Table 5-4 FoS Summary

Pit Depth (m)	Material Properties	Blasting	Bedding	Case	Failure	FoS	Required FOS	Comments
150[5]	Mean	Good	Flat	Short Term	Circular	2.21	1.3	Acceptable
150	Mean	Good	Flat	Seismic	Circular	2.00	1.1	Acceptable
150	Mean	Good	Adverse	Short Term	Circular	2.29	1.3	Acceptable
150	Mean	Good	Adverse	Short Term	2D Planar	1.82	1.3	Acceptable
150	Lower	Good	Flat	Short Term	Circular	1.73	1.3	Acceptable
150	Lower	Good	Adverse	Short Term	2D Planar	1.46	1.3	FoS 2.64 with pit fill to 2nd bench
100	Mean	Good	Flat	Short Term	Circular	3.41	1.3	Acceptable
100	Mean	Good	Flat	Short Term	2D Planar	3.18	1.3	Acceptable

---

[5] Based on Borehole STX1903A

6 Deformation Analysis

6.1 Introduction

Deformation modelling was undertaken using PLAXIS 2D software. The cross section geometry was identical to the geometry used to develop the slope stability model described in Section 5.2.

6.2 Material Properties

The following material models were used:

> Spoil and Overburden	Mohr Coulomb Model
> Rock and Coal	Mohr Coulomb Model

The material properties used are summarised in Table 4-5.

6.3 Excavation Sequence

Table 6-1 Plaxis Model Sequence

Phase	Description	Comments
Initial Phase	Initial Conditions	No construction
Phase 1	Construct Safety Bunds	
Phase 2	Excavate to 2nd bench RHS	Deformations reset to zero after bund construction
Phase 3	Excavate to 3rd bench RHS	
Phase 4	Excavate to full depth (150m) RHS	
Phase 5	Fill to 3rd bench	
Phase 6	Fill to 2nd bench	
Phase 7	Fill to original ground surface	

Figure 6-1 Plaxis model initial phase and phase 4

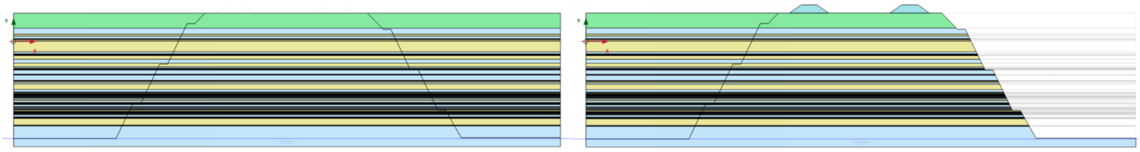
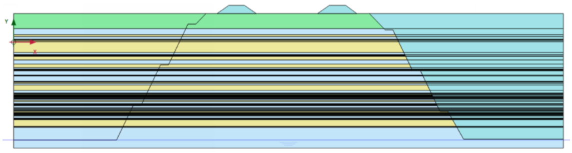


Figure 6-2 Plaxis model phase 7



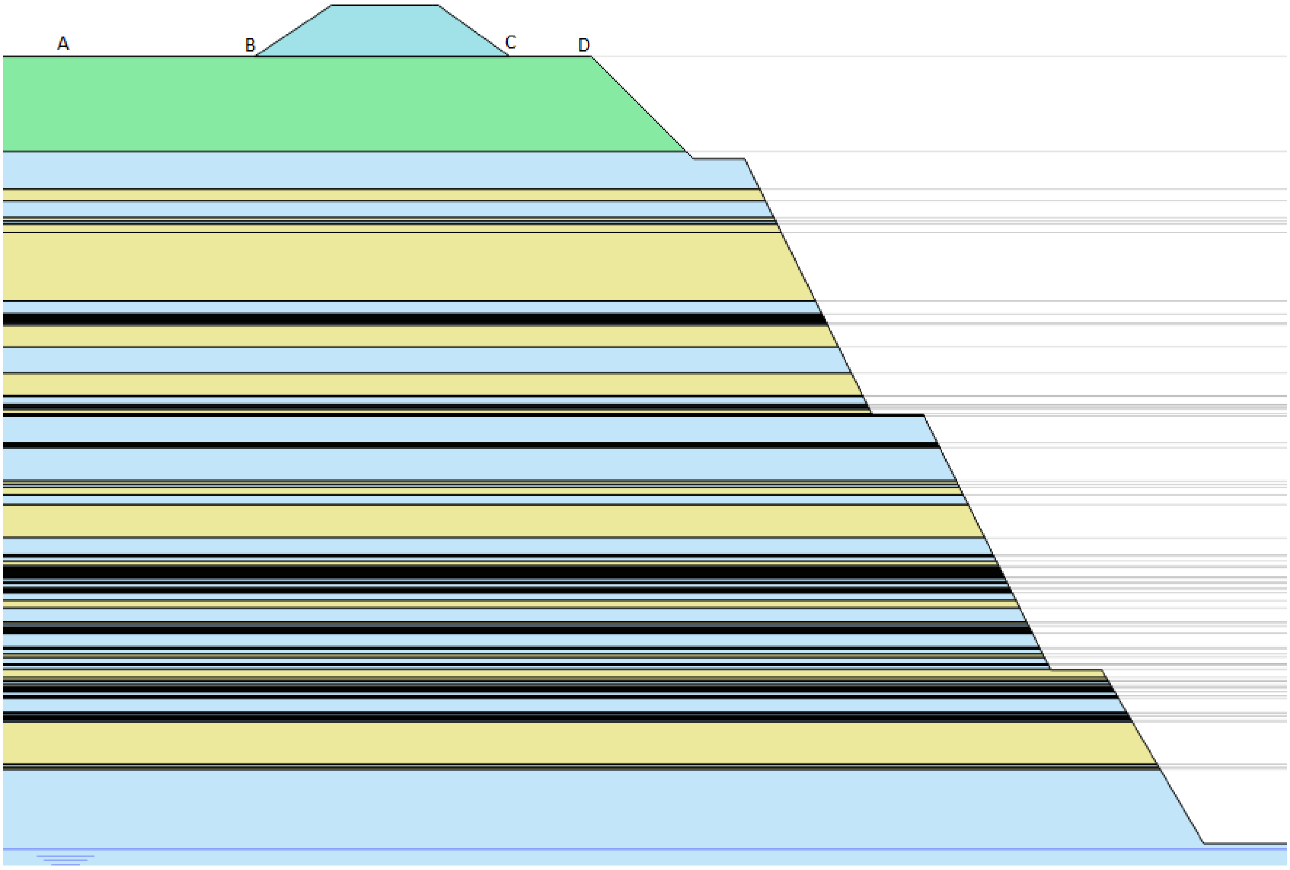
Deformations were output for points as described in Table 6-2 and Figure 6-3.

Additional deformation information including deformed mesh, deformation contours etc. is available from the Plaxis model but has not been presented here. It is understood that the primary concern is horizontal and vertical movement at the highway alignment.

Table 6-2 Deformation Points

Point Number	Node No	Location
A	15952	Road centreline
B	14071	Bund inside edge
C	11031	Bund outside edge
D	8293	Edge of pit

Figure 6-3 Deformation Points



6.4 Results

Calculated deformations are presented in Table 6-3 to Table 6-8. Analyses were prepared for the following in-situ stress conditions:

- Isostatic (K_0 = 1.0)
- Anisotropic (K_0 = 1.5) (Stress conditions are believed to be isotropic for depths less than 150m).
- K_0 determined automatically by Plaxis

Calculated deflection at the highway centreline and RHS pit edge are summarised in Figure 6-4 and Figure 6-5.

Table 6-3 Calculated Horizontal Deformations (mm) Isostatic Stress Condition

	A	B	C	D
Phase 1	0.0	-1.6	1.5	1.5
Phase 2	1.6	1.5	1.6	1.6
Phase 3	6.2	6.9	7.7	7.7
Phase 4	7.8	8.8	10.0	10.0
Phase 5	7.8	8.8	10.0	10.0
Phase 6	7.7	8.9	10.5	10.5
Phase 7	6.9	9.1	13.1	13.1

Table 6-4 Calculated Vertical Deformations (mm) Isostatic Stress Condition

	A	B	C	D
Phase 1	-0.6	-2.1	-2.1	-0.3
Phase 2	0.3	1.1	3.3	5.8
Phase 3	-0.5	0.0	1.8	4.3
Phase 4	-0.9	-0.6	0.9	3.4
Phase 5	-0.9	-0.6	0.9	3.3
Phase 6	-0.8	-0.6	0.6	2.9
Phase 7	-0.8	-1.3	-3.2	-4.3

Table 6-5 Calculated Horizontal Deflections (mm) σ_H=1.5σ_V

	A	B	C	D
Phase 1	0.0	-1.6	1.5	1.0
Phase 2	3.6	4.1	5.3	5.2
Phase 3	12.2	14.8	18.2	18.3
Phase 4	14.8	18.6	23.1	23.5
Phase 5	14.8	18.6	23.2	23.5
Phase 6	14.7	18.6	23.6	24.1
Phase 7	13.8	18.7	26.0	29.8

Table 6-6 Calculated Vertical Deflections (mm) σ_H=1.5σ_V

	A	B	C	D
Phase 1	-0.6	-2.1	-2.1	-0.3
Phase 2	0.3	1.0	2.9	5.2
Phase 3	-1.2	-1.3	-0.8	1.4
Phase 4	-1.8	-2.3	-2.6	-0.5
Phase 5	-1.8	-2.3	-2.6	-0.5
Phase 6	-1.7	-2.2	-2.8	-0.8
Phase 7	-1.7	-2.8	-6.4	-8.0

Table 6-7 Calculated Horizontal Deflections (mm) K0 Automatic

	A	B	C	D
Phase 1	0.0	-1.6	1.5	1.0
Phase 2	-1.1	-2.2	-3.4	-4.0
Phase 3	-0.7	-1.8	-3.1	-3.7
Phase 4	-0.5	-1.5	-2.8	-3.4
Phase 5	-0.5	-1.5	-2.8	-3.4
Phase 6	-0.5	-1.4	-2.4	-3.0
Phase 7	-1.2	-1.1	0.2	1.7

Table 6-8 Calculated Vertical Deflections (mm) K_0 Automatic

	A	B	C	D
Phase 1	-0.6	-2.1	-2.1	-0.3
Phase 2	0.3	1.1	3.7	6.4
Phase 3	0.2	1.1	3.8	6.6
Phase 4	0.1	1.0	3.7	6.5
Phase 5	0.1	1.0	3.7	6.5
Phase 6	0.2	1.0	3.4	6.1
Phase 7	0.3	0.2	-0.4	-1.2

Figure 6-4 Calculated deflections highway centreline

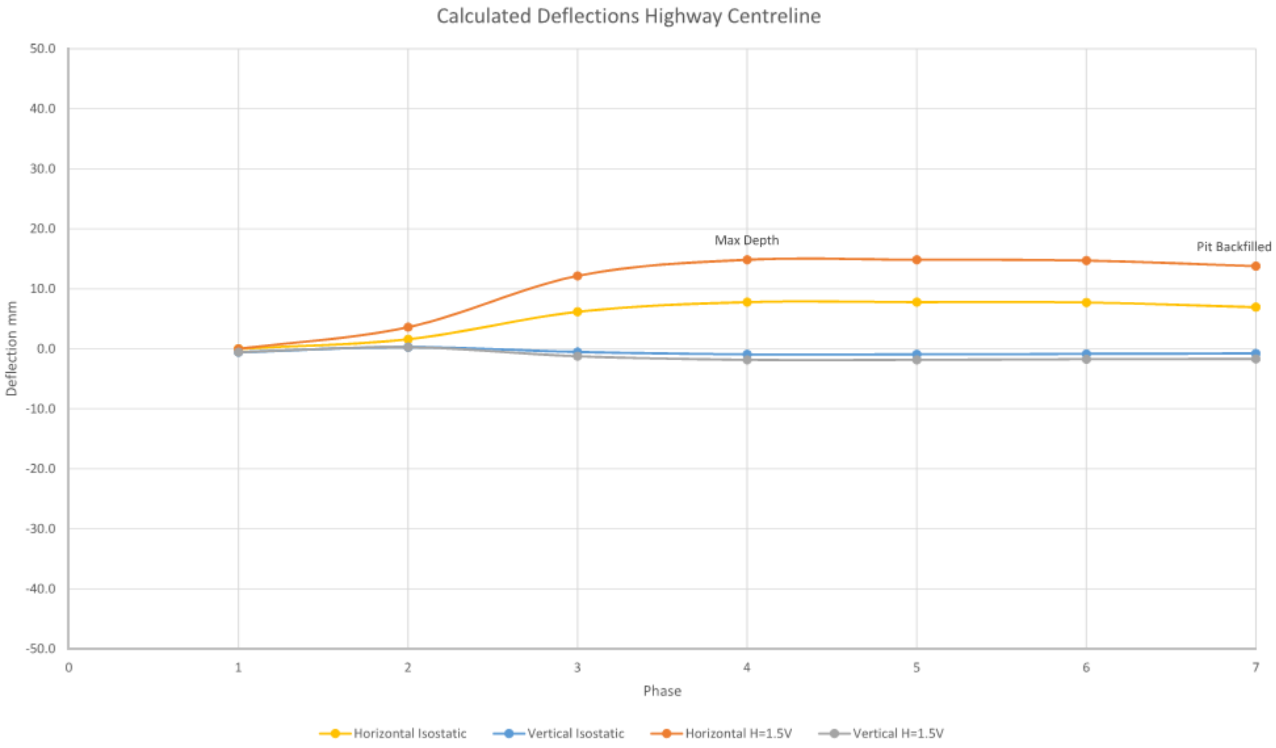
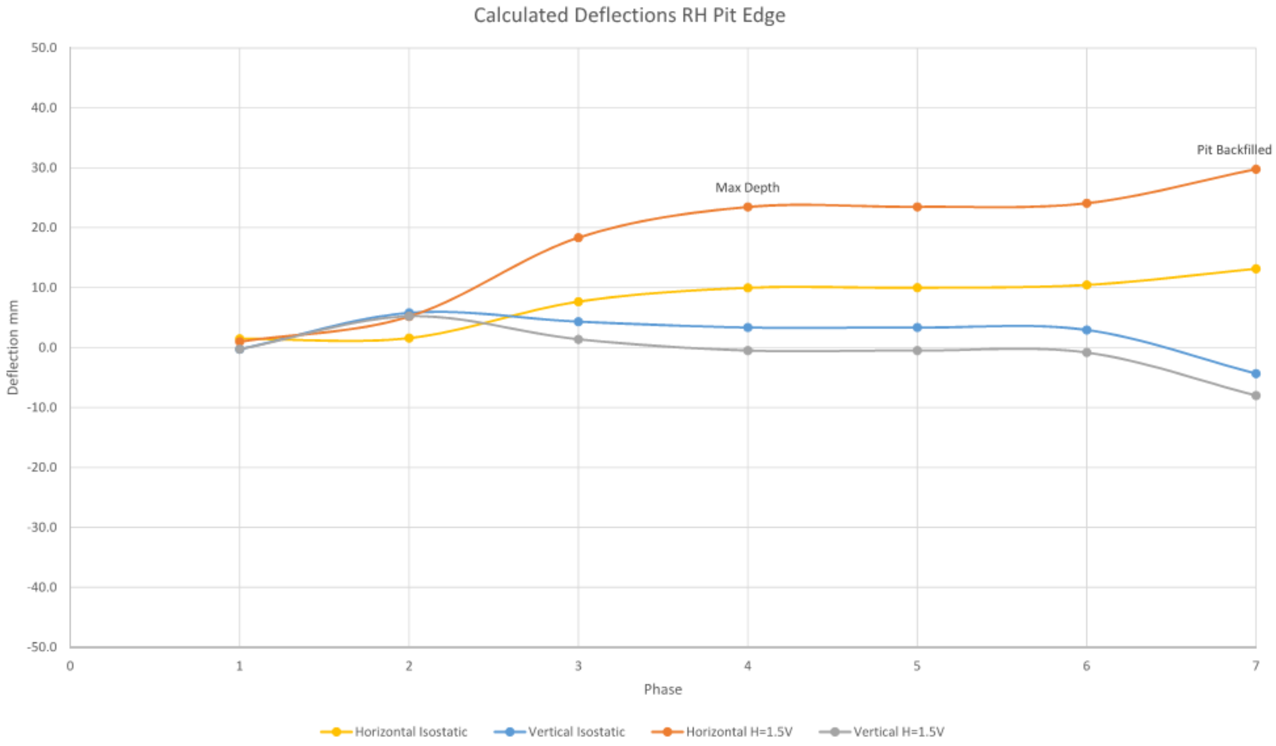


Figure 6-5 Calculated deflections pit edge



6.5 Discussion

Maximum calculated horizontal and vertical deflections at the highway centreline are less than 15mm and 5mm respectively. Maximum calculated horizontal deflection at the pit edge is approximately 30mm. These calculated values are similar to those obtained in the previous study.

Deflections at the highway centreline show very little change on backfilling of the pit.

7 Recommendations on Construction

The following recommendations are understood to be part of the mine development plan.

- Excavation of highwalls adjacent to the highway will not proceed until excavations at a minimum distance of 500m from the highway have been successfully undertaken and the slopes examined and mapped as necessary.
- Geological model to be revised as necessary based on further exploration drilling and mapping as above.
- Highwalls to be excavated using pre-splitting and with appropriate vibration monitoring at all blasts.
- Pits adjacent to the highway be progressively backfilled following coal extraction.
- Pits on both sides of the highway not to be concurrently open.
- Appropriate deformation monitoring systems and inspection regimes to be in place before and during mining operations.
- Appropriate safety measures to be enforced during blasting operations.
- Minimum distances and safety bunds to be maintained.

8 Limitation

Geotechnical and environmental services are provided by Cardno (QLD) Pty Ltd in accordance with generally accepted professional engineering and geologic practice in the area where these services are rendered. The client acknowledges that the present standard in the engineering, geologic and environmental profession does not include a guarantee of perfection, and no other warranty, expressed or implied, is extended by Cardno.

It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein. Cardno assumes no responsibility for misunderstandings or improper interpretations that result in unsatisfactory or unsafe work products. It is the reader's further responsibility to acquire copies of any supplemental reports, addenda or responses to public agency reviews that may supersede recommendations in this report.

The findings presented in this report have been based on the investigation described herein. It is unlikely that the measurements and values obtained from sampling and testing during this investigation will represent the extremes of conditions that may exist within the site. Hence, if any ground conditions different to those described in this report are encountered, further advice should be immediately sought from Cardno.

It is recommended that Cardno be commissioned to provide a review of any design and documentation to confirm that the intents of this report are properly reflected in this design.

This report has been prepared specifically for Waratah Coal Pty Ltd. Information contained in this report should not be construed as appropriate for other purposes or other users.

APPENDIX

A

PREVIOUS STABILITY REPORT

Pits Adjacent to Bruce Highway - Slope Stability Assessment

Central Queensland Coal Project

M30133

Prepared for
Central Queensland Coal

10 May 2018

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Date Approved 11/05/2018

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Executive Summary

This report presents a desktop study on the feasibility of open cut mining operations on either side of the Bruce Highway approximately 25 km northwest of Marlborough, Central Queensland.

Project Details

The proposed development comprises the opening of pit walls parallel to the highway on both sides for a total length of approximately 3 km. The maximum depth of the portions of the pits near the highway is approximately 150m. The total width of the corridor between the pits is approximately 200m, ie the distance from the road centreline to each pit wall is approximately 100m.

Pits on either side of the highway will not be open concurrently and will be backfilled with spoil once the coal has been extracted.

Safety berms will be provided between the highway and the pit walls.

Overburden (surficial soils and weathered rock) will be excavated using standard earthmoving plant with a batter slope of 1H:1V. Rock cuts will be excavated with 45m deep benches and 10m berms with pre-splitting to reduce disturbance.

Geotechnical Information

Most of the geotechnical information supplied is derived from exploration boreholes which were drilled primarily to provide information on the quality and distribution of the coal seams in the project area. Selected boreholes near the highway alignment were re-analysed to provide geotechnical logs. This work was performed by a qualified experienced engineering geologist with R.P.E.Q. certification.

Rock strength properties were derived from logs, downhole sonic velocity tests and laboratory tests on cores from other boreholes in the project area.

Cross sections showing identified coal seams were provided and these together with the re-worked logs were used to prepare geotechnical cross sections for slope stability and deformation analyses. These cross sections were judged to provide a better indication of bedding inclination across the cross sections than could be determined based on the supplied borehole logs.

Geotechnical Analysis Slope Stability

Slope stability analyses were undertaken using GeoStudio software. This software package is preferred by DTMR and availability and expertise with package is a requirement for GE2 and GE3 certification. Initial analyses were performed using a simplified model prepared before detailed mapping of coal seams was made available. The results showed factors of safety in excess of 1.5 for pit depths up to 100m and in excess of 1.3 for pit depths up to 150m using rock strength parameters supplied by AMEC.

Following this analysis, further investigation of rock strength and elastic modulus properties was undertaken and a Hoek-Brown strength model was adopted with rock strength values derived from downhole sonic velocity tests. These were in general somewhat lower than typical laboratory strength values, hence it was judged that the strength model adopted was conservative and could potentially be improved by further investigation and testing.

The analysis produced the following results with probable lower bound strength values:

- 2D circular slip failures produced FOS > 1.5 (As per DTMR requirement) for pit depths to 150m;
- Planar wedge failures produced FOS > 1.5 for pit depths to approximately 125m and > 1.4 for pit depths to 150m;
- Seismic stability is not critical;
- 3D wedge failures not analysed but not considered plausible; and
- Analyses were done with pore pressure coefficient (Ru) = 0.15 as per DTMR requirements (this is considered to be conservative).

Geotechnical Analysis Deformation

Finite element deformation analyses were performed using Plaxis software. This software package is preferred by DTMR and availability and expertise with package is a requirement for GE2 and GE3 certification. Mohr Coulomb modelling was used for overburden and spoil and Hoek-Brown modelling for rock and coal seams.

The analysis showed maximum horizontal and vertical deflections at the highway centreline of 25mm and 8mm respectively. These results are preliminary but indicate that horizontal movement and settlement of the highway alignment is not likely to be significant.

Slope Monitoring

A slope monitoring programme including instrumentation would be required prior to commencement of excavations. This will most likely include installation of inclinometers.

Conclusions

The desktop study has shown that excavation of coal mining pits on either side of the highway is feasible without disruption to the highway. Additional geotechnical investigation is recommended, particularly if pit depths exceed 125m. Requirements for additional investigation would need to be discussed with DTMR before proceeding.

Limitations

This report is a desktop study based on information primarily obtained for the purpose of resource extraction.

This report does not form part of a certified pit design.

Table of Contents

Appendices

Tables

Figures

1 Introduction

This report provides a desktop study of pit stability and likely ground movements associated with proposed mining works approximately 25km northwest of Marlborough, Central Queensland (Refer Figure 1-1). The proposed works comprise the excavation and re-filling of coal mine pits on either side of the Bruce Highway.

Detailed pit designs have not been prepared. The geotechnical information provided has been largely derived from coal exploration boreholes which were drilled to determine the spatial distribution and quality of coal seams. Selected boreholes were re-logged to provide geotechnical information and these logs together with geological commentary are presented in Appendix A.

Figure 1-1 Project Location

This report is a desktop study based on existing information and should not be considered as a final pit wall design. Slope stability and deformation analyses have been prepared for a range of material strength parameters and pit excavation sequences.

Preliminary details of the proposed pits are provided in Section 2.

The information used in the preparation of this report is summarised in Section 3.

Geotechnical Conditions are described in Section 4.

Slope stability and deformation modelling are described in Sections 5 and 6.

2 Pit Configuration

The draft pit designs comprise:

- Box cut in overburden 1H:1V
- Safety berms 10m high with 1.5H:1V slopes
- Rock excavation with 0.5H:1V cut slopes and 10m berms at maximum 50m intervals.

Rock slopes along the road alignment are to be excavated using pre-splitting techniques. The configuration was adopted based on likely available drilling equipment. Slope stability and deformation analyses were performed using geometries based on the concept sketch shown in Figure 2-1. Figure 2-2 shows a typical section for Year 2032, Figure 2-3 shows a typical section for Year 2033. Pits will be back-filled with spoil following extraction of the coal.

At no time will pits be open on both sides of the highway.

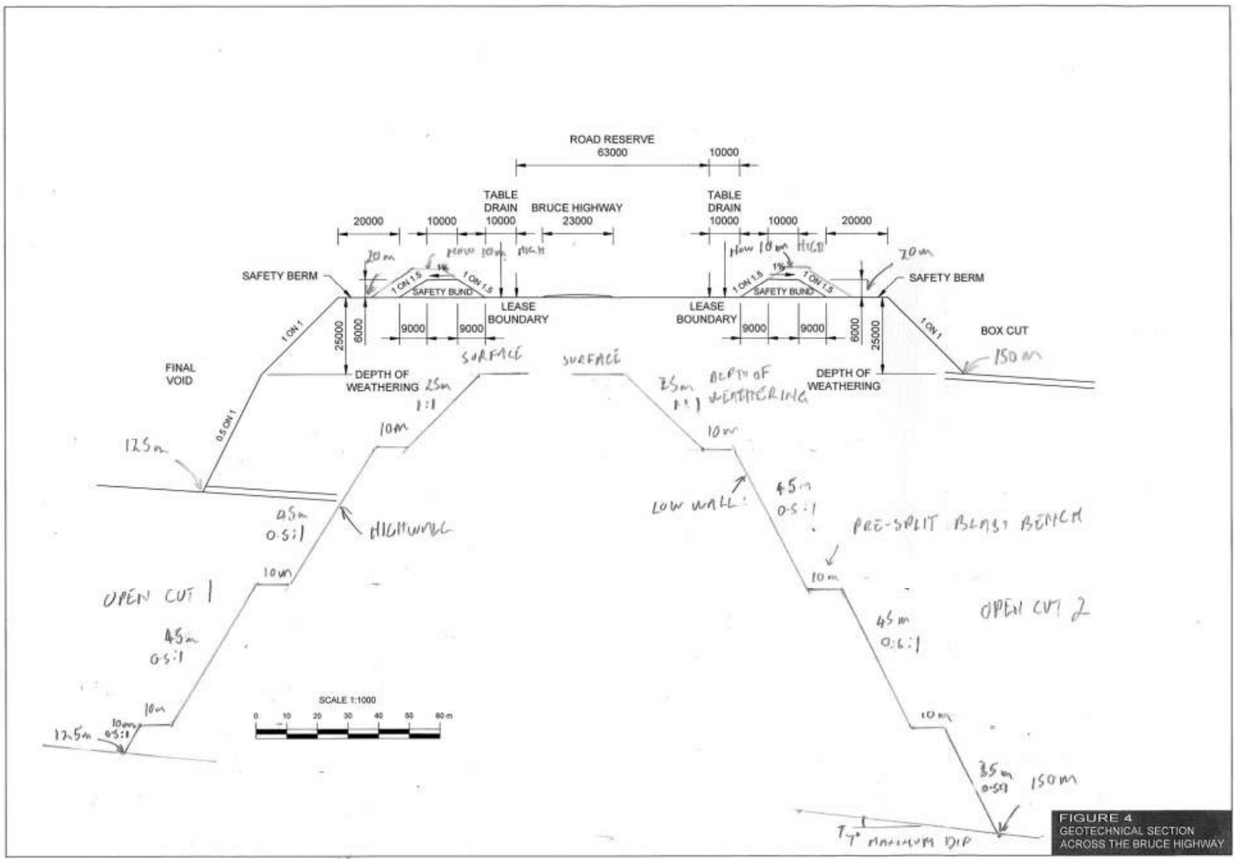


Figure 2-1 Concept Pit Design

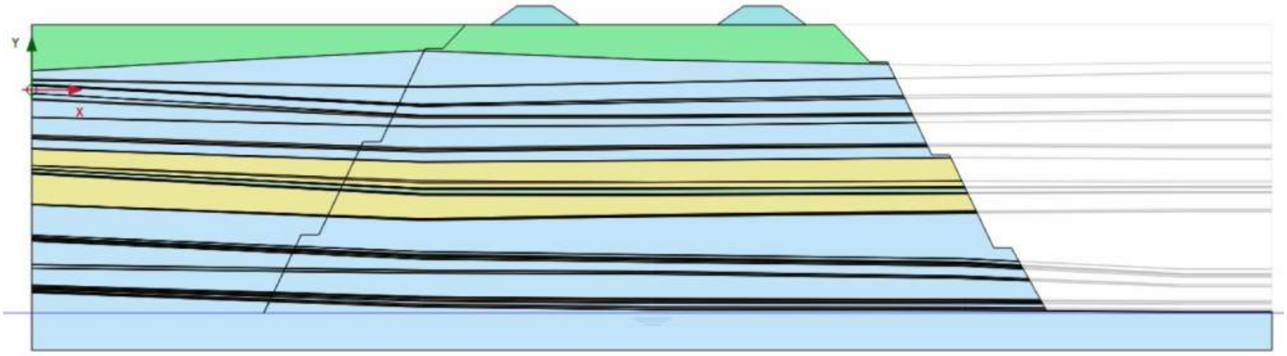


Figure 2-2 Pit excavation year 2032

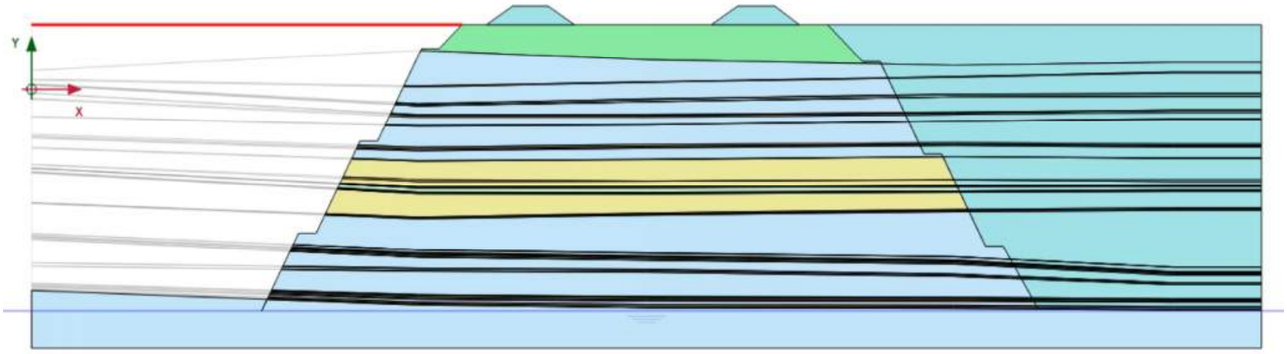


Figure 2-3 Pit excavation year 2033

3 Information Supplied

3.1 Reports

The following reports have been supplied:

- Geotechnical Assessment of Bruce Highway (AMEC 2018)
- Geotechnical Assessment of Open Cut Mining Adjacent to the Bruce Highway, STYX Project (AMEC 2017 a)
- Groundwater Investigations for the Styx Trial Pit (AMEC 2014)
- Geotechnical Report for the Styx Coal Project (AMEC 2017 b)
- Preliminary Investigations for Sediment Dam, Water Storage Dam, Train Loadout and Haul Road, Styx Coal Project (AMEC 2017 c)

3.2 Boreholes

A large number of exploration boreholes have been drilled across the project, however these provide limited geotechnical information due to the absence of detailed geotechnical logging and the remoteness of the boreholes from the highway. A total of 10 boreholes near the highway were re-logged by an engineering geologist; the re-worked logs are presented in AMEC 2018 (Refer Appendix A). Detailed logging of discontinuities was not provided, however some core photos were provided although these do not cover the full cored depth of the boreholes.

Unconfined Compressive strength values derived from downhole sonic velocity logging were provided on some logs.

3.3 Pit Cross Sections

Pit geometries were provided in three stages:

1. Initial sketches provided by George Klenowski (Refer Figure 2-1)
2. Cross Sections with mapped coal layers provided by Michael McShane
3. Cross Sections with revised coal layers provided by Adriaan Benson (Refer Figure 3-1)

A total of five cross sections were provided as shown in Figure 3-1. Stability and deformation models were prepared for Cross Section 5 which had the deepest proposed excavation (Refer Figure 3-2 and Figure 3-3).

Figure 3-1 Location of Cross Sections

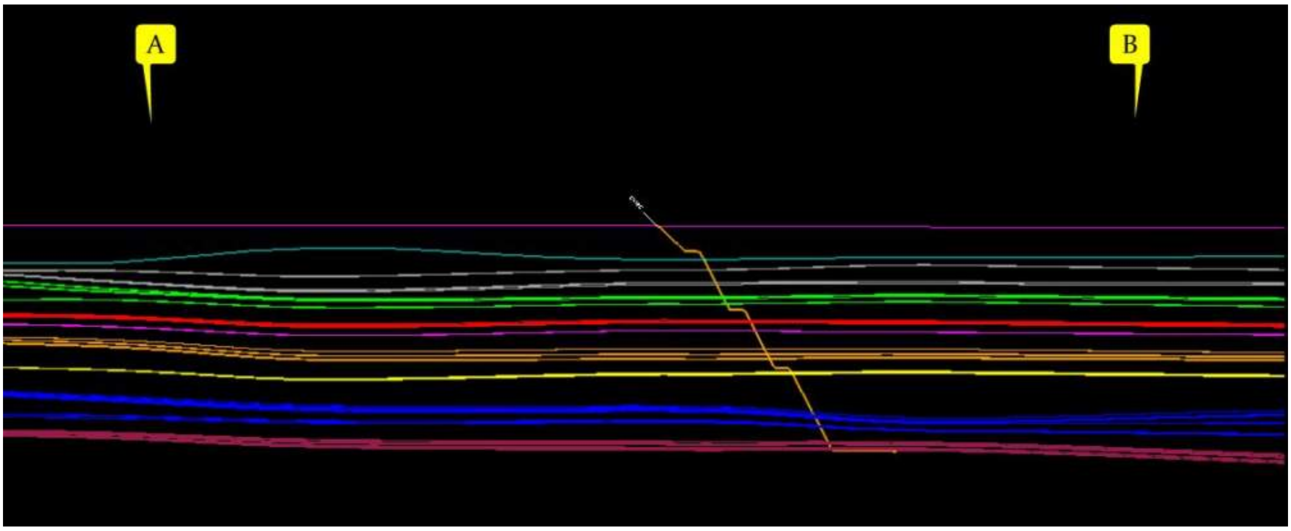


Figure 3-2 XSect 5 NE side

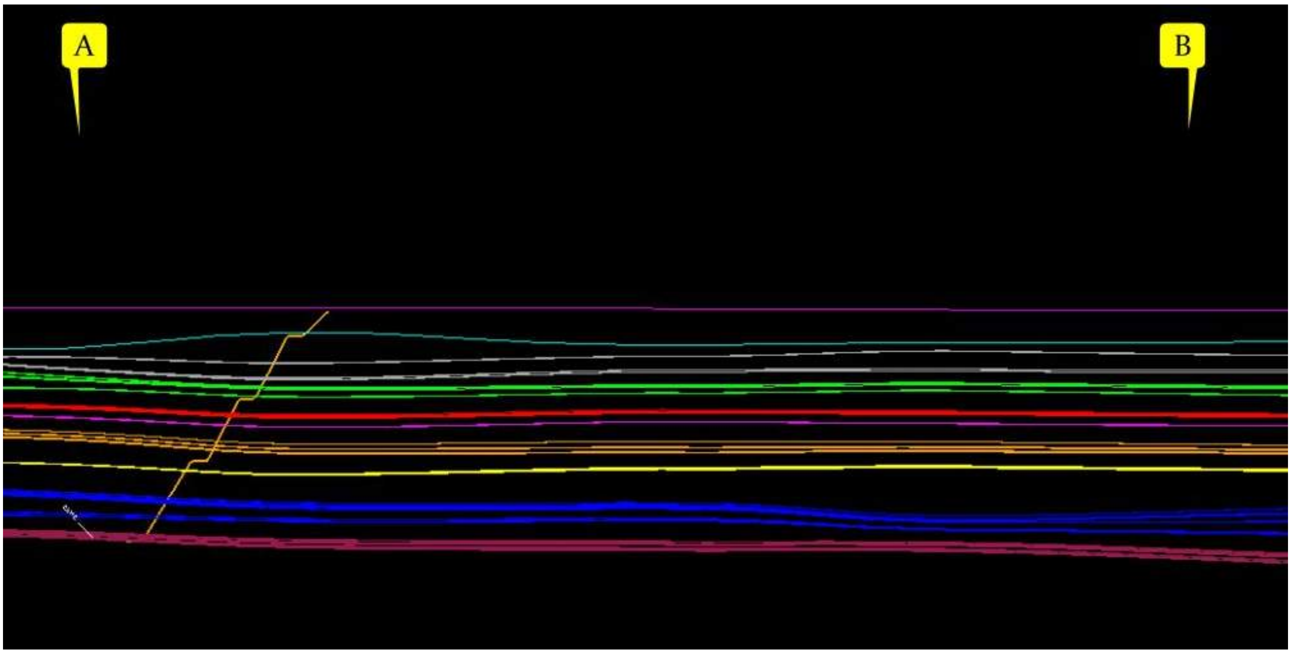


Figure 3-3 XSect 5 NW Side

4 Geotechnical Conditions

4.1 Geology

The local geology is described in Appendix A.

4.2 Material Parameters

4.2.1 Overburden

Refer Table 4-1.

4.2.2 Spoil

Refer Table 4-1.

4.2.3 Rock Strength and Modulus

Initial rock strength parameters were supplied by AMEC (2018) and are summarised in Table 4-1 below. These parameters were used in the initial stability model (Refer Section 5.4.1).

Table 4-1 Initial Material Properties

Material	Density (kN/m3)	Angle of Internal Friction φ (degrees)	Cohesion (kPa)
Overburden (clay and CW rock)	19.6	25	40
Spoil	18.6	34	0
Mudstone CW	18.6	24	60
Mudstone MW	18.6	25	200
Mudstone Fr	19.6	38	200
Siltstone CW	24.5	43	60
Shale Fr Competent	24.5	15	38 400
Sandstone HW	19.6	38	60
Sandstone Fr Weak	24.5	40	200
Sandstone Fr, Competent	24.5	28	27 200
Coal Fr	14.7	35.5	420
Coal CW	11.8	22	0
Soot	11.8	9	0
Intraformational Shear Zone	-	25	9

Additional stability modelling was undertaken based on Hoek-Brown strength parameters (Refer Appendix F). Typical values were derived from lab testing on core samples taken from project boreholes (not the boreholes with geotechnical logs provided). The following process was adopted:

- Determine intact rock modulus from sonic velocity tests (Assume Poisson’s Ratio 0.2);
- Obtain UCS from laboratory test;
- Assign GSI, mi and D parameters based on qualitative assessment of core; and
- Calculate equivalent Mohr-Coulomb parameters using RocLab software.

The measured and derived rock properties are summarised in Table 4-2

Table 4-2 Rock Strength Parameters from Laboratory Tests

Sample	Rock Type / Failure Mechanism	Sonic Velocity (m/s)	UCS (MPa)	Young's Modulus (GPa)	GSI	mi	d	c (MPa)	Φ (deg)
STX084RR - GT001	Sandstone Shear Failure	3333	25.2	18.20	70	17	0	2.00	41.0
STX084RR - GT002	Sandstone Conical Failure	2323	4.6	8.30	40	17	0	0.23	32.1
STX084RR - GT003	Siltstone shear failure	n/a	5.02	n/a	n/a	n/a	n/a	n/a	n/a
STX084RR - GT004	Sandstone Shear Failure	3458	24.5	21.01	50	17	0	1.43	35.1
STX084RR - GT005	Sandstone Shear Failure	2938	20.9	14.25	70	17	0	1.66	41.0
STX084RR - GT007	Sandstone Shear Failure	3049	5.43	16.09	30	17	0	0.23	29.0
STX084RR - GT008	Mudstone Shear Failure	2938	18.4	13.62	30	7	0	0.57	21.8
STX084RR - GT009	Siltstone Shear Failure	3731	36.6	25.76	40	7	0	1.37	24.7
STX084RR - GT010	Sandstone Shear Failure	3004	18	15.20	70	7	0	1.21	33.1
STX084RR - GT011	Sandstone Shear Failure	3080	19.3	16.92	50	17	0	1.13	35.1
STX084RR - GT012	Sandstone Shear Failure	3223	30.5	16.88	50	17	0	1.78	35.1
STX084RR - GT013	Mudstone shear Failure	2702	19.6	12.54	40	7	0	0.74	24.7
STX090RR - GT001	Mudstone shear Failure	2144	3.56	6.74	30	7	0	0.11	21.8
STX090RR - GT002	Sandstone Conical Failure	n/a	6.25	n/a	n/a	n/a	n/a	n/a	n/a
STX090RR - GT003	Sandstone Shear Failure	2825	19.4	12.91	40	17	0	0.98	32.1
STX090RR - GT004	Mudstone Shear Failure	3072	22.8	15.15	40	7	0	0.86	24.7
STX090RR - GT005	Mudstone Shear Failure	2861	16.1	13.19	40	7	0	0.60	24.7
STX090RR - GT006	Siltstone Axial Failure	2984	11.7	14.29	40	7	0	0.44	24.7
STX090RR - GT007	Sandstone Shear Failure	2974	21.5	14.55	40	17	0	1.08	32.1
STX090RR - GT010	Mudstone Shear Failure	2929	12	13.88	40	7	0	0.45	24.7

GSI, mi and d are Hoek-Brown parameters, Mohr Coulomb c and φ derived using RocLab Software

UCS and sonic velocity measured in tests on core

4.2.4 Composite Strength Model

Core logs showed mixed sandstone/siltstone/mudstone in many instances making it impractical to model individual rock strata. In addition, the initial slope stability modelling showed failure surfaces passing through the flat dipping strata at steep angles, hence a composite strength model was used with parameters defined in Table 4-3 on the following page. UCS values were determined from those shown on bore logs, these values were in turn derived from down-hole sonic tests as described in AMEC (2018).

:

Table 4-3 Composite Strength Properties

Material Type	Bulk Density (kN/m^3)	c(kPa)	Φ(deg)	E' (GPa)	v	σ_{ci} (MPa)	m_i	GSI	D
Spoil	18.6	0	34	N/A Mohr Coulomb model only					
Overburden	19.6	40	25	N/A Mohr Coulomb model only					
Mixed Sedimentary High	24	0.75	30.5	15	0.3	15	10	50	0
Mixed Sedimentary Low	14.7	350	24.6	10	0.3	10	10	30	0
Coal	14.7	670	21.8	10	0.3	10	7	30	0
Sandstone Fr	24	2375	41	15	0.3	30	17	70	0

4.2.5 Discontinuities

Bedding is generally uniform with an average dip of 3°. Maximum dip is about 7°. Partings occur along bedding planes. Jointing is generally widely spaced. Limited core photo data and geophysical logging of boreholes did reveal occasional discontinuities with steeper apparent dips, the persistence of such discontinuities is unlikely to be sufficient to permit the formation of other than small wedges.

To date no significant faults or dykes have been encountered during geological investigations.

5 Slope Stability Modelling

5.1 Introduction

Slope stability modelling was undertaken using the GeoStudio software package. Cross section geometries for the detailed model were generated from AutoCad files derived from 3d mining software used to map coal measures. These were supplied as AutoCad files and imported into GeoStudio as pictures. The stratigraphy between coal beds was filled in by referring to geotechnical borehole logs with sonic logs used to select appropriate strength properties.

5.2 Failure Modes Considered

5.2.1 2D Slip Circle Failure in Overburden

Overburden failure surfaces were modelled together with 2D rock failure surfaces. Where a lower FOS was calculated in the overburden this was noted in the results summary in Table 5-2.

5.2.2 2D Failure Surface in Rock

5.2.2.1 Circular Failure Surfaces

These were modelled using the Morgenstern and Price method.

5.2.2.2 2D Planar Failures

These were modelled assuming the presence of a thin layer with properties equivalent to the intra formational sheared zone as described in Table 4-1. At this stage there is no information as to whether such zones are continuous between beds. Zones were modelled at several locations at the top of coal seams.

5.2.3 3D Wedge Failure

Wedge failures have not been modelled. Occasional steeply dipping discontinuities were observed in core photos, however it is considered unlikely that the persistence of such discontinuities will be large enough to allow the development of large wedge failures affecting the highway. Small wedge failures in benches may be possible.

5.2.4 Toppling Failure

Toppling failures were not modelled and are considered unlikely considering the 0.5H:1V cut slopes.

5.3 Material Parameters

Material Parameters used are described in Section 4.2. Rock parameters were determined based on rock type and UCS derived sonic velocities from boreholes.

5.4 2D Slip Surface Models

5.4.1 Initial Model

5.4.1.1 Model Configuration

Initial modelling was done using pit geometry and stratigraphy based on borehole information (Borehole STX050). The boreholes with geotechnical logs did not provide sufficient information to determine the dip and dip direction of the bedding; for this preliminary study two models were prepared with zero bedding dip and constant 7° dip across the section as shown in Figure 5-1 and Figure 5-2 on the following page.

Material strength parameters from Table 4-1 were used. Fresh sandstone was modelled using the “weak” strength values ie $c=200$ kPa, $\varphi=40°$.

A perched water table was modelled, ie pore pressures were only considered in the overburden.

Additional modelling for the detailed model was undertaken using a pore pressure coefficient (R_u) of 0.15 as per Section 3.3.2 of the DTMR Geotechnical Design Standard.

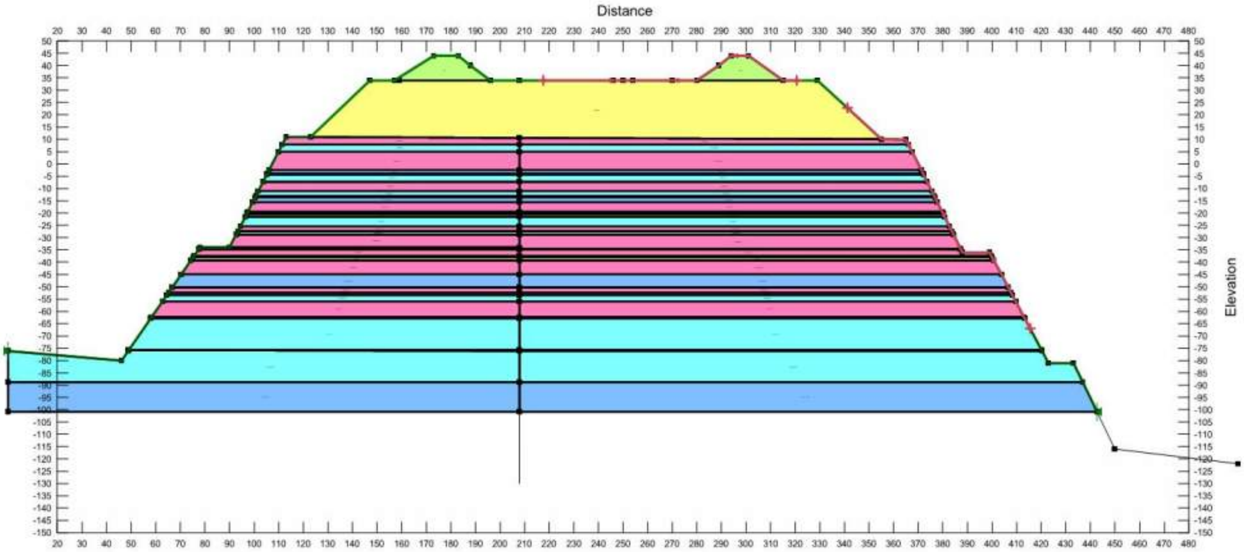


Figure 5-1 Initial Slope Stability Model Zero Bedding Dip

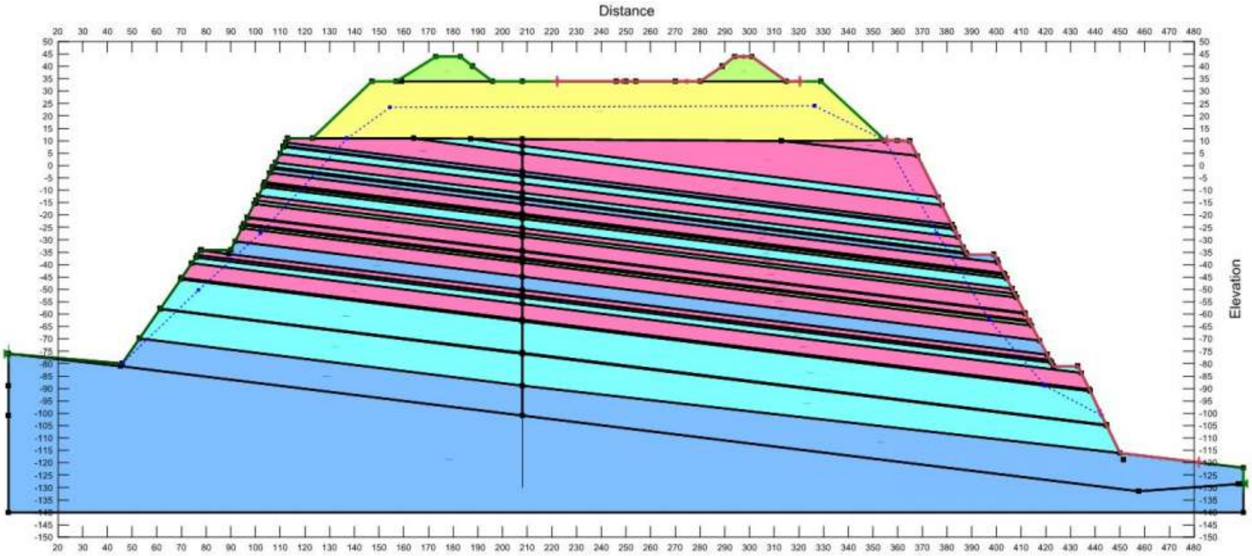


Figure 5-2 Initial Slope Stability Model 7° Bedding Dip

5.4.1.2 Results

The results of the preliminary slope stability analysis are summarised in Table 5-1.

Table 5-1 Slope Stability Results Preliminary Model

Model Geometry	Pit Depth	Water Table	FOS	Comments
Zero Dip	100m	Perched 11m deep	1.52	Refer Figure 5-3
	150m	Perched 11m deep	1.33	Refer Figure 5-4
7°Dip	100m	Perched 11m deep	1.57	Refer Figure 5-5
7°Dip	150m	Perched 11m deep	1.34	Refer Figure 5-6

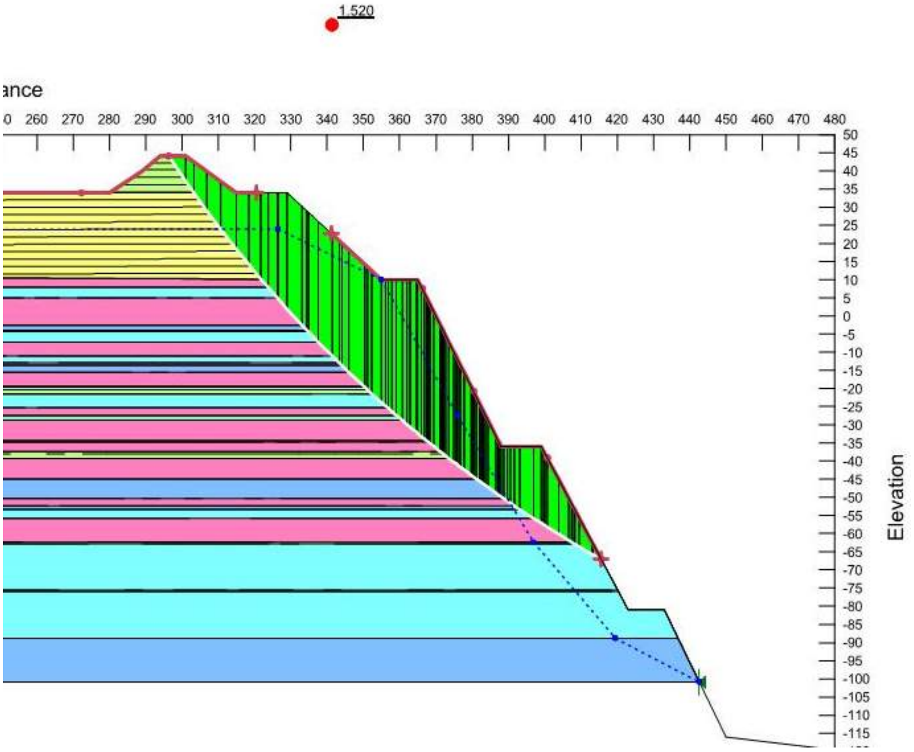


Figure 5-3 Failure Surface Zero Dip 100m pit depth

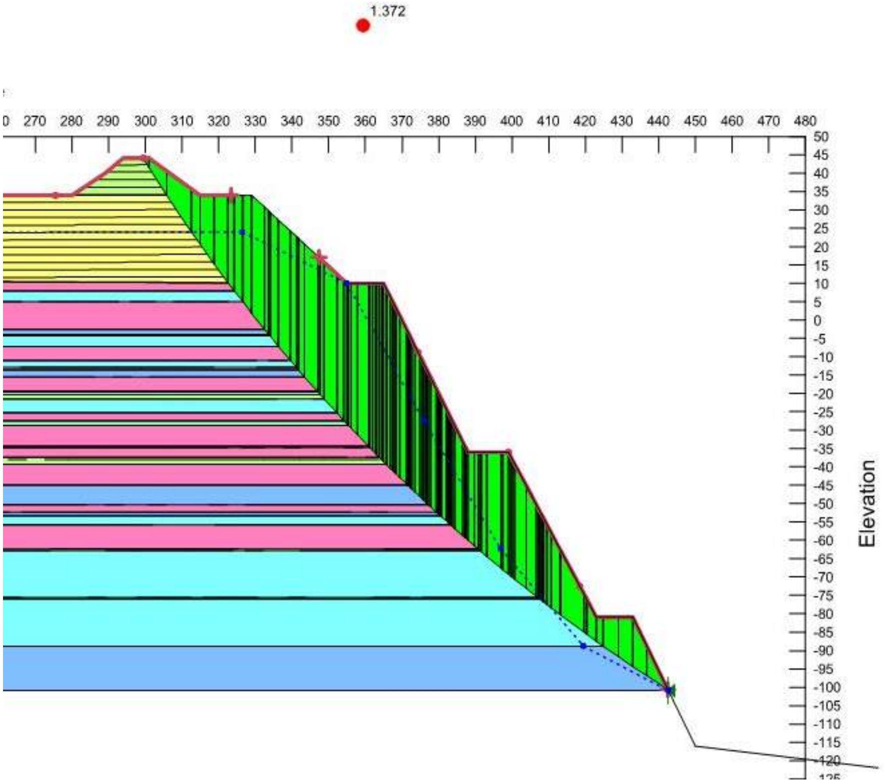


Figure 5-4 Failure Surface Zero Dip 150m pit depth

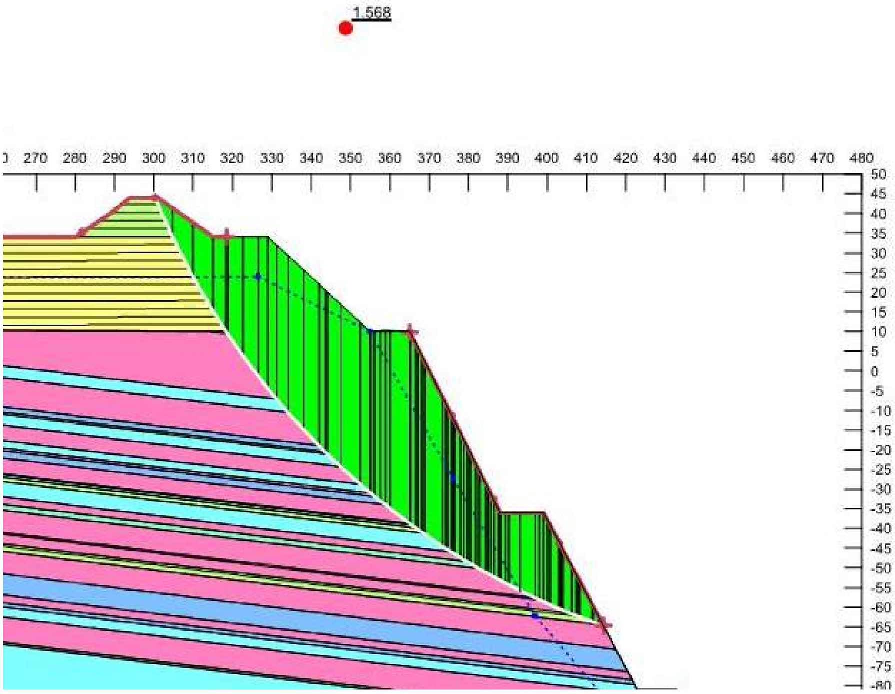


Figure 5-5 Failure Surface 7° Dip 100m pit depth

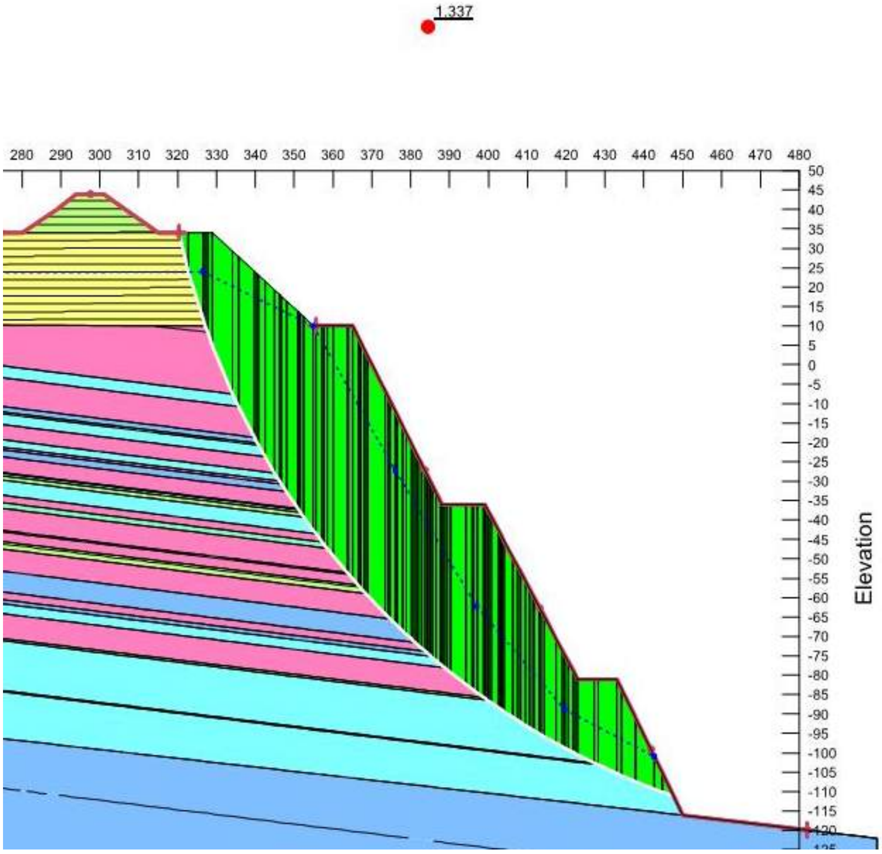


Figure 5-6 Failure Surface 7° Dip 150m pit depth

5.4.1.3 Discussion

The initial modelling showed factors of safety in excess of 1.5 for pit depth up to 100m and in excess of 1.3 for pit depths up to 150m. Further stability modelling was done using a model based on Hoek brown material parameters and stratigraphy based on 3D modelling of coal seams as described in Section 3.3.

5.4.2 Detailed Model

5.4.2.1 Model Setup

Following receipt of cross sections with coal seam depths derived from 3D pit modelling a revised slope stability analysis was performed. Hoek-Brown strength parameters were derived from logs and UCS values from sonic velocities. As many of the logs showed finely interbedded sandstone, siltstone and mudstone, a mixed sedimentary model was adopted as described in Section 4.2.4.

A perched water table was modelled, i.e. pore pressures were only considered in the overburden.

Additional modelling was undertaken using a pore pressure coefficient (R_u) of 0.15 as per Section 3.3.2 of the DTMR Geotechnical Design Standard.

5.4.2.2 Results

A summary of results is presented in Table 5-2. These analyses are for open pits.

Table 5-2 Slope Stability Results Revised Model

Model Geometry	Pit Depth	Water Table	FOS	Comments
High Strength RHS	100m	Perched	1.54/2.00	Lower value is failure in overburden Refer Figure 5-7
High Strength LHS	Full Depth	Perched	2.07	Refer Figure 5-8
Low Strength RHS	Full Depth	Perched	1.02	Refer Figure 5-9
Low Strength RHS	100m	Perched	1.34	Refer Figure 5-10
Probable Lower Bound Strength RHS	Full Depth	Perched	1.54/1.65	Lower value is failure in overburden Refer Figure 5-11
Probable Lower Bound Strength RHS	Full Depth	Perched	1.63	Refer Figure 5-12
Probable Lower Bound Strength RHS	100m	R_u 0.15	1.62/1.91	Lower value is failure in overburden Refer Figure 5-13
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	1.56	Refer Figure 5-14
Planar Failure RHS	100m	R_u 0.15	1.73	Refer Figure 5-15
Planar Failure RHS	125m	R_u 0.15	1.43	Unfavourable geometry on dipping coal seam Refer Figure 5-16
Planar Failure RHS	Full Depth	R_u 0.15	1.44	Figure 5-17
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	1.41	Pseudo static seismic 0.08g Refer Figure 5-18

Table 5-3 Slope Stability Results – Pit Filling

Model Geometry	Pit Depth	Water Table	FOS	Comments
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	1.88	Pit filled to bottom of 2nd bench Refer Figure 5-19.
Probable Lower Bound Strength RHS	Full Depth	R_u 0.15	2.80	Pit filled to bottom of 1st bench Refer Figure 5-20.

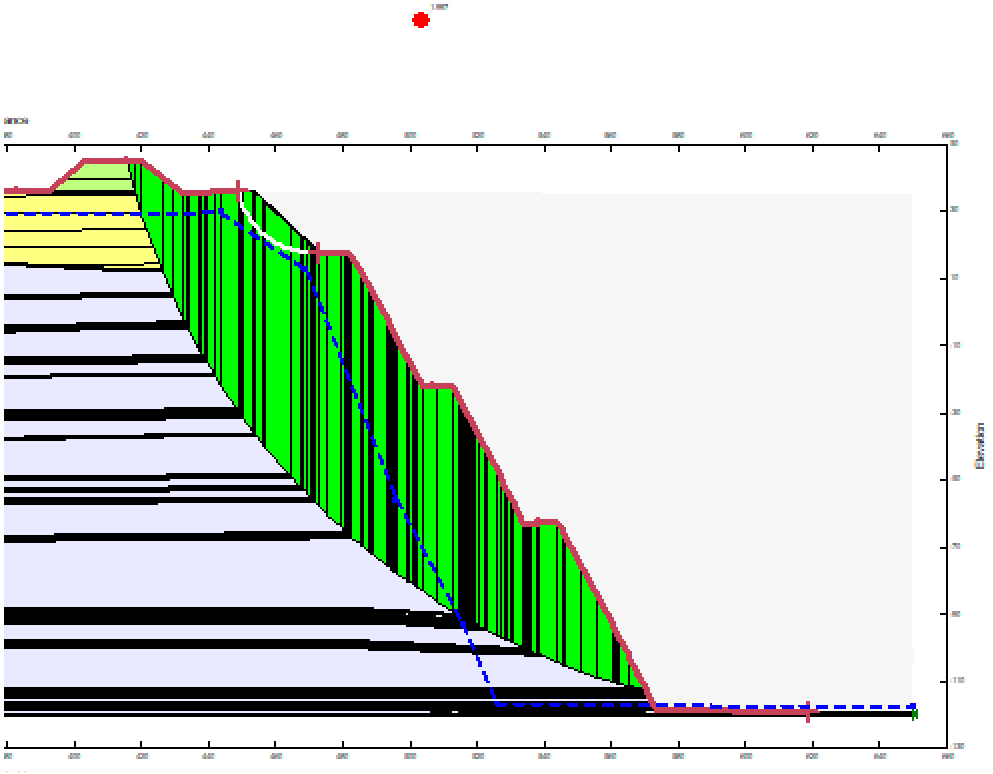


Figure 5-7 High Strength Model 150m Pit RHS

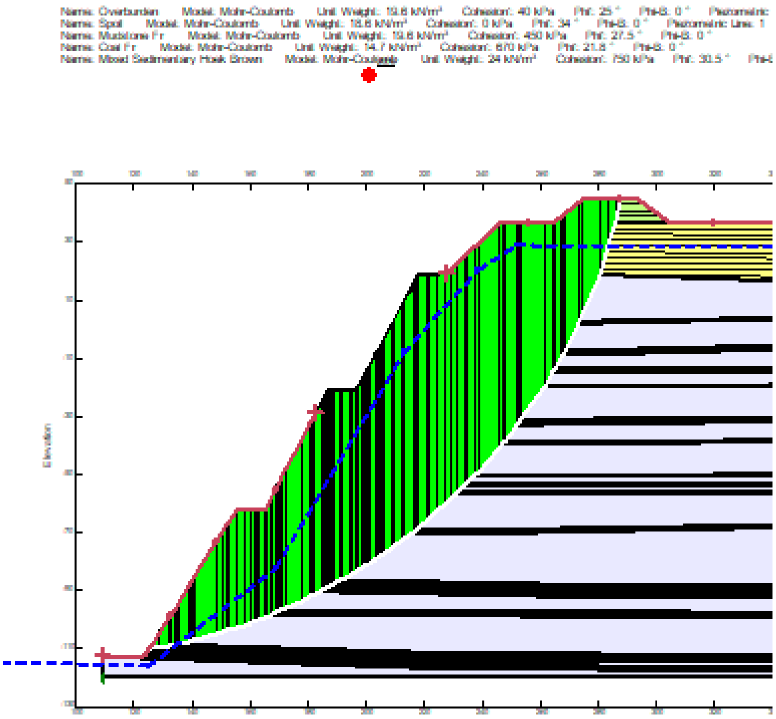


Figure 5-8 High Strength Model 150m Pit LHS

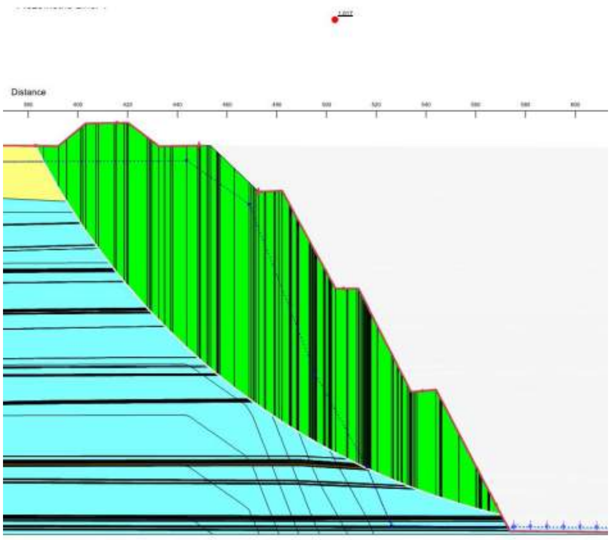


Figure 5-9 Low Strength Model Full Depth \ Pit RHS

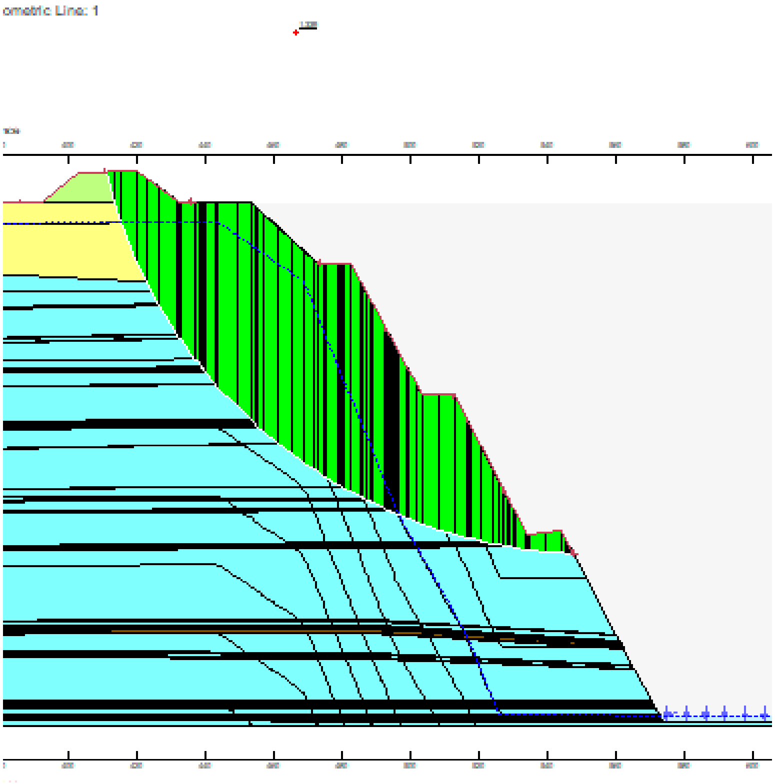


Figure 5-10 Low Strength Model 150m Pit RHS

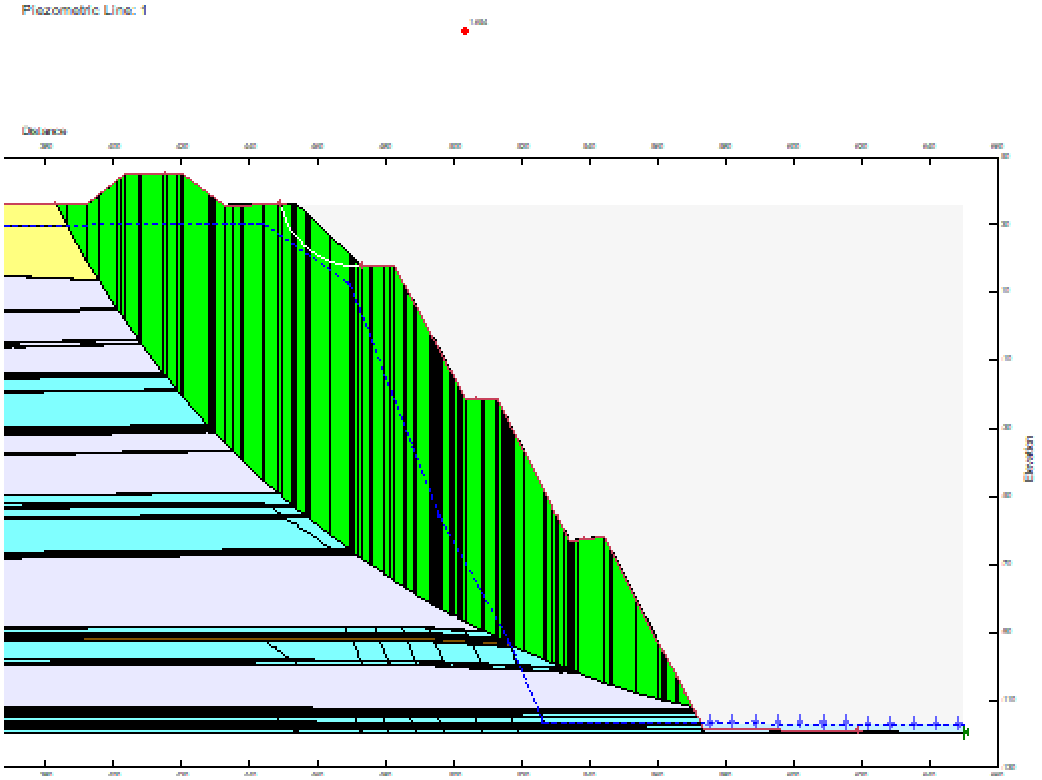


Figure 5-11 Lower Bound Strength RHS

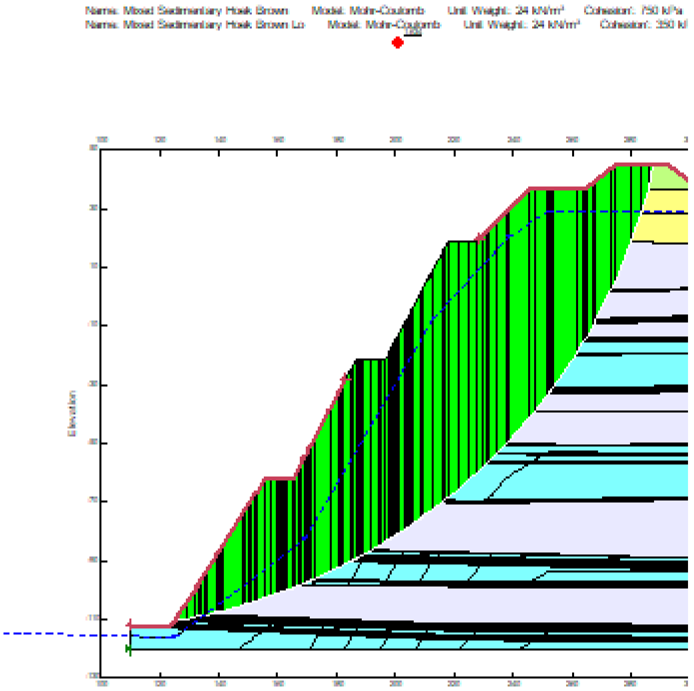


Figure 5-12 Lower Bound Strength LHS

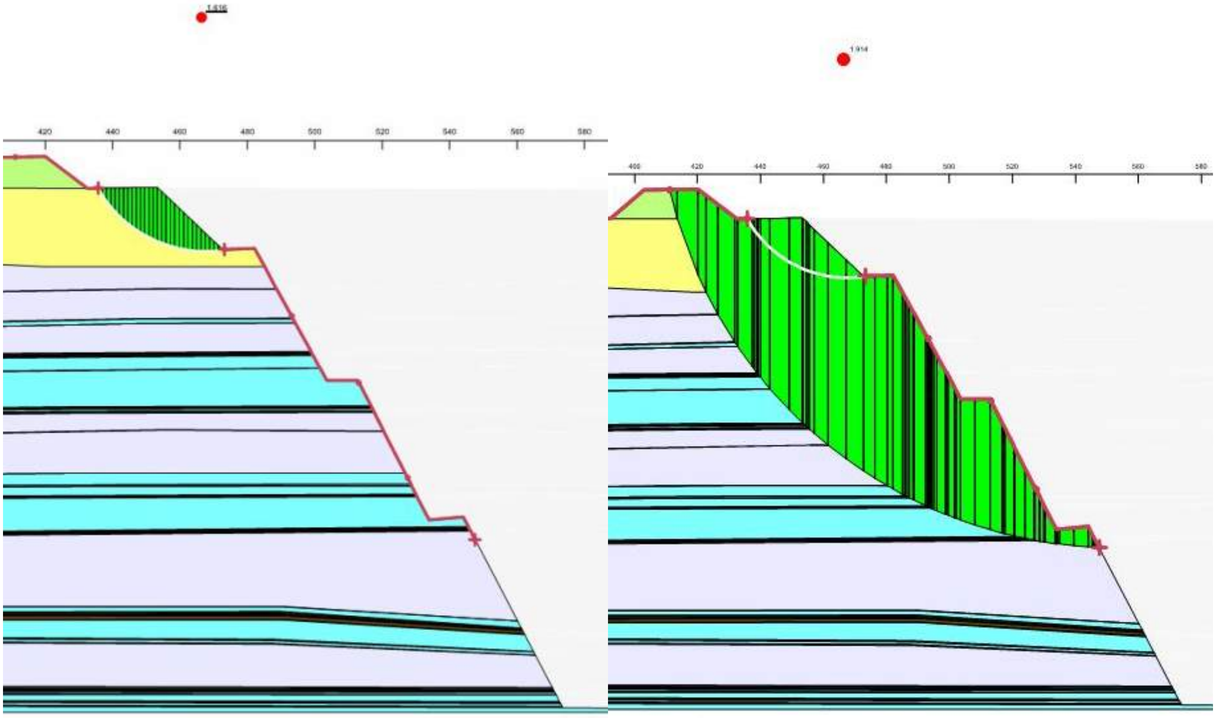


Figure 5-13 Lower Bound Strength R_u 0.15 100m deep pit RHS

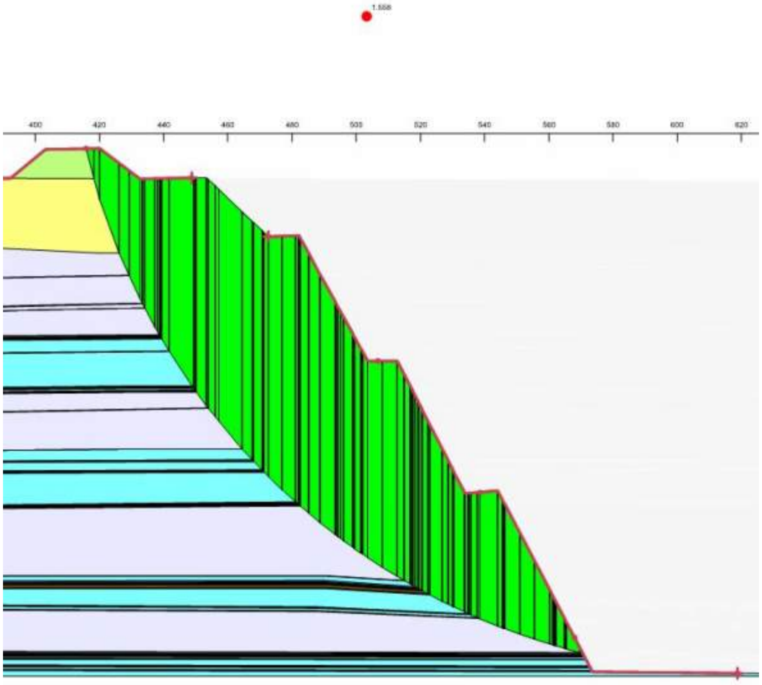


Figure 5-14 Lower Bound Strength R_u 0.15 full depth pit RHS

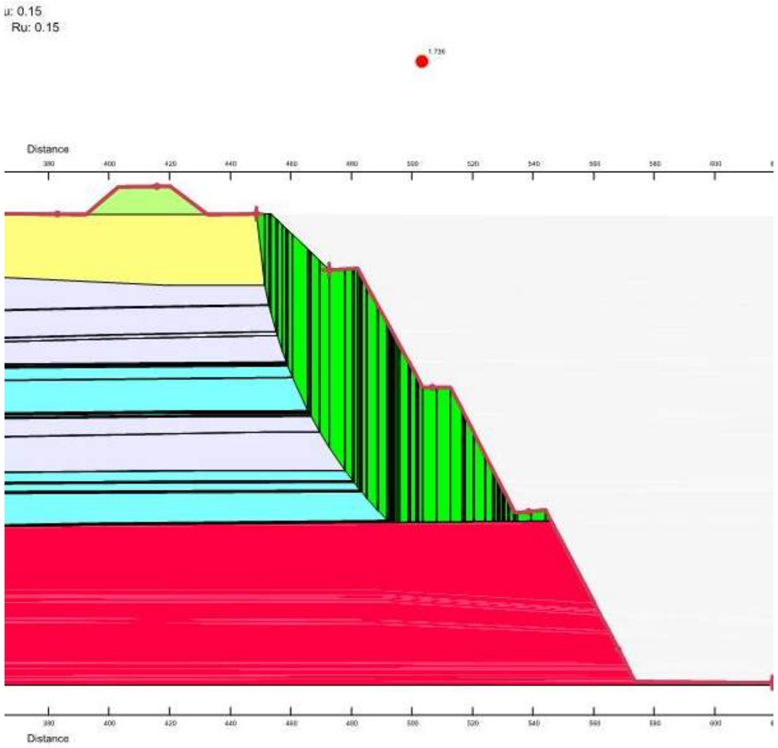


Figure 5-15 Planar Failure 100m deep pit

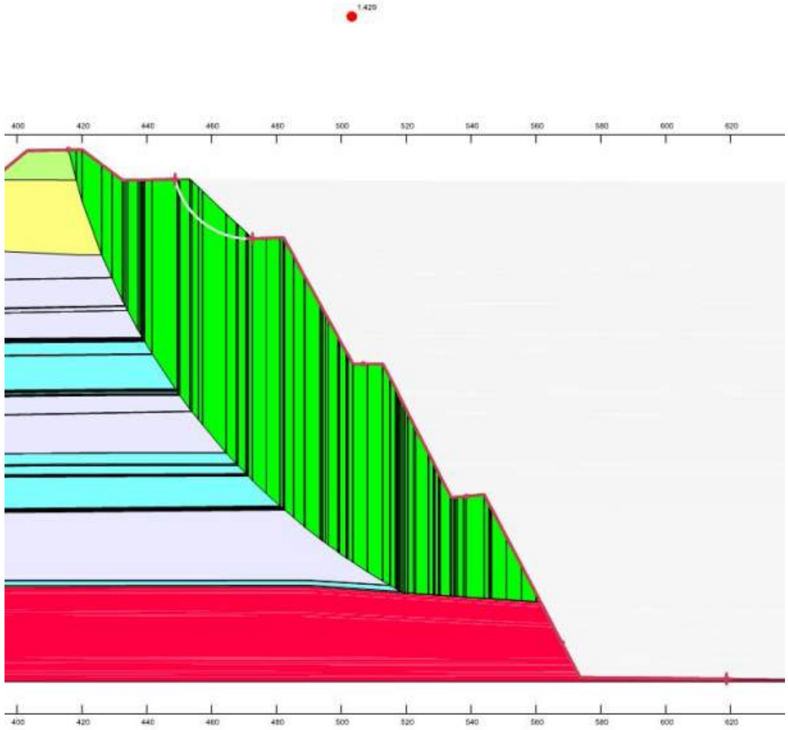


Figure 5-16 Planar Failure Unfavourable Dip

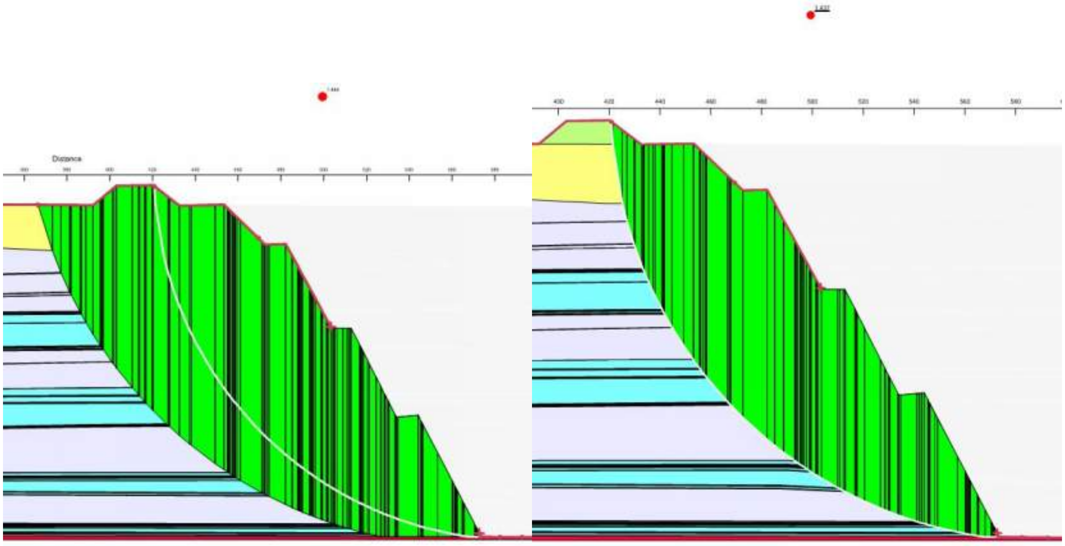


Figure 5-17 Planar Failure bottom coal seam

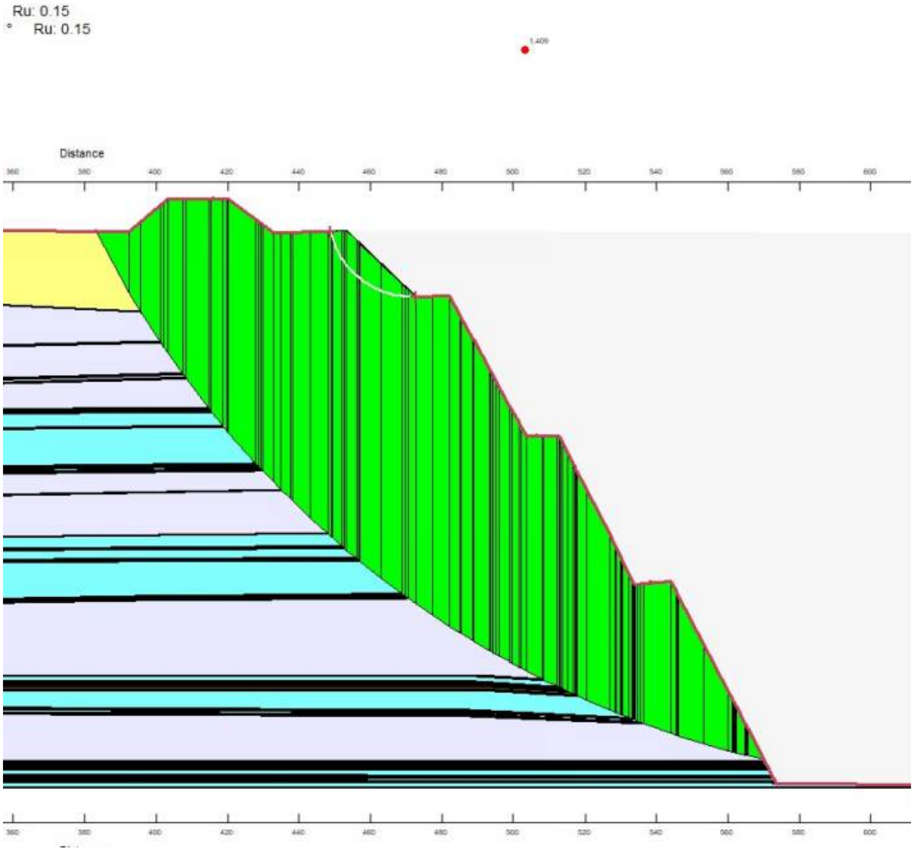


Figure 5-18 Full Depth Pit RHS Pseudo Static 0.08g

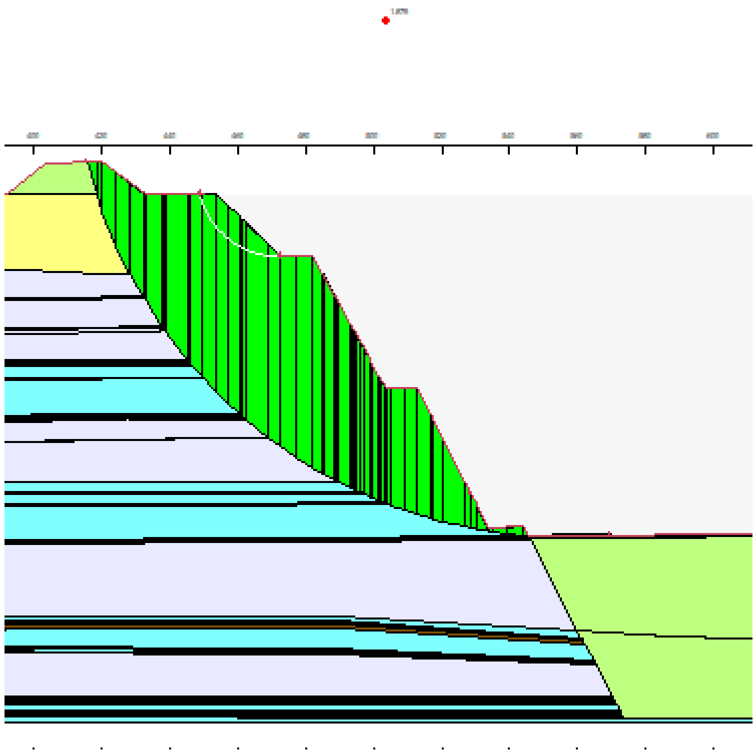


Figure 5-19 Partial Pit Filling Stage 1

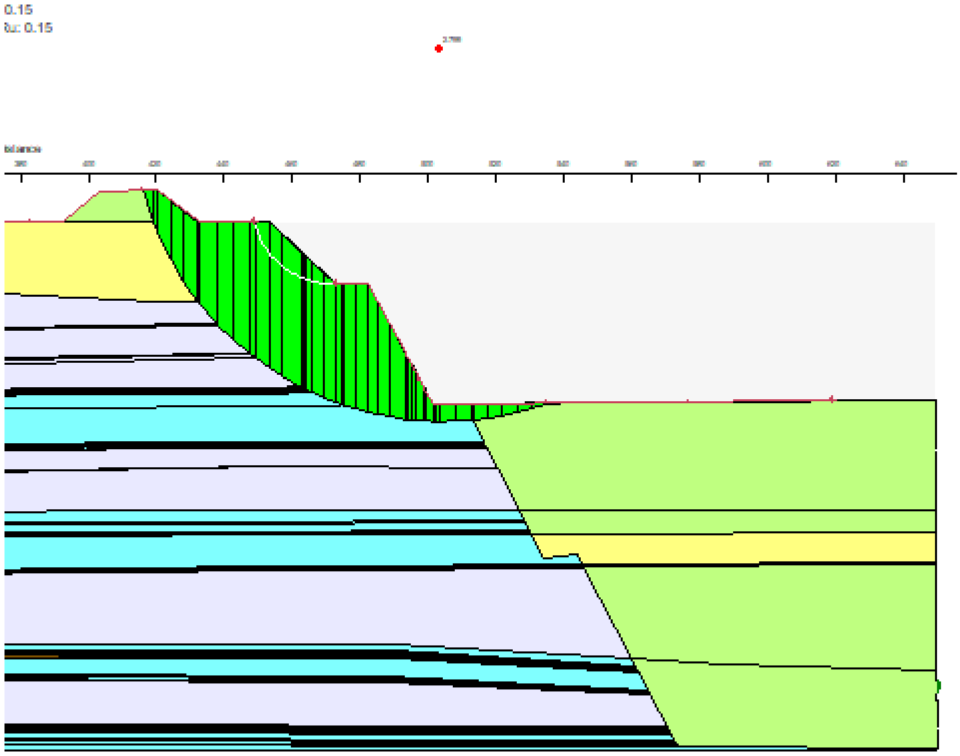


Figure 5-20 Partial Pit Filling Stage 2

6 Deformation Modelling

6.1 Introduction

Deformation modelling was undertaken using PLAXIS 2D software. The cross section geometry was identical to the geometry used to develop the slope stability model described in Section 5.4.2.

6.1.1 Material Properties

The following material models were used:

> Spoil and Overburden	Mohr Coulomb Model
> Rock and Coal	Hoek Brown Model

The material properties used are summarised in Table 4-3.

6.1.2 Excavation Sequence

Table 6-1 Plaxis Model Sequence

Phase	Description	Comments
Initial Phase	Initial Conditions	No construction
Phase 1	Construct Safety Bunds	
Phase 2	Excavate to base of overburden RHS	
Phase 3	Excavate to bottom of 1st bench RHS	
Phase 4	Excavate to middle of 2nd bench RHS	Base of coal seam approx. 100m deep
Phase 5	Excavate to middle of 3rd bench RHS	
Phase 6	Excavate to bottom of deepest mapped coal seam RHS	Full pit depth
Phase 7	Fill to bottom of 1st bench	
Phase 8	Fill to base of overburden	
Phase 9	Fill to original ground level	
Phase 10	Excavate to base of overburden LHS	
Phase 11	Excavate to approx. RL -10 LHS	
Phase 12	Excavate to approx. RL -65 LHS	
Phase 13	Excavate to bottom of deepest mapped coal seam	

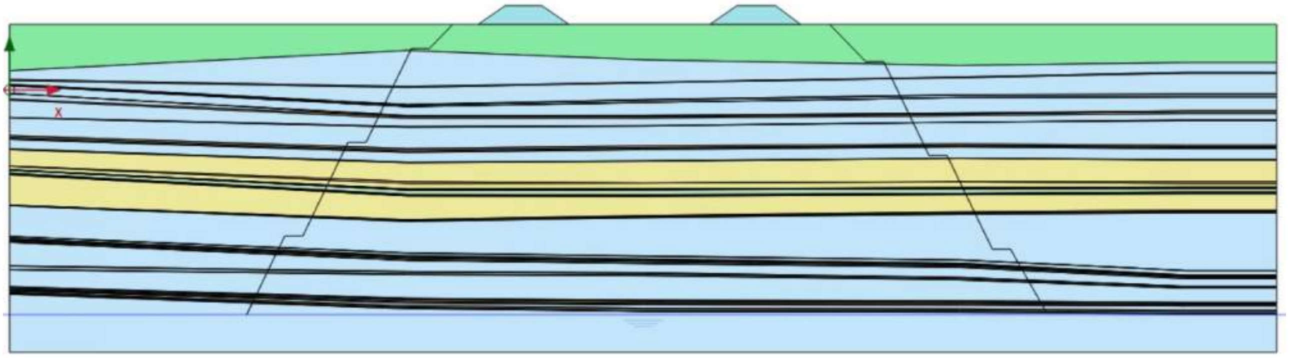


Figure 6-1 Plaxis Model Initial Phase

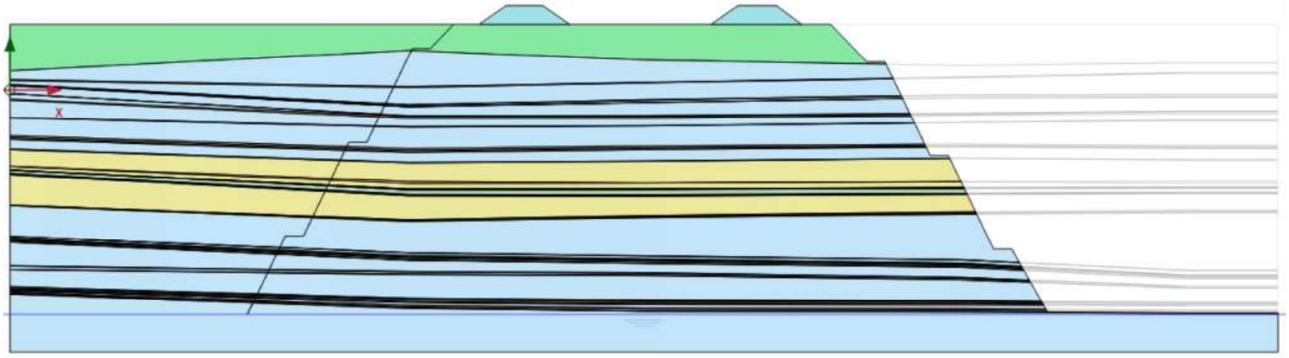


Figure 6-2 Plaxis Model Full Depth Excavation RHS

6.1.3 Initial Stress Conditions

Three initial stress states were considered, namely:

- Automatic determination of K_0
- Isostatic Conditions ($\sigma_H=\sigma_V$)
- Locked in Stresses ($\sigma_H=2\sigma_V$)

6.1.4 Calculated Deformations

Deformations were output for points as described in Table 6-2. Additional deformation information including deformed mesh, deformation contours etc is available from the Plaxis model but has not been presented here. It is understood that the primary concern is horizontal and vertical movement at the highway alignment.

Table 6-2 Deformation Points

Point Number	Location
A	Road centreline
B	Top of cut in overburden
C	Inside of 1st bench
D	Outside of 1st bench
E	Inside of 2nd bench
F	Outside of 2nd bench
G	Inside of 3rd bench
H	Outside of 3rd bench
I	Bottom of cut (lowest coal bed)

6.2 Results

Calculated deformations are presented in Table 6-3 to Table 6-6.

6.2.1 Isostatic Model

Table 6-3 Calculated Horizontal Deformations (mm) Isostatic Stress Condition

	A	B	C	D	E	F	G	H	I
Phase 1	0.1	1.4	0.2	-0.1	0.1	0.1	0.1	0.1	0.0
Phase 2	0.3	0.9	0.0	4.1	0.7	0.7	0.5	0.5	0.2
Phase 3	1.9	3.2	3.2	5.4	4.3	3.5	2.4	2.2	0.9
Phase 4	3.8	6.1	6.3	4.4	9.7	10.0	3.8	3.3	1.4
Phase 5	6.5	10.0	10.2	2.3	14.7	15.0	15.3	16.0	2.0
Phase 6	7.7	12.3	13.0	0.6	17.2	17.6	21.0	22.1	3.6

Table 6-4 Calculated Vertical Deformations[1] (mm) Isostatic Stress Condition

	A	B	C	D	E	F	G	H	I
Phase 1	-0.1	0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0
Phase 2	-0.2	2.7	3.4	4.1	2.1	2.2	1.2	1.2	0.4
Phase 3	-0.5	3.1	4.3	5.4	5.2	6.9	3.9	4.2	1.5
Phase 4	-1.0	2.1	3.3	4.4	4.8	6.1	5.0	5.8	2.2
Phase 5	-1.8	0.2	1.3	2.3	2.8	4.1	4.3	6.1	3.0
Phase 6	-2.3	-1.2	-0.2	0.6	0.7	1.9	3.5	5.3	3.8

Table 6-5 Calculated Horizontal Deformations (mm) $\sigma_H=2\sigma_V$

	A	B	C	D	E	F	G	H	I
Phase 1	0.2	1.5	0.3	0.2	0.2	0.2	0.1	0.1	0.0
Phase 2	0.4	1.0	0.3	-0.4	0.8	0.7	0.5	0.5	0.2
Phase 3	4.6	8.4	9.7	9.7	8.4	6.6	3.9	3.6	1.3
Phase 4	12.2	19.9	21.7	21.6	28.1	29.2	16.8	16.7	2.4
Phase 5	21.3	36.2	40.1	39.9	48.5	49.7	51.9	54.1	5.3
Phase 6	24.7	48.2	48.0	59.5	59.5	60.6	65.4	67.6	12.0

---

[1] +ve up, -ve down

Table 6-6 Calculated Vertical Deformations (mm) Isostatic $\sigma_H=2\sigma_V$

	A	B	C	D	E	F	G	H	I
Phase 1	-0.2	0.0	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0
Phase 2	-0.2	0.0	3.5	4.5	2.1	2.2	1.2	1.2	0.4
Phase 3	-0.9	0.0	3.2	4.2	4.4	6.6	3.9	4.3	1.4
Phase 4	-3.0	0.0	-1.4	-0.1	2.9	5.0	5.6	6.2	1.9
Phase 5	-6.9	0.0	-11.8	-10.7	-3.2	0.4	5.0	8.3	5.7
Phase 6	-8.6	0.0	-20.8	-19.3	-7.3	-3.2	3.4	7.4	8.0

6.3 Discussion

The deflection calculations show maximum lateral movements of 8mm and 25mm respectively at the highway centreline for isostatic and $\sigma_H=2\sigma_V$ stress conditions. Calculated settlements (vertical deformation) are 2mm and 9mm.

Deflections of this order of magnitude are unlikely to significantly affect the performance of the highway pavement and drainage.

7 Conclusions

7.1 Pit Stability

7.1.1 Acceptable Factor of Safety

DTMR Geotechnical Design Standards Minimum Requirements require a minimum factor of safety of 1.5 for long-term stability (Section 3.3). No acceptable factor of safety is provided for temporary works or short term conditions although a lower factor of safety of 1.3 is referenced for fill slopes in other parts of the document. As the proposed works differ from those normally undertaken by or for DTMR it is not clear whether a factor of safety less than 1.5 would be acceptable.

No factor of safety for seismic conditions is supplied; the document does state that the relevance of seismic stability issues shall be investigated. Limited slope stability modelling using a pseudo static acceleration of 0.08g indicates that seismic factors of safety are well in excess of the value typically used in dam studies (1.1).

7.1.2 Pore Pressure Conditions

Groundwater investigations indicate a perched water table in the overburden material (i.e. not affecting the sedimentary rocks and coal layers. DTMR Geotechnical Design Standards require analyses to be performed using a minimum pore pressure coefficient (R_u) of 0.15, both cases have been considered.

7.1.3 Discussion of Results

A summary of the results is provided in Table 5-2. The most critical section is the high wall on the north-eastern side of the pit. Using probable lower-bound strength parameters in excess of 1.5 were obtained for all circular failure surfaces.

Factors of safety as low as 1.02 were obtained for lowest strength parameters (considered an unlikely scenario).

Planar wedge failures along a postulated low strength shear zone produced factors of safety as low as 1.43 for the full depth pit and 1.73 for a 100m deep pit.

For planned pit depths greater than 100m additional geotechnical investigations are recommended; it is probable that these would give more certainty to pit designs with depths greater than approximately 120m (Refer Section 7.4).

7.2 Deformations

A deformation study was undertaken using Plaxis finite element software. The results can only be considered indicative, however they indicate likely maximum horizontal deflections at the highway centreline of the order of 25mm.

7.3 Construction Feasibility

This report does not provide comments on construction feasibility. It should be noted that the assumption has been made that rock slopes will be pre-split. This should minimise disturbance to the rock, a disturbance factor (d) of zero has been assumed for Hoek-Brown strength parameters used in modelling.

7.4 Recommendations for Additional Investigation

On the basis of the desktop evaluation and prior to DTMR and regulatory negotiations we suggest the following as a minimum scope for further additional investigation work. We strongly recommend that this scope is discussed with all stake holders prior to commencement of further investigation.

We propose that four geotechnical holes are drilled by specialist drilling contractors to 165m depth (pit depth plus 10%) with SPT sampling in the upper soil horizons at 1.5m depth intervals and rock coring as soon as 2 consecutive SPTs achieve refusal. These holes will be logged to AS1726 by an experienced geologist or geotechnical engineer at site. Particular attention needs to be given to logging of the structural defects within the core.

The cores will be photographed and then wrapped and stored carefully to preserve moisture levels. Representative cores will be selected for geomechanical analysis to further understand the rock strength and deformation parameters. Laboratory testing is likely to include:

- CU triaxials for weathered overburden material;
- Rock triaxials with appropriate cell pressures considering the depth of the pits; and
- Shear box tests on sheared zones if encountered.

A geotechnical investigation report will then be written that will use both this desktop study plus the new information from the borehole investigation to supplement the geotechnical model and stability analysis.

7.5 Slope Monitoring

A properly designed monitoring system will be required, details will need to be discussed and finalised. This may include the following items:

- Surface monitoring points (x,y,z movements) with baseline as required;
- Inclinometers to full pit depth (either inside or outside safety bunds); and
- Regular inspections.

Instruments would be monitored on a regular basis and following each blast.

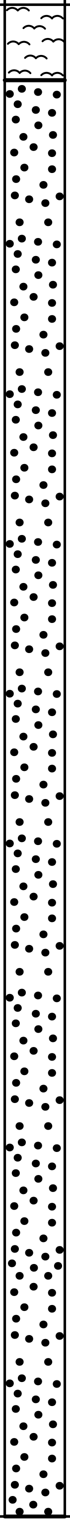
APPENDIX

B

HISTORICAL BOREHOLE DATA

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 657.01 N 7 486 063.69	BOREHOLE No: STX00505 SHEET 1 OF 5
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 35.21	DRILLING DATE: 09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SOIL, dark brown					**N.A.**			**N.A.**
SAND, medium brown		1.00						
		5						5
		10						10
		15						15
		20						20



REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 657.01
N 7 486 063.69

BOREHOLE No: STX00505

SHEET 2 OF 5

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 35.21

DRILLING DATE: 09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SAND, medium brown		25 28.50	⁘		N.A. Base of weathering 28.50			N.A.
SANDSTONE, light grey, fresh, fine to medium grained		30 35 40	⁘		INDETERMINATE			No sonic log

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 657.01
N 7 486 063.69

BOREHOLE No:
STX00505

SHEET 3 OF 5

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
35.21

DRILLING DATE:
09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, fresh	45		INDETERMINATE			No sonic log
COAL, fresh	48.68					
SANDSTONE, light grey, fresh	48.98 50 55					
COAL, undifferentiated, fresh	57.36					
SANDSTONE, light grey, fresh	59.22 60					

REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 657.01
N 7 486 063.69

BOREHOLE No:
STX00505

SHEET 4 OF 5

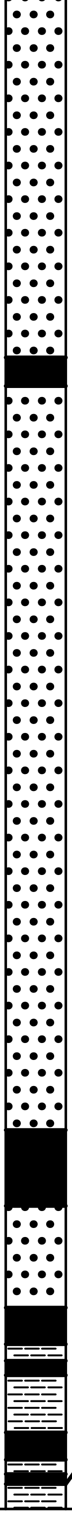
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
35.21

DRILLING DATE:
09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, light grey, fresh					**INDETERMINATE**			No sonic log
COAL, fresh		64.77 65						
SANDSTONE, light grey, fresh		65.15 70						
COAL, undifferentiated, fresh		74.99 75						
SANDSTONE, light grey, fresh		75.99						
COAL, undifferentiated, fresh		77.34						
MUDSTONE, fresh		77.82						
COAL, fresh		78.04						
MUDSTONE, dark grey, fresh		78.23						
COAL, fresh		78.99						
MUDSTONE, fresh		79.35						
COAL, fresh		79.54						
		79.67 80			MUDSTONE, fresh			



65
70
75
80

REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 657.01
N 7 486 063.69

BOREHOLE No:
STX00505

SHEET 5 OF 5

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY,
GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
35.21

DRILLING DATE:
09/11/14

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, fresh	80.05			INDETERMINATE			No sonic log
COAL, fresh	80.30						
SANDSTONE, light grey, fresh							
END OF HOLE 81.46 m							
	85						85
	90						90
	95						95
	100						100

REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

NO CORE PHOTOGRAPHS AVAILABLE

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 774 009.06

N 7 485 907.95

BOREHOLE No: STX050C

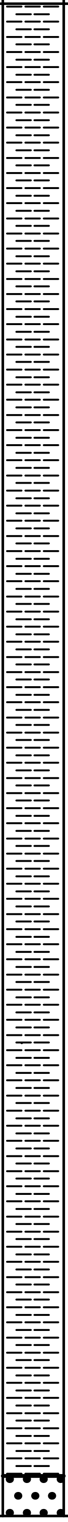
SHEET 1 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 33.65

DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAYSTONE, dark blackish brown, weak, moderately weathered					**INDETERMINATE**			N.A.
		5						
		10						
		15						
CLAYSTONE, brown, moderately weathered		18.93						
SANDSTONE, weathered		19.54						
		20						

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No: STX050C

SHEET 2 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

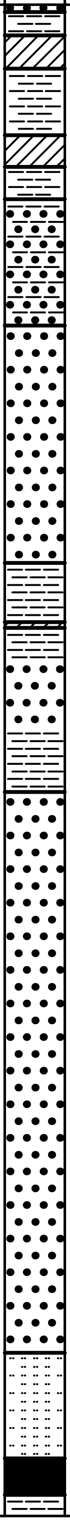
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 33.65

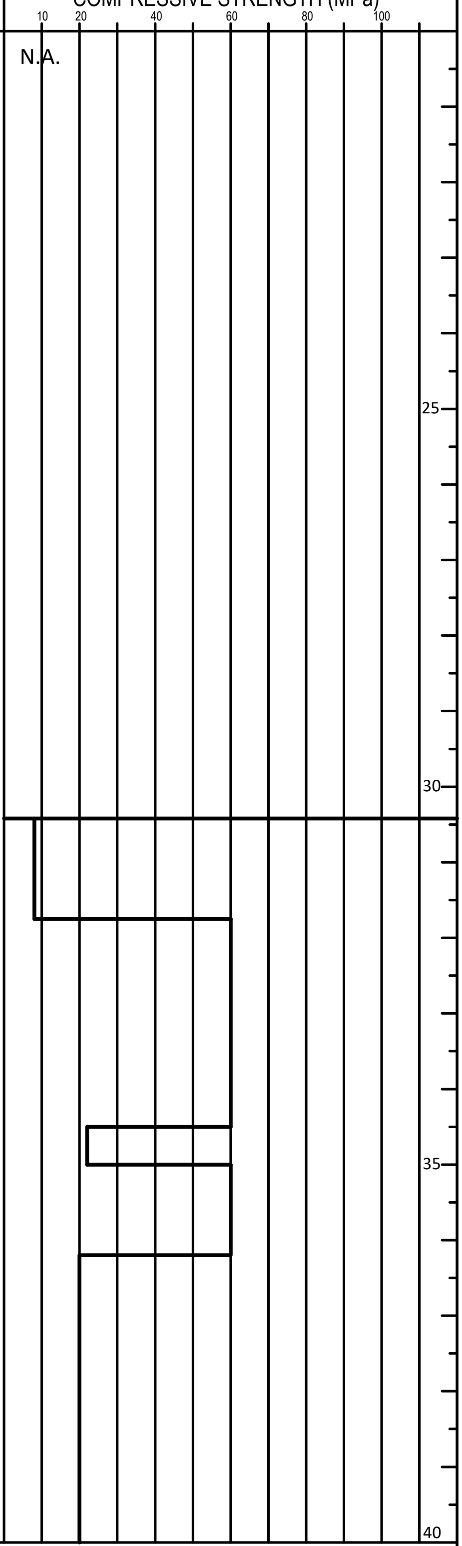
DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, weathered	20.10					
CLAYSTONE, MUDSTONE, brownish grey, weathered	20.41		INDETERMINATE			N.A.
Core loss	20.41 – 20.85					
	20.85					
Core loss	21.73 – 22.15					
	22.15					
SANDSTONE, MUDSTONE, slightly weathered	22.58					
SANDSTONE, light grey, fresh, moderately weak	24.25		Base of weathering 24.70			
	25					
Mainly MUDSTONE, grey, fresh, moderately weak. Minor SANDSTONE	27.39					
Core loss						
	30					
SANDSTONE, light grey, fresh, moderately strong	30.42					
	35					
SILTSTONE, grey, fresh, moderately strong	37.84					
COAL, fresh, weak	39.24					
MUDSTONE, fresh,	39.72					
	40					

GRAPHIC LOG



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No:
STX050C

SHEET 3 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

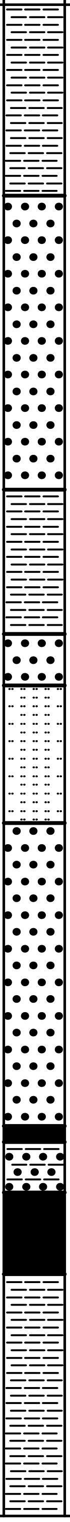
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.65

DRILLING DATE:
12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS
MUDSTONE, dark brown, fresh, weak to strong		**INDETERMINATE**
SANDSTONE, light grey, fresh, moderately strong	42.53	
	45	
MUDSTONE, carbanaceous, dark brown, fresh, weak	46.42	
Coal		
SANDSTONE, light grey, fresh	48.33	
Coal		
SILTSTONE, mid grey, fresh, moderately weak	49.01	
Coal		
Coal	50	
Coal		
SANDSTONE, light grey, fresh, mainly moderately strong	50.83	
COAL, fresh	54.84	
	55	
SANDSTONE, MUDSTONE, fresh	55.05	
Mainly COAL, fresh, broken	55.72	
Mainly MUDSTONE, dark grey, fresh, moderately weak	56.80	
Coal	60	

GRAPHIC LOG

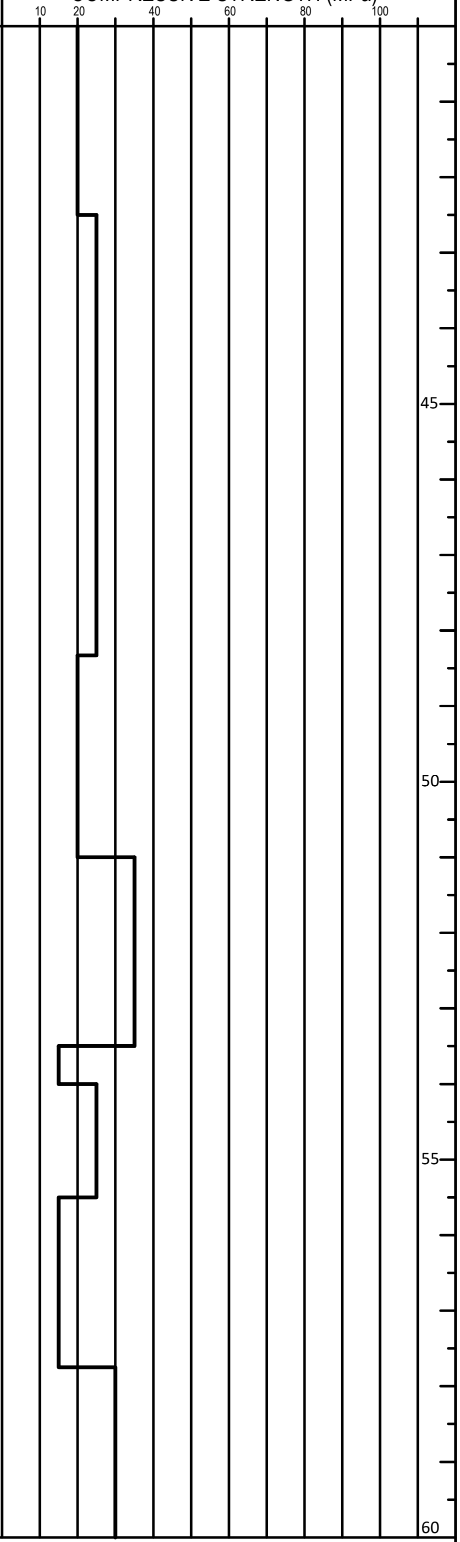


DUR-ABILITY %

FRAC. PER METRE

R.Q.D.

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No:
STX050C

SHEET 4 OF 7

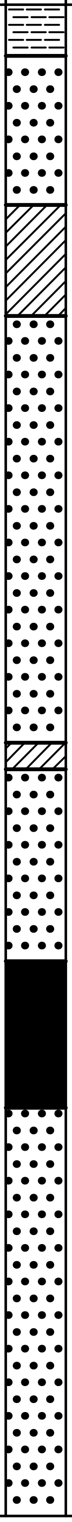
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY,
GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.65

DRILLING DATE:
12/09/10

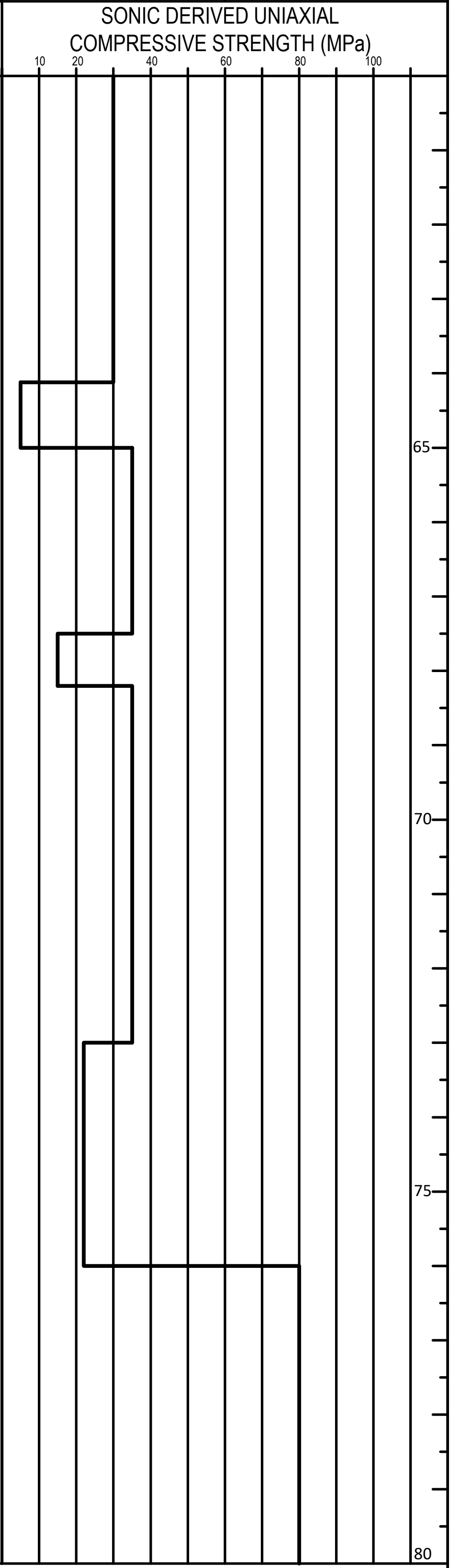
DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS
MUDSTONE, fresh Coal		INDETERMINATE
Mainly SANDSTONE, light grey, fresh, mainly moderately strong	60.68	
	62.65	
Core loss		
	64.12	
	65	
Core loss	69.77 70 70.12	
COAL, fresh, weak	72.66	
SANDSTONE, light grey, fresh, moderate to strong	74.60 75	Slickensides at 70°, pyrite
	80	



DUR-ABILITY %

FRAC. PER METRE

R.Q.D.



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:
CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No:
STX050C

SHEET 5 OF 7

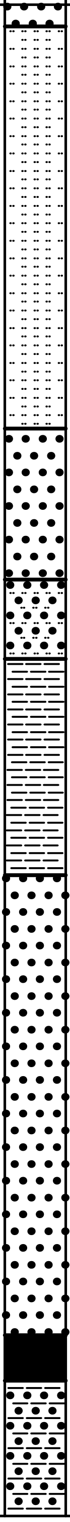
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

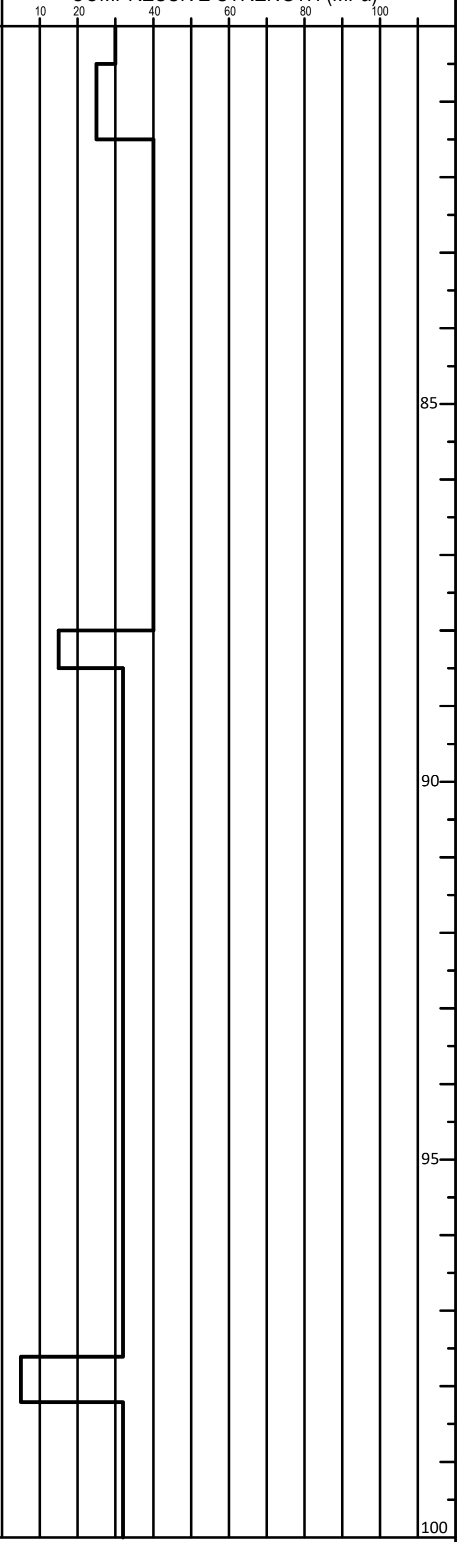
GROUND LEVEL (AHD)
33.65

DRILLING DATE:
12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, fresh						
SILTSTONE, grey, fresh, moderately strong Coal	80.29 85			**INDETERMINATE**		
SANDSTONE, light grey, moderately strong	85.61					
SILTSTONE, grey, SANDSTONE, light grey, fresh, strong	87.61					
MUDSTONE, dark grey, fresh, moderately strong	88.66 90					
SANDSTONE, light grey, moderately strong. Minor SILTSTONE	91.52 95					
COAL, fresh, weak	97.61					
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong	98.21 100					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 774 009.06

N 7 485 907.95

BOREHOLE No: STX050C

SHEET 6 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

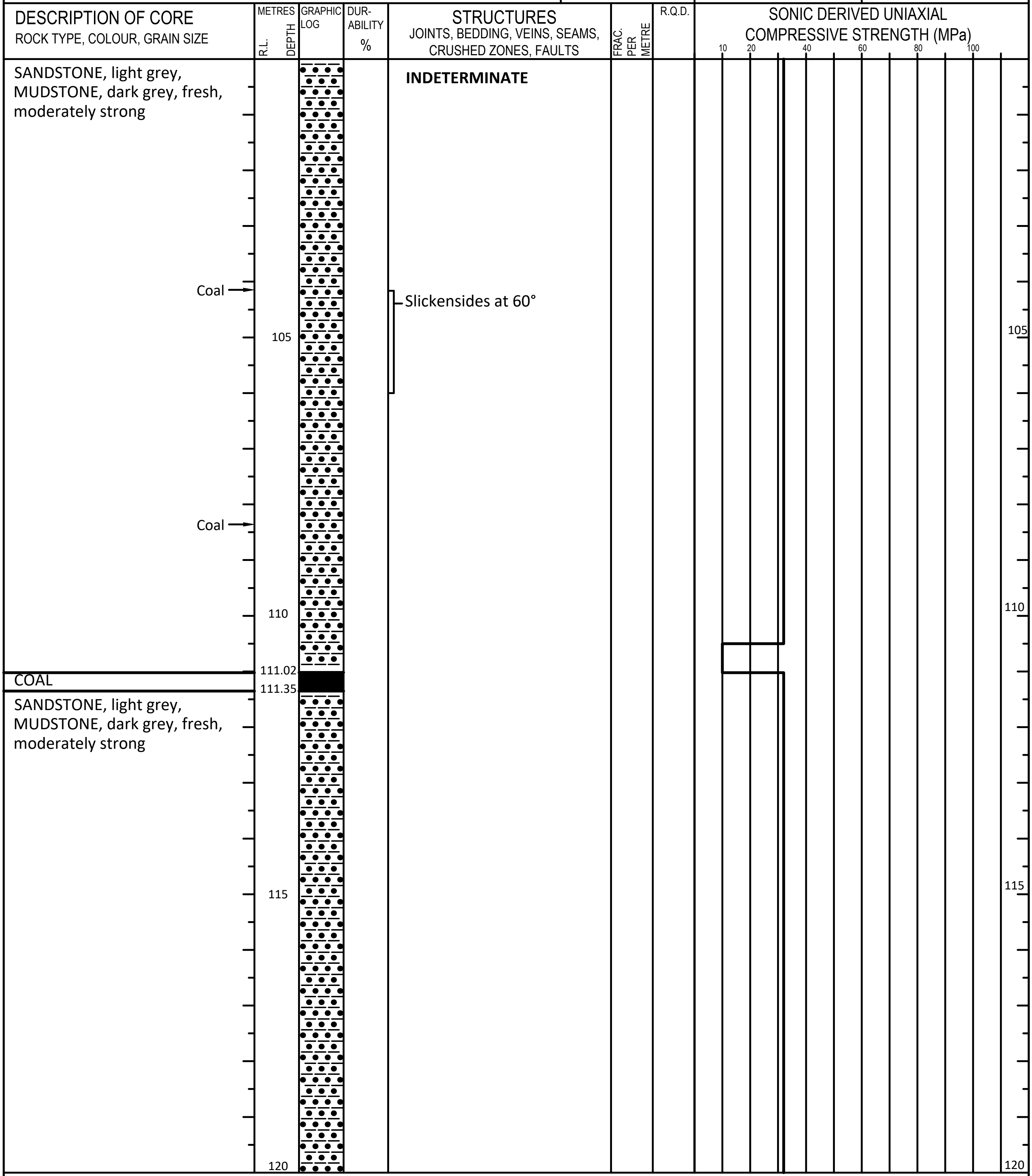
DEPTH:

LEVEL:

GROUND LEVEL (AHD) 33.65

DRILLING DATE: 12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong Coal → Coal →					INDETERMINATE Slickensides at 60°			
COAL		111.02						
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong		111.35						



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 009.06
N 7 485 907.95

BOREHOLE No:
STX050C

SHEET 7 OF 7

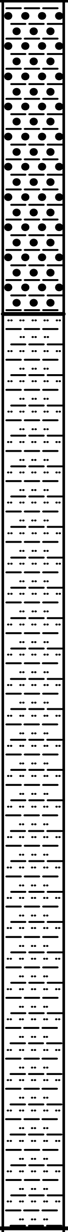
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY,
GEOTECHNICAL ASSESSMENT

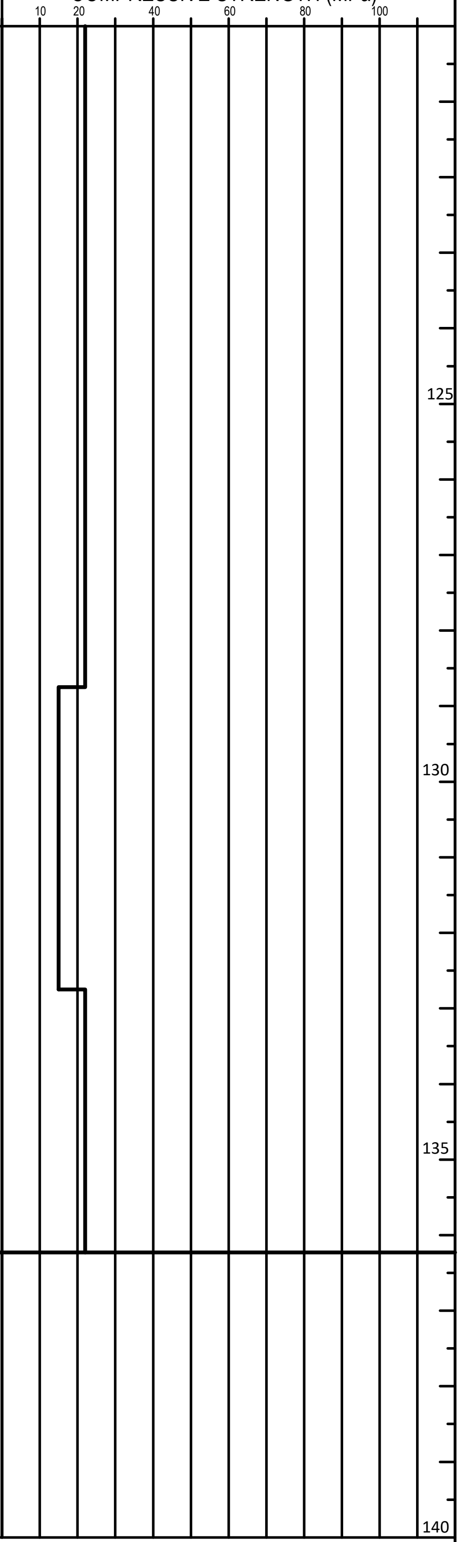
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.65

DRILLING DATE:
12/09/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong					INDETERMINATE			
SILTSTONE, medium grey, MUDSTONE, dark brown		124.14						
		125						125
Core loss →								
Coal →								
Coal → Core loss → Coal → Coal →		130						130
		135						135
END OF HOLE 136.23 m								
		140						140





REMARKS:
Cored hole

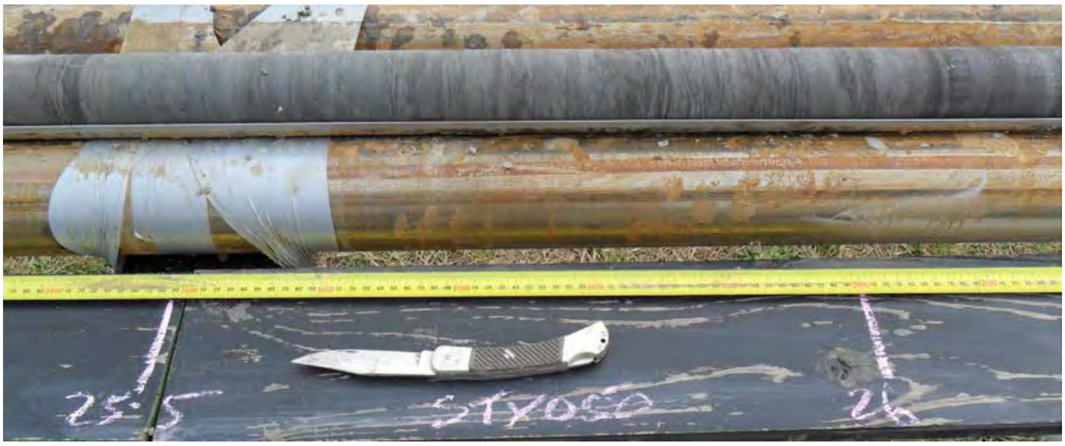
N.A. Not Applicable

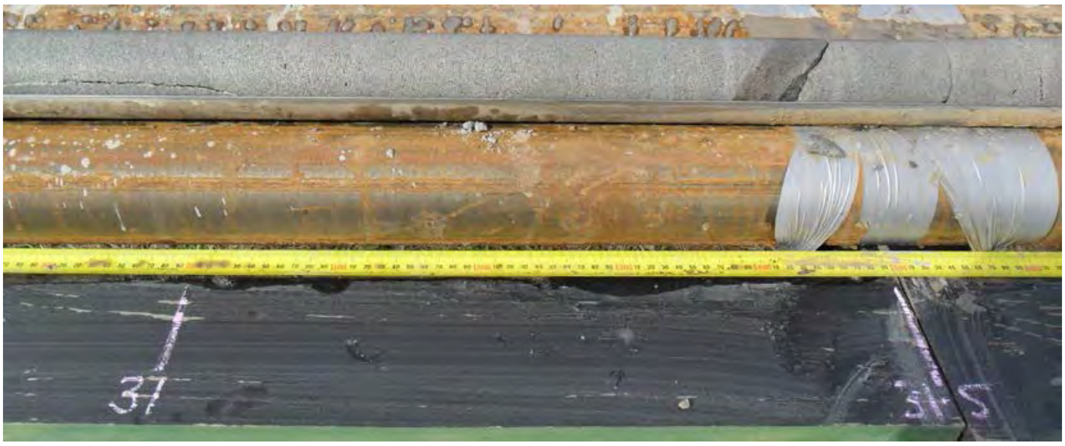
SCALE 1 : 100

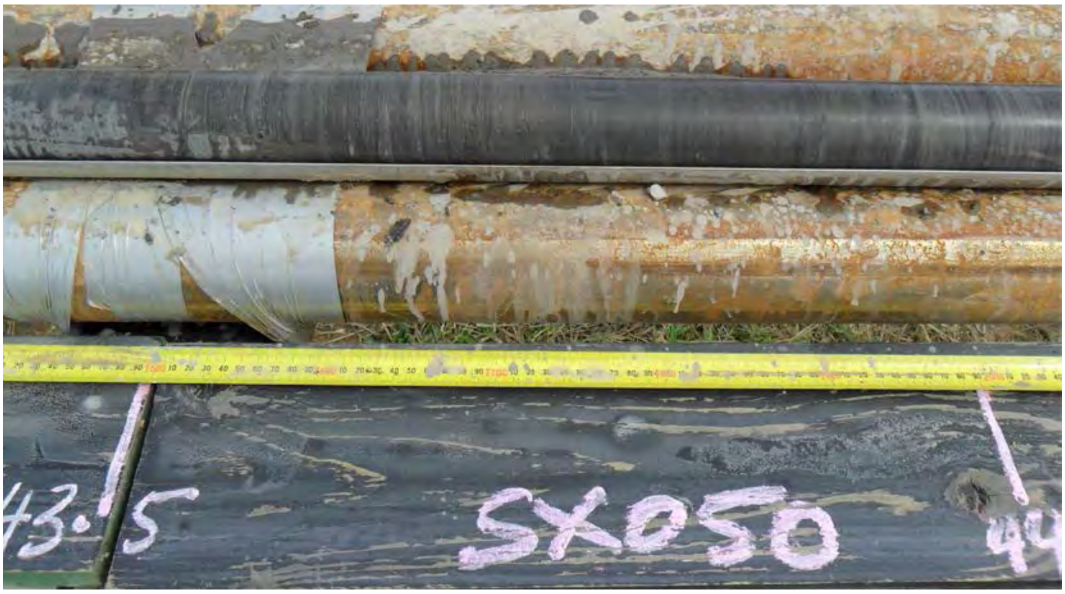
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

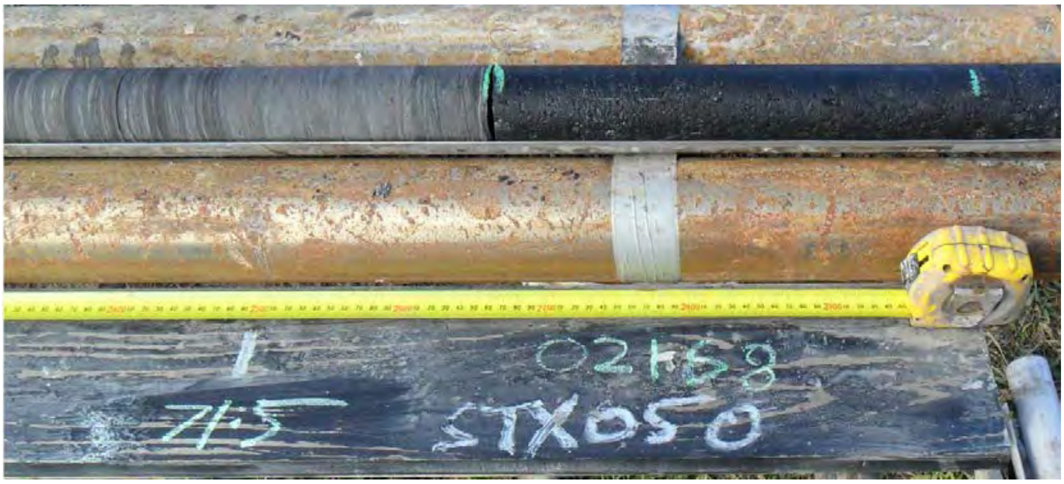

R: 2 1.0 mm
C: 2.05
R: 1.61
T.D: 19.85
RUN 2
C: 1.5
R: .88
T.D: 21.45
10 STX050 17.80


25.5
STX050
26

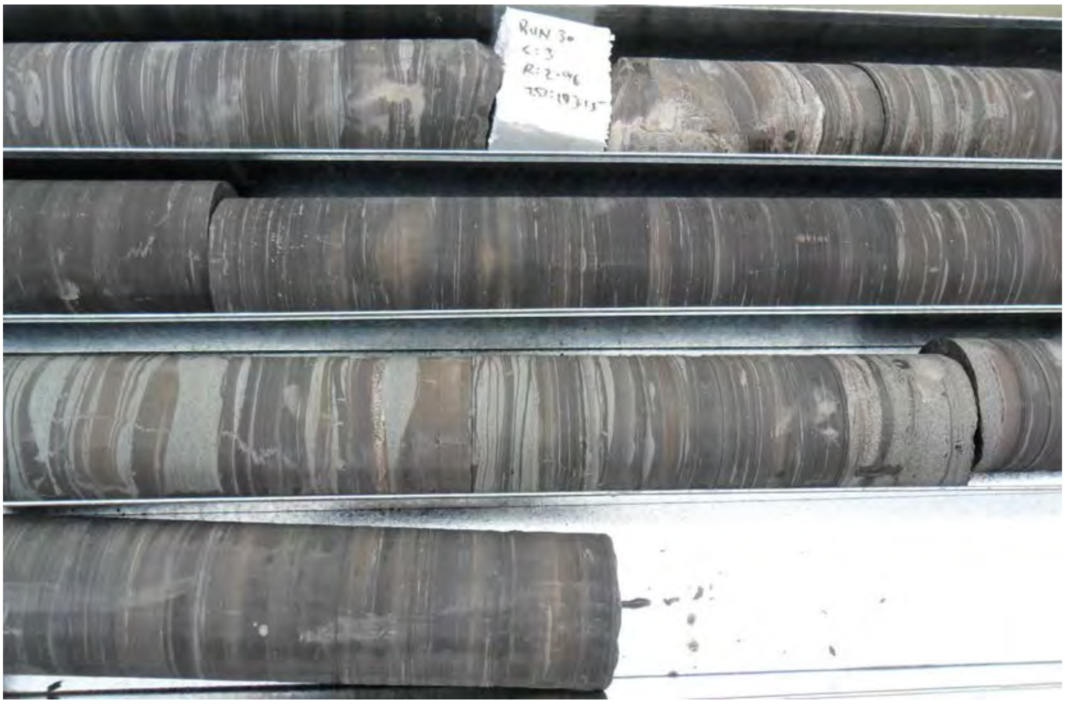

37
37.5


43.5
SX050
44


02166
55
STX050


02168
71.5
STX050


8
9.5
STX050
90


RUN 30
C: 3
R: 2.96
TD: 197.15


STX050


134
STX050
134·5

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

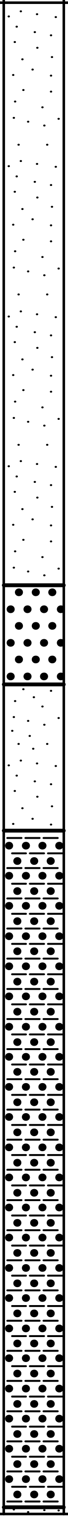
LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No: STX080

SHEET 1 OF 7

GROUND LEVEL (AHD) 33.1

DRILLING DATE: 10/02/10



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, orange brown, pughy					**INDETERMINATE**			No sonic log
		5						
SANDSTONE, brownish, weathered		7.71						
CLAY, brown		9.02						
		10						
SANDSTONE, MUDSTONE, brown, weathered, weak		10.96						
		15						
CLAY, brown		19.91						
		20						

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

LOCATION
E 773 422.08
N 7 486 312.65

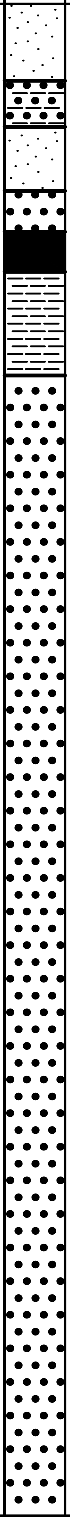
GROUND LEVEL (AHD) 33.1

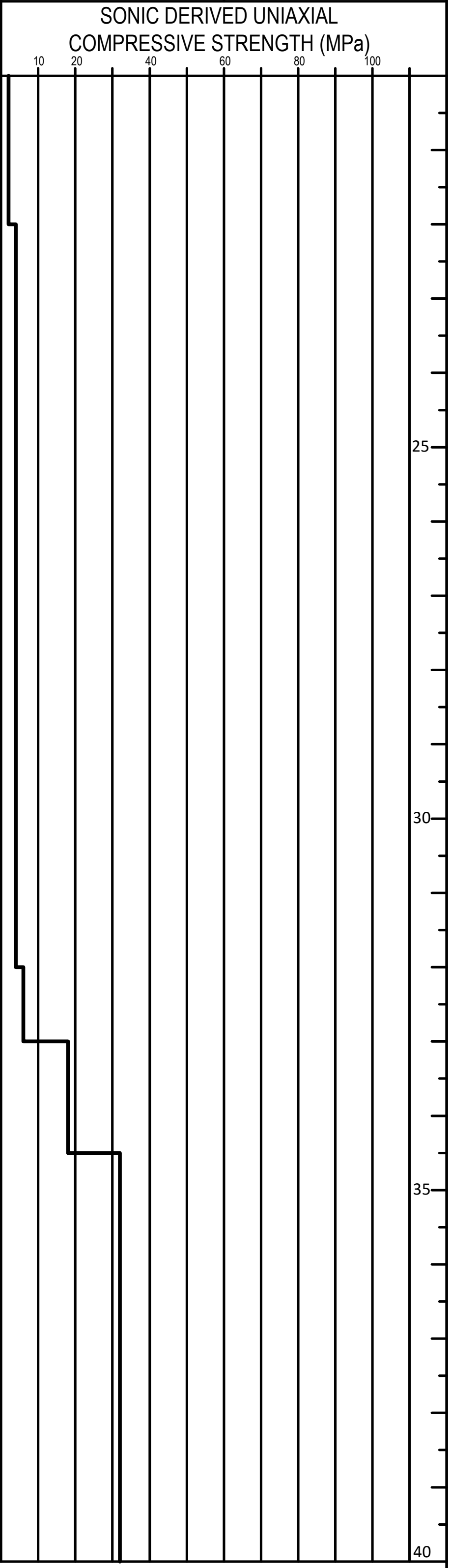
BOREHOLE No: STX080

SHEET 2 OF 7

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
CLAY, SILT, brown				INDETERMINATE		
SANDSTONE, MUDSTONE, weathered		21.02				
CLAY, brown		21.63				
SANDSTONE, weathered		22.48				
COAL, weathered		23.02				
MUDSTONE, grey, slightly weathered, broken		23.55				
SANDSTONE, light grey, fresh, weak to moderately weak		24.92		← Base of weathering 25.14		





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No: STX080

SHEET 3 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

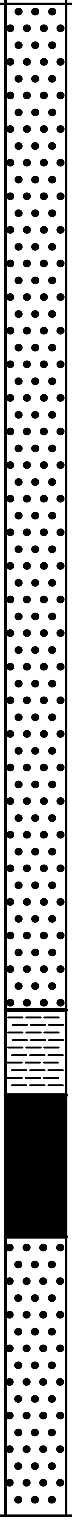
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 33.1

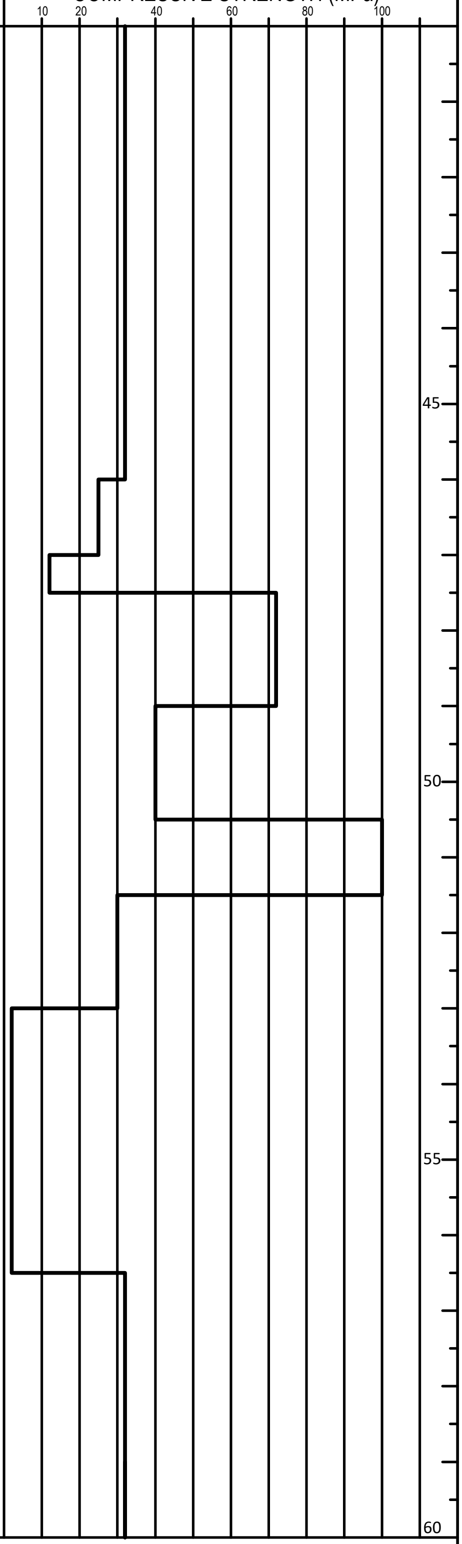
DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, fresh, mainly moderately weak	45 50		INDETERMINATE		
Siderite	53.31				
MUDSTONE, grey, brown,fresh, moderately strong	53.31				
COAL, fresh, solid core	54.44 55				
SANDSTONE, light grey, moderately strong	56.31 60				

GRAPHIC LOG



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No: STX080

SHEET 4 OF 7

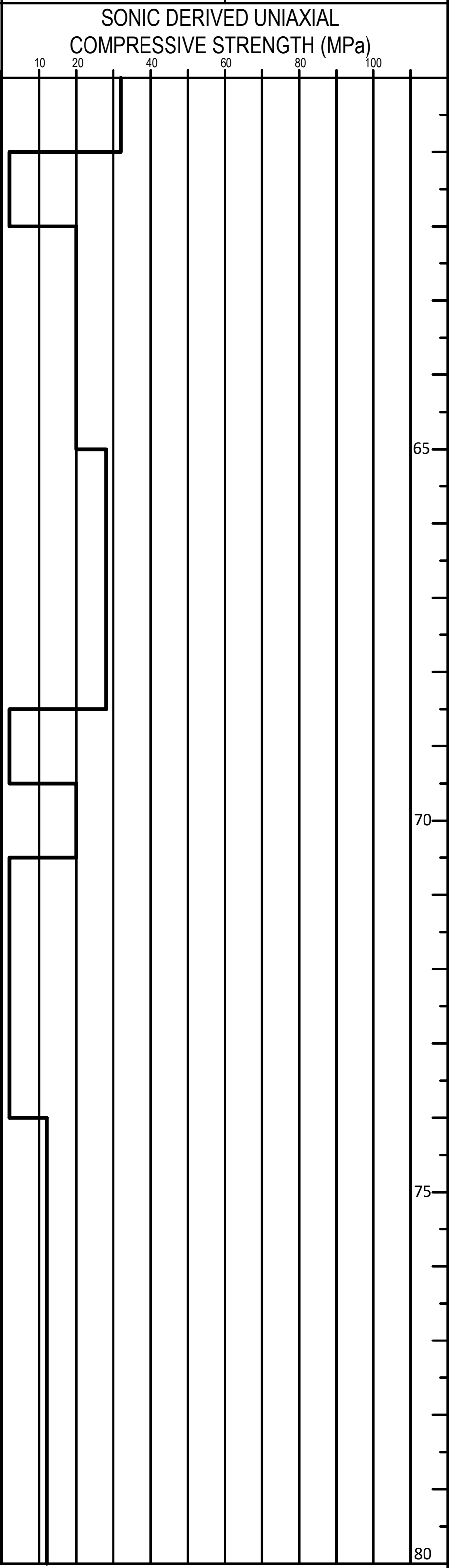
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 33.1

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, moderately strong				INDETERMINATE		
COAL, fresh		61.26				
SILTSTONE, MUDSTONE, grey, fresh, moderately strong		61.62		Slickensides 30°		
SANDSTONE, light grey, fresh		63.97		Faults, slickensides 30°		
		65				
		70				
Siderite		70.85				
Mainly MUDSTONE, dark grey, fresh, mainly moderately strong						
Coal Coal						
		75				
Coal						
		80				



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330$e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

LOCATION
E 773 422.08
N 7 486 312.65

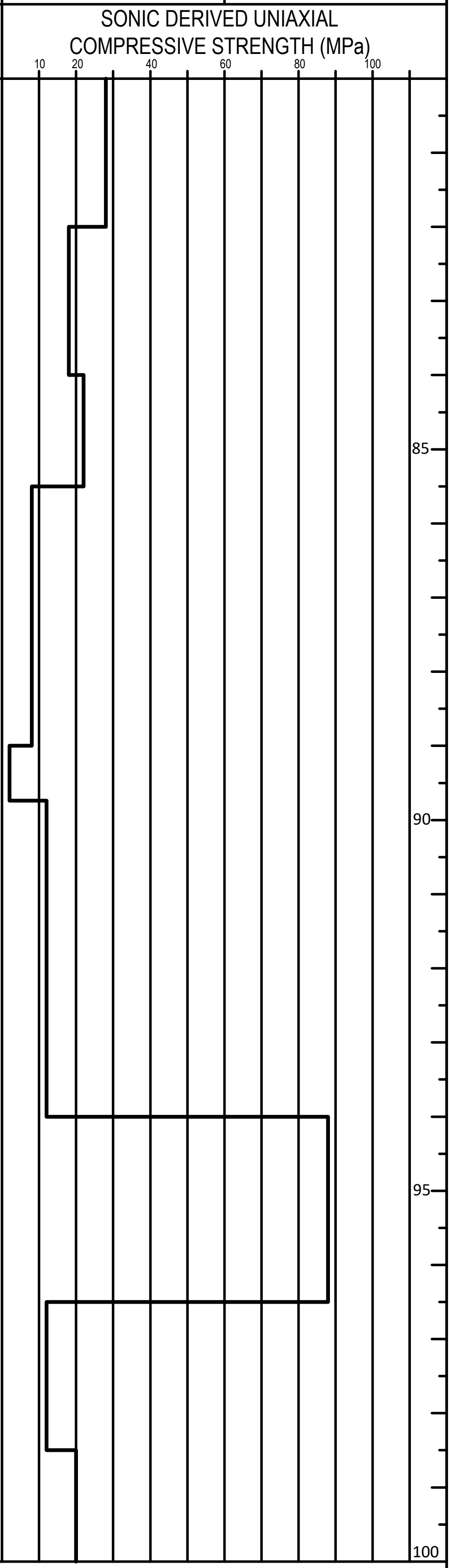
GROUND LEVEL (AHD) 33.1

BOREHOLE No: STX080

SHEET 5 OF 7

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
MUDSTONE, fresh	80.12			**INDETERMINATE**		
SANDSTONE, light grey, fresh, moderately strong		⁘				
MUDSTONE, dark grey, brown,fresh, moderately weak	83.42 85	☰				
COAL, fresh	89.29	■				
MUDSTONE, grey, moderately weak	89.74 90	☰				
SANDSTONE, light grey, fresh, moderately weak	90.49 95	⁘				
MUDSTONE, dark grey, fresh, moderately weak	97.15 100	☰				



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No: STX080

SHEET 6 OF 7

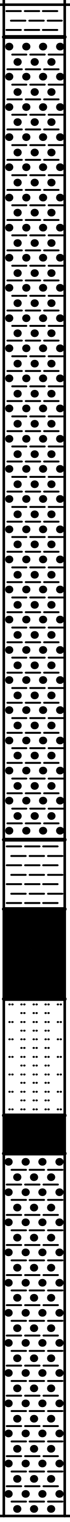
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

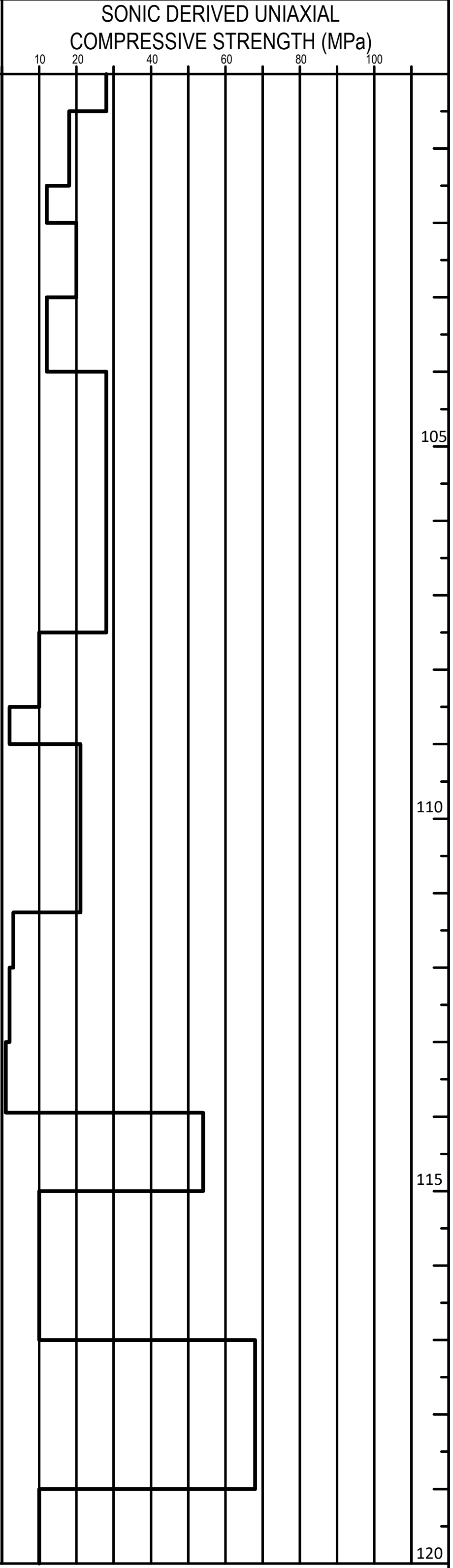
GROUND LEVEL (AHD) 33.1

DRILLING DATE: 10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
MUDSTONE, fresh				INDETERMINATE		
SANDSTONE, light grey, MUDSTONE, dark grey, fresh Coal Coal	100.43 105 110					
MUDSTONE, dark grey, fresh, moderately strong	111.05					
COAL, fresh, partially broken	111.97					
SILTSTONE, carbonaceous, grey, fresh, moderately strong	113.16					
COAL, fresh, strong	114.70					
Mainly SANDSTONE, light grey, MUDSTONE, dark grey, fresh, moderately strong	115 115.21 120					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 422.08
N 7 486 312.65

BOREHOLE No:
STX080

SHEET 7 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

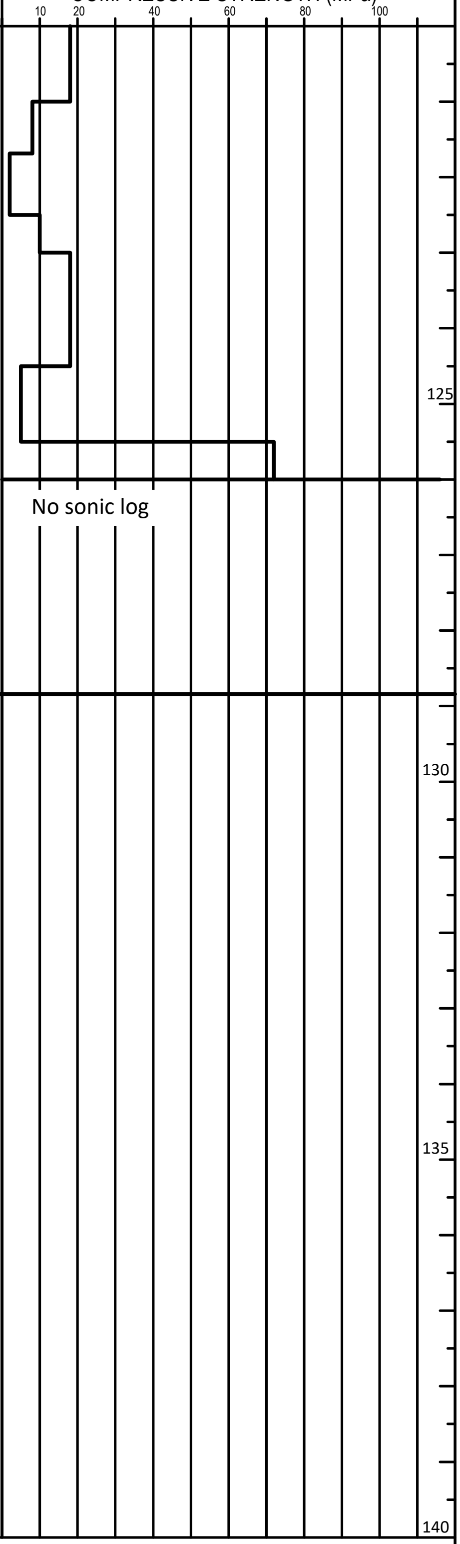
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
33.1

DRILLING DATE:
10/02/10

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, MUDSTONE, fresh					INDETERMINATE		
MUDSTONE, dark grey, fresh, moderately strong Coal →		120.54					
COAL, fresh, weak		121.99					
MUDSTONE, dark grey, fresh, moderately weak Coal → Coal →		122.86 125			Slickensides 30°, 60°, faults 10°		
SANDSTONE, light grey, fresh, moderately weak		127.15					
END OF HOLE 128.84 m		130 135 140					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

NO CORE PHOTOGRAPHS AVAILABLE

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 002.01 N 7 486 199.69	BOREHOLE No: STX104CR SHEET 1 OF 6
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) Not available	DRILLING DATE: 14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
No record					INDETERMINATE			No sonic log
		5						5
		10						10
		15						15
		20						20

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No:
STX104CR

SHEET 2 OF 6

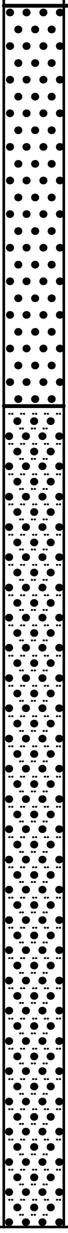
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY,
GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

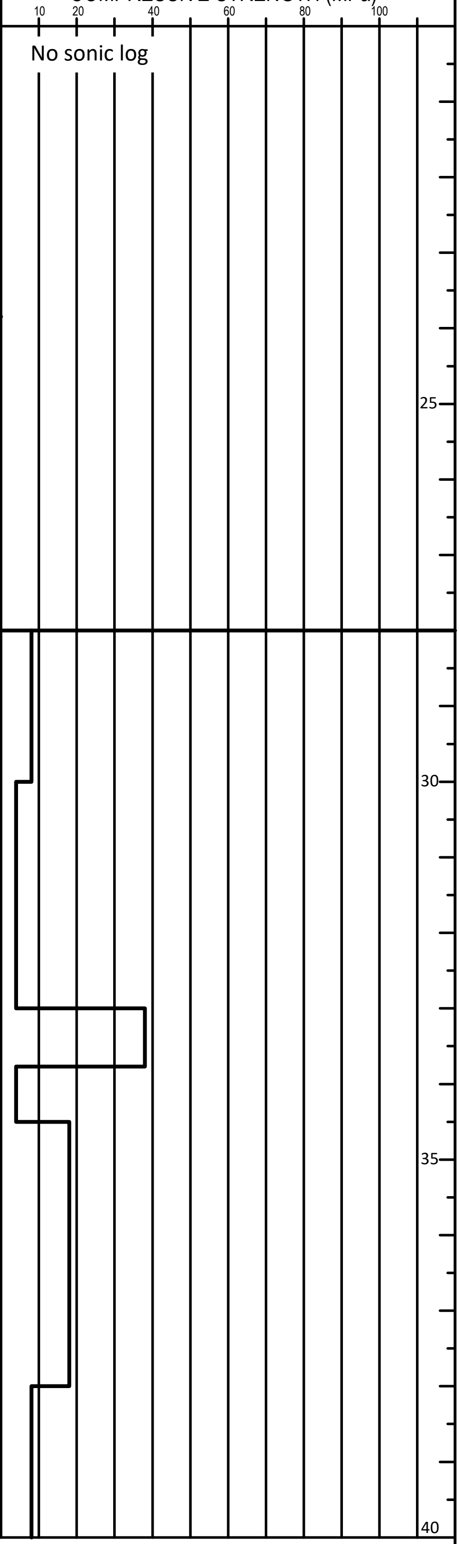
GROUND LEVEL (AHD)
Not available

DRILLING DATE:
14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
No record					**INDETERMINATE**		
SANDSTONE, light grey, fresh, moderately weak Core loss →		23.85 25					
SILTSTONE, medium grey, SANDSTONE, light grey, fresh, weak to moderately weak Coal →		29.14 30 35 40					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No:
STX104CR

SHEET 3 OF 6

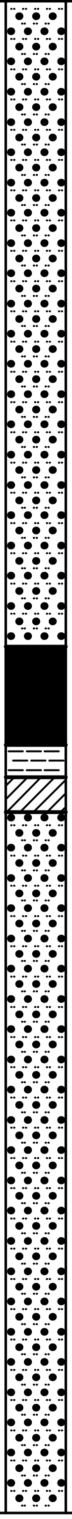
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

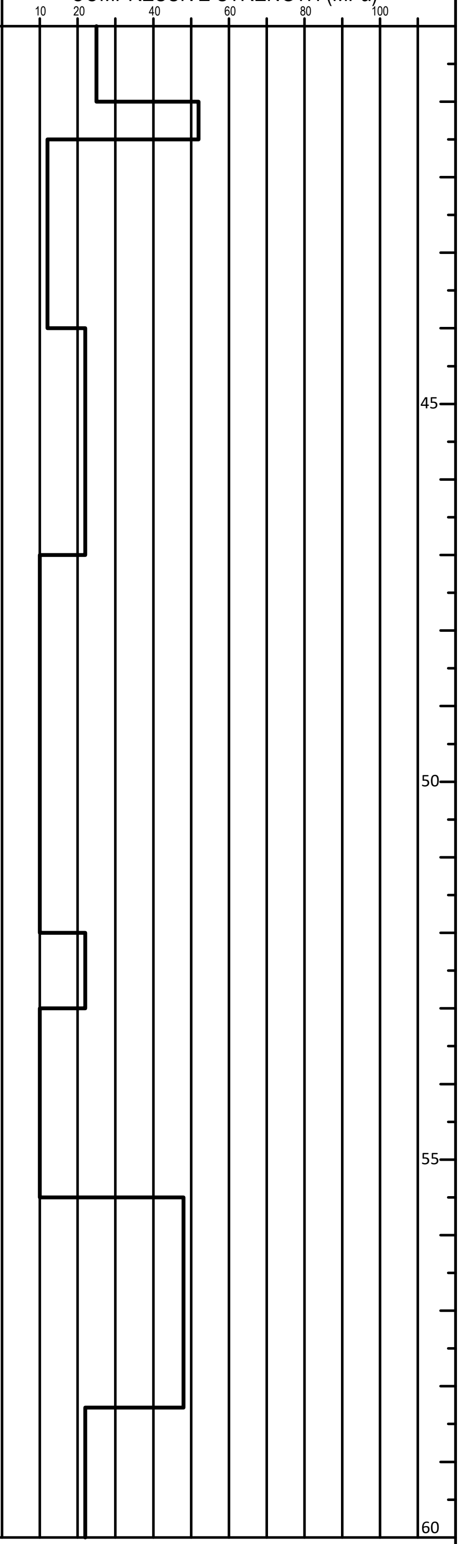
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
Not available

DRILLING DATE:
14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SILTSTONE, medium grey, SANDSTONE, light grey, fresh, moderately weak to weak Core loss → Coal → Coal →	45			**INDETERMINATE**			
COAL, fresh, very weak Mudstone →	48.54						
MUDSTONE, weak	49.84 50						
CORE LOSS	50.27						
SANDSTONE, grey, SILTSTONE, medium to dark grey, fresh, moderately weak to very weak Coal →	50.73 55 60						





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No: STX104CR

SHEET 4 OF 6

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

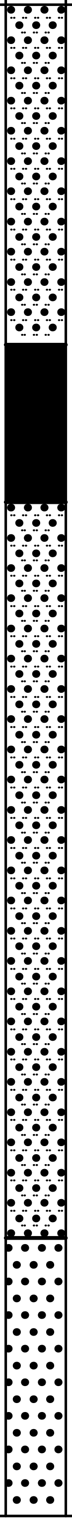
WATER TABLE
DEPTH:
LEVEL:

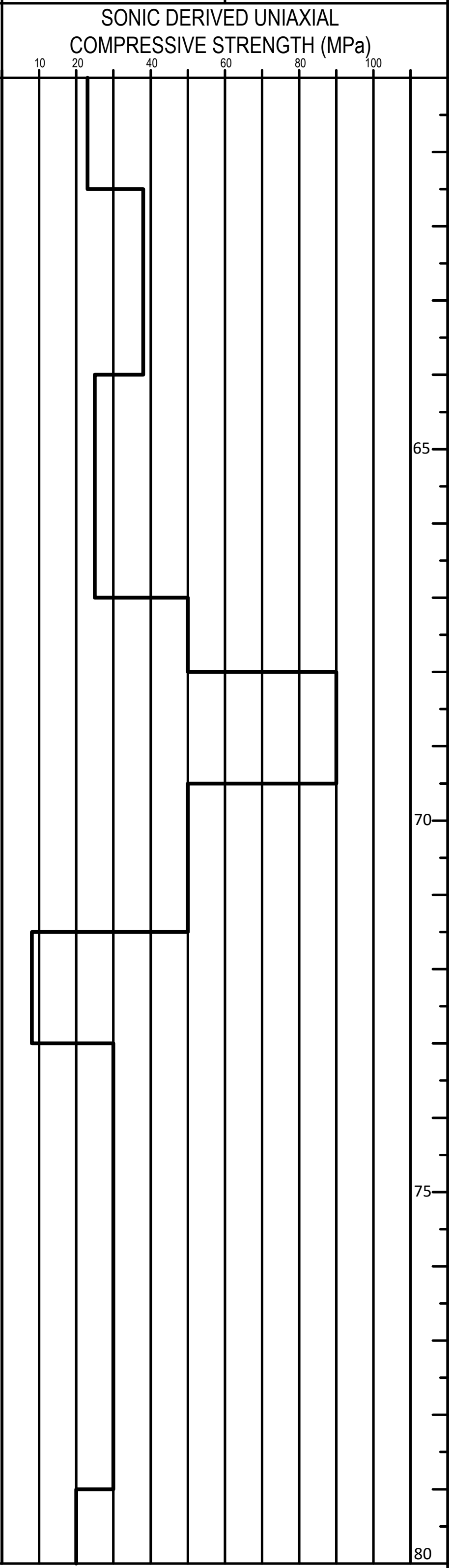
GROUND LEVEL (AHD) Not available

DRILLING DATE: 14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, grey, SILTSTONE, medium to dark grey, fresh, weak to very weak				**INDETERMINATE**		
COAL, fresh, very weak		64.64 65				
Mainly SANDSTONE, grey, SILTSTONE, dark grey, fresh, moderately weak to very weak Coal →		66.59 70 75		Faults Dip 30°, faulted Bedding 30°, calcite		
SANDSTONE, grey, fresh, very weak to moderately weak		76.32 80				

GRAPHIC LOG





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No:
STX104CR

SHEET 5 OF 6

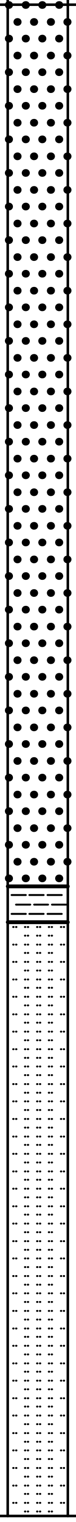
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

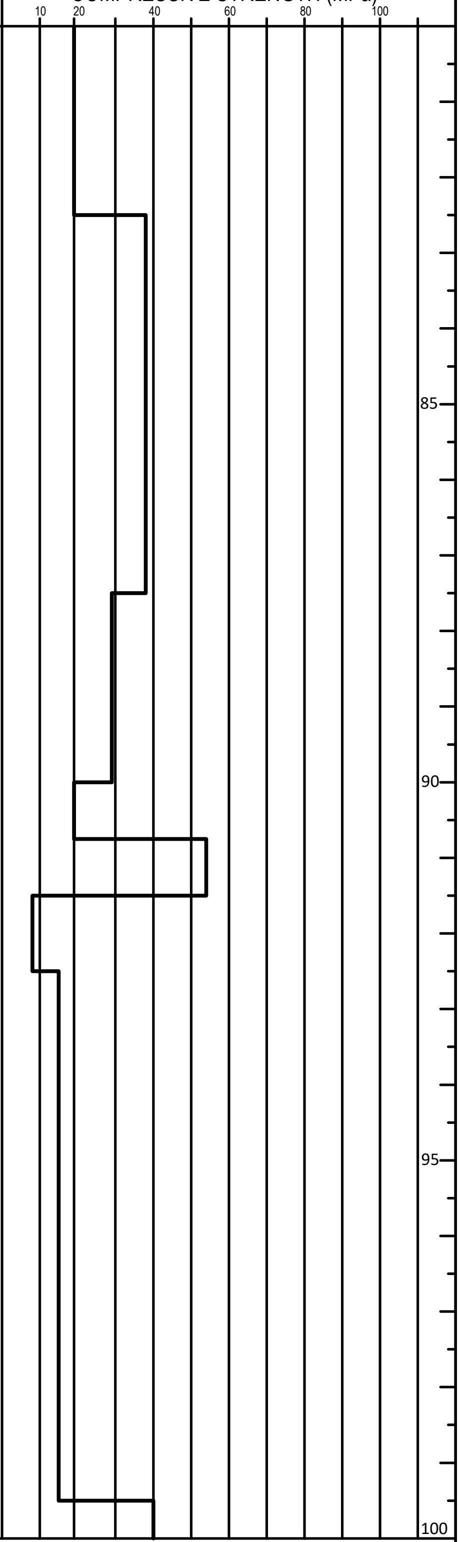
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
Not available

DRILLING DATE:
14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, light grey, fresh, weak to moderately weak		85 90			INDETERMINATE			
Coal		91.67						
MUDSTONE, fresh		91.67						
SILTSTONE, medium grey, fresh, moderately weak Coal Coal		95 100						





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 002.01
N 7 486 199.69

BOREHOLE No:
STX104CR

SHEET 6 OF 6

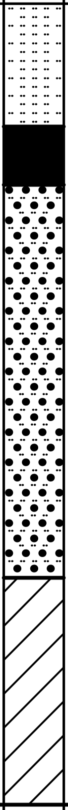
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

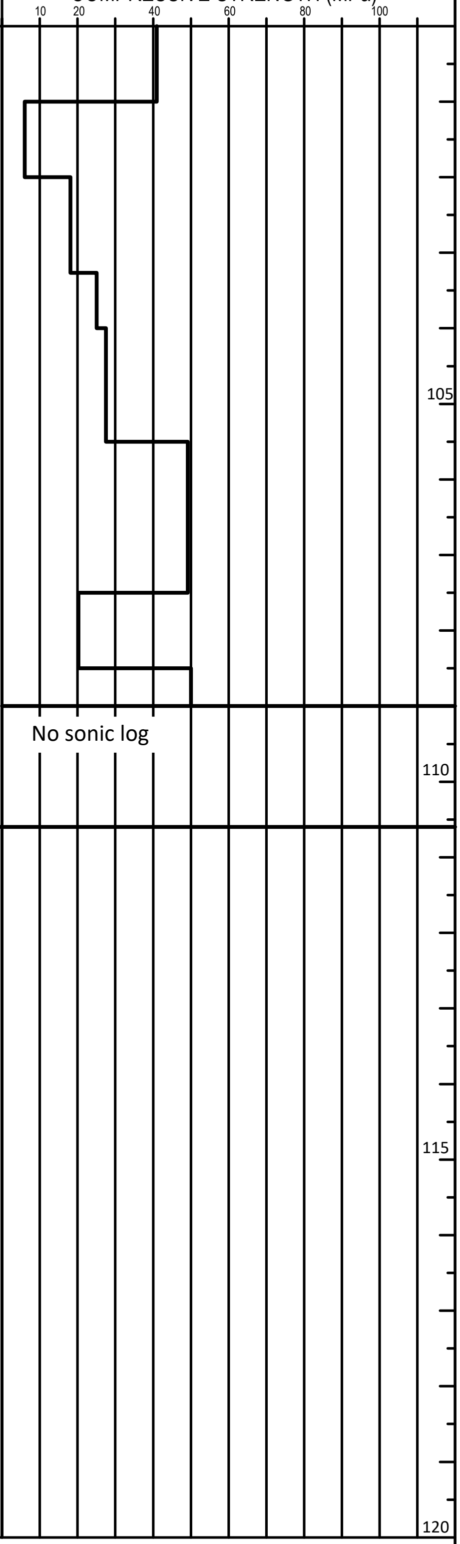
GROUND LEVEL (AHD)
Not available

DRILLING DATE:
14/11/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SILTSTONE, medium grey, fresh, moderately weak					**INDETERMINATE**		
COAL, fresh, weak Core loss →		101.63					
SANDSTONE, grey, SILTSTONE, medium grey, fresh, moderately weak Coal →		102.40					
		105					
Not logged		107.60					
		110					
END OF HOLE 110.60 m							
		115					
		120					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



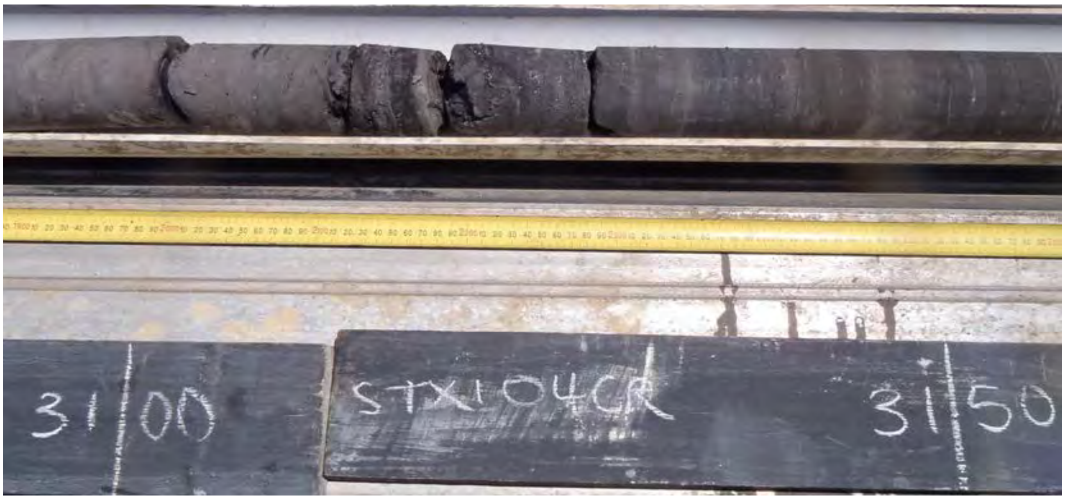
REMARKS:
Cored hole

N.A. Not Applicable

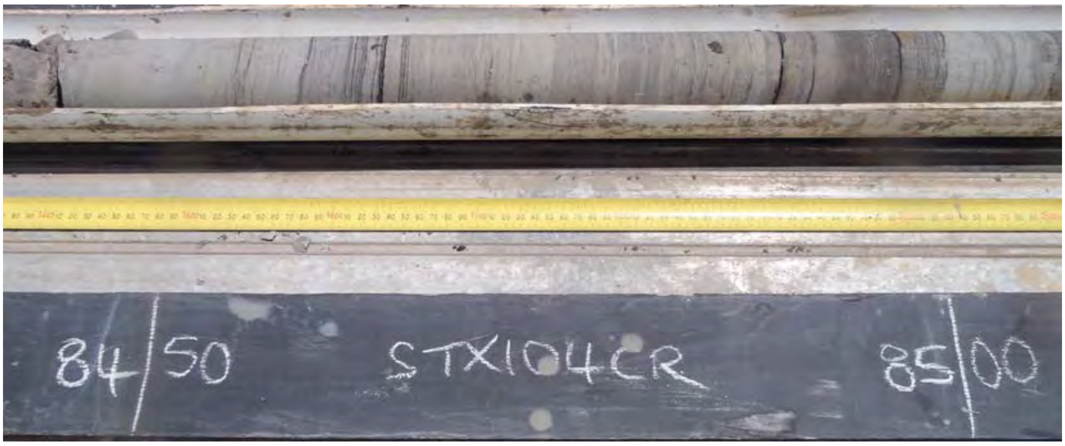
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist


31|00
STX104CR
31|50


78|50
STX104CR
79|00


84|50
STX104CR
85|00


93 00
STX104CR
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19378
99 00
STX104CR
99 50


103 50
STX104CR
104 00

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 631.50

N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 1 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

DEPTH:

LEVEL:

GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, brown, sticky					**INDETERMINATE**			No sonic log
		5						5
		10						10
SILT, brown, loose		11.00						
SANDSTONE, brown, friable, completely weathered		15						15
		20						20

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 773 631.50

N 7 486 178.54

BOREHOLE No: STX113CR

SHEET 2 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

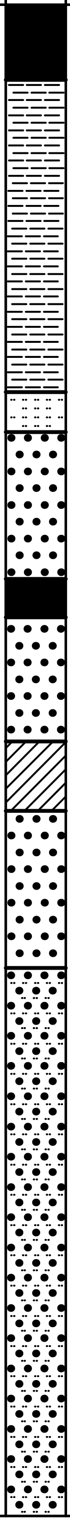
DEPTH:

LEVEL:

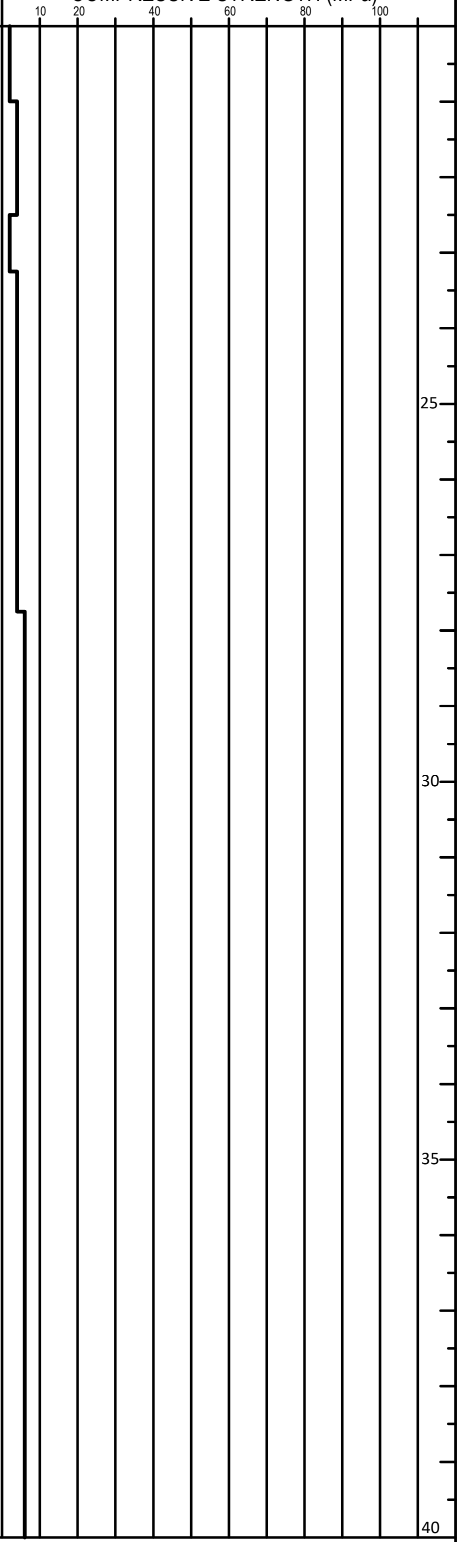
GROUND LEVEL (AHD) 32.88

DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
COAL, completely weathered				INDETERMINATE		
MUDSTONE, black, completely weathered	21.00					
	25					
SILTSTONE, fresh	25.13			← Base of weathering 25.13		
Mainly SANDSTONE, light grey, fresh, moderately strong Coal → Coal →	25.66					
COAL, fresh, weak	27.60					
Mainly SANDSTONE, grey, fresh, moderately strong Coal → Coal → Coal →	28.11			Slickensides		
Core loss	29.75 30 30.67					
SANDSTONE, grey, SILTSTONE, medium grey, fresh, weak to moderately weak	32.75 35 40					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

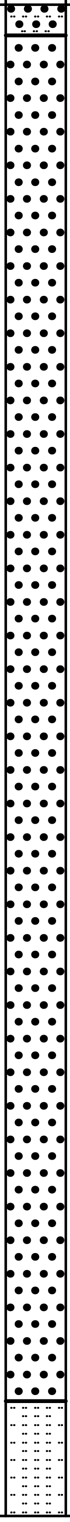
SCALE 1 : 100

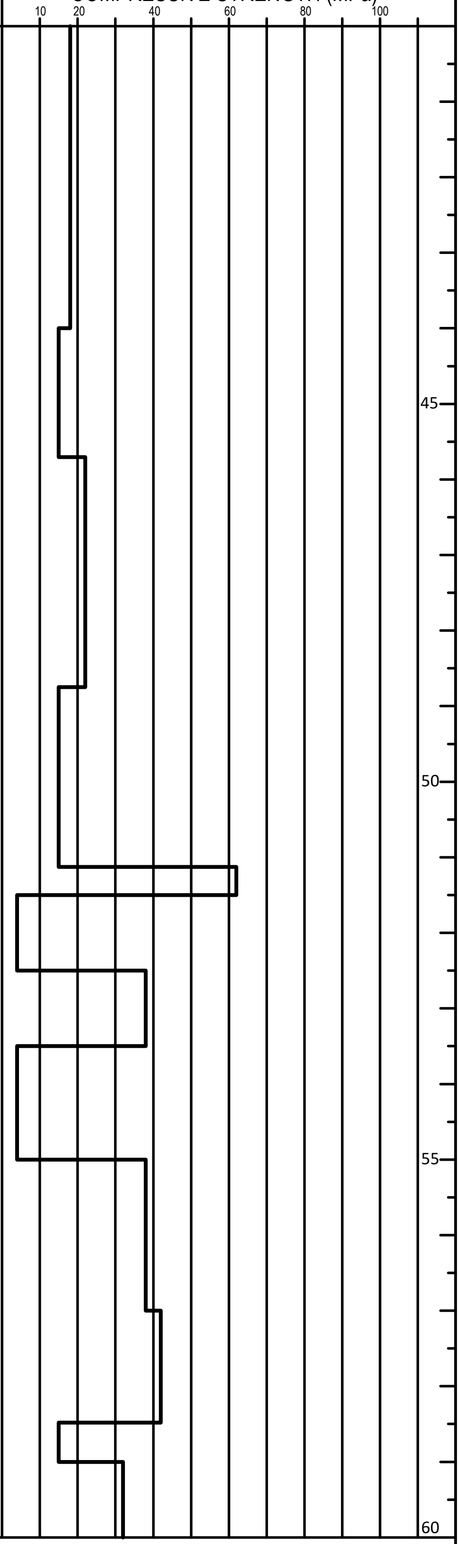
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 631.50 N 7 486 178.54	BOREHOLE No: STX113CR SHEET 3 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 32.88	DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SANDSTONE, SILTSTONE,				**INDETERMINATE**			
Mainly SANDSTONE, light grey, fresh, moderately weak to moderately strong	40.41						
Coal →							
Coal →							
Mudstone →							
SILTSTONE, grey, fresh, weak	58.48						





Depth: 45, 50, 55, 60

REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 631.50
N 7 486 178.54

BOREHOLE No:
STX113CR

SHEET 4 OF 7

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY,
GEOTECHNICAL ASSESSMENT

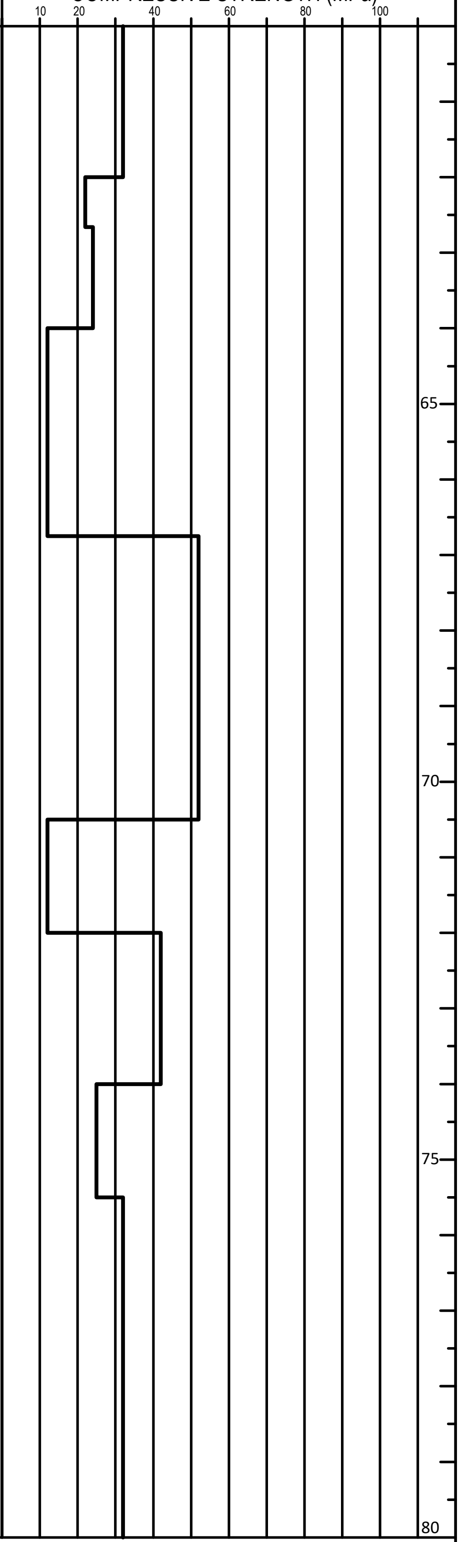
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
32.88

DRILLING DATE:
19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
Mainly SILTSTONE, grey, fresh, weak to moderately weak		65 70 75			INDETERMINATE		
Coal →							
Siderite		76.80					
SANDSTONE, carbonaceious, black, fresh, strong Coal →							
Coal → Coal →		80			← Siderite		

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

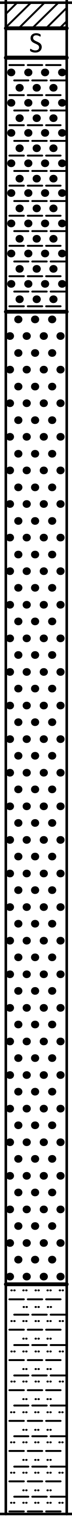
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

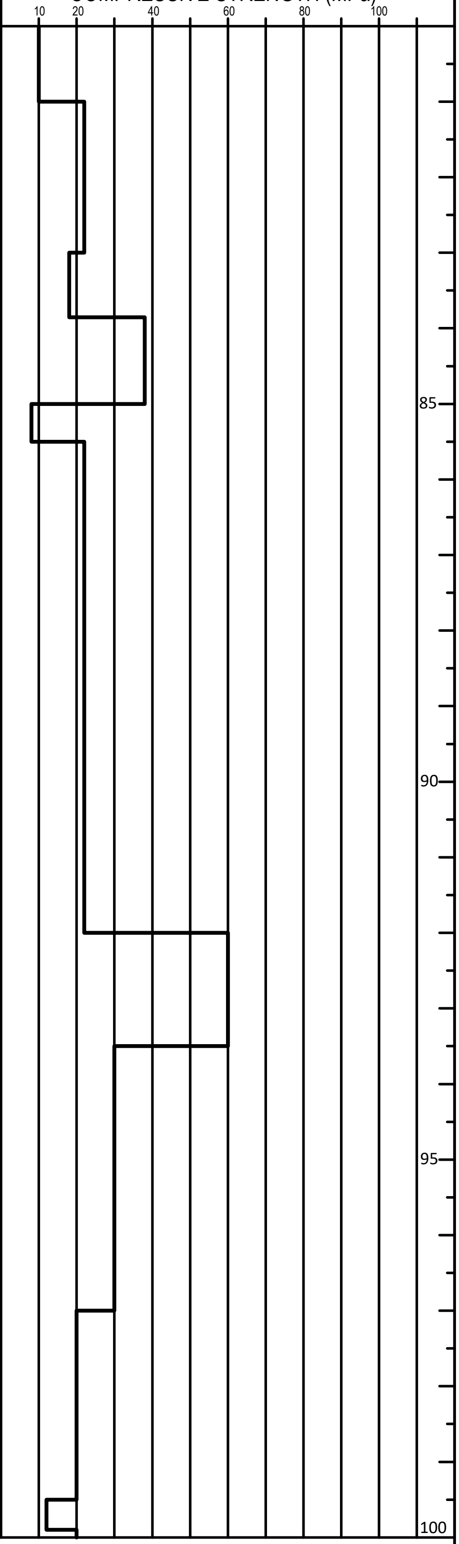
LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 773 631.50 N 7 486 178.54	BOREHOLE No: STX113CR SHEET 5 OF 7
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 32.88	DRILLING DATE: 19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
Core loss SIDERITE Coal		S		**INDETERMINATE**		
MUDSTONE, black, SANDSTONE, grey, fresh, weak	80.73					
SANDSTONE, grey, fresh, mainly moderately weak	84.09					
	85					
	90					
Mudstone →						
	95					
Core loss →						
SILTSTONE, grey, MUDSTONE, black, fresh, moderately weak	96.96					
Coal →	100					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 631.50
N 7 486 178.54

BOREHOLE No:
STX113CR

SHEET 6 OF 7

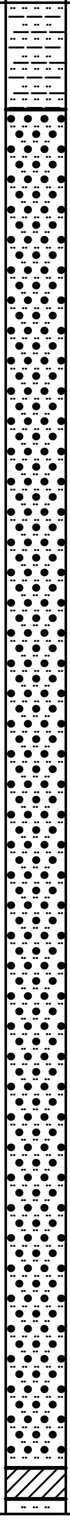
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

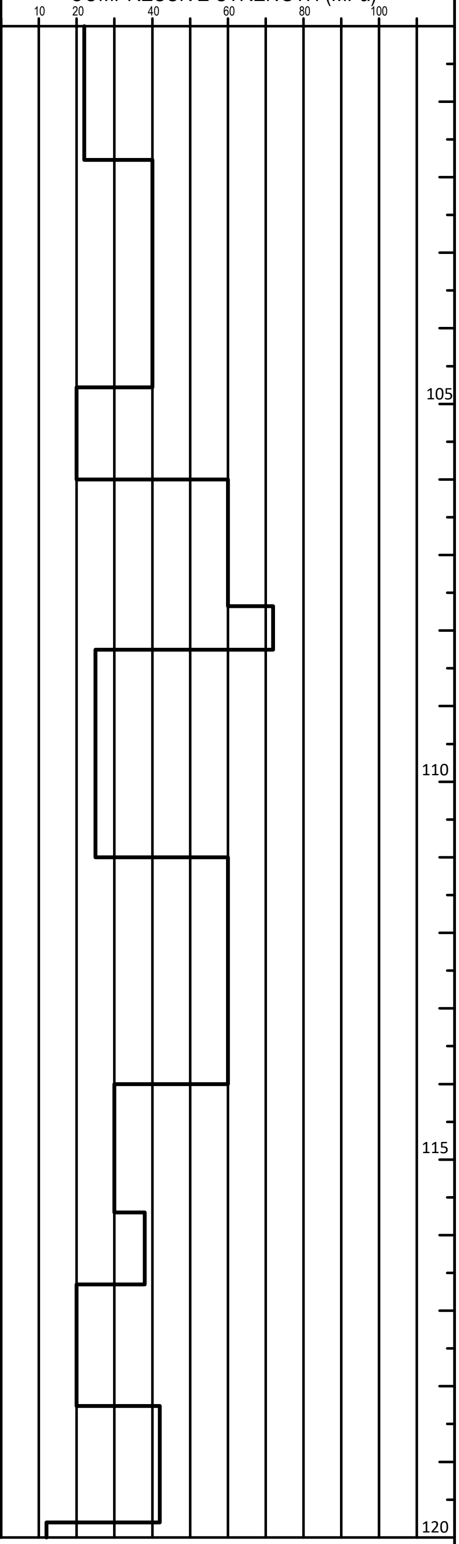
GROUND LEVEL (AHD)
32.88

DRILLING DATE:
19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SILTSTONE, MUDSTONE				INDETERMINATE		
SANDSTONE, light grey, SILTSTONE, medium grey, fresh, mainly moderately weak, broken core	101.44					
	105					
	110					
Core loss →	115					
Core loss	119.39					
	119.80					
	120					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 773 631.50
N 7 486 178.54

BOREHOLE No:
STX113CR

SHEET 7 OF 7

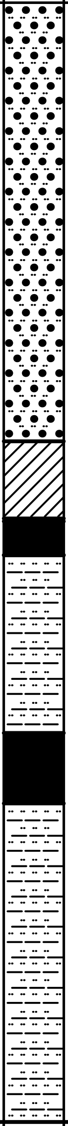
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

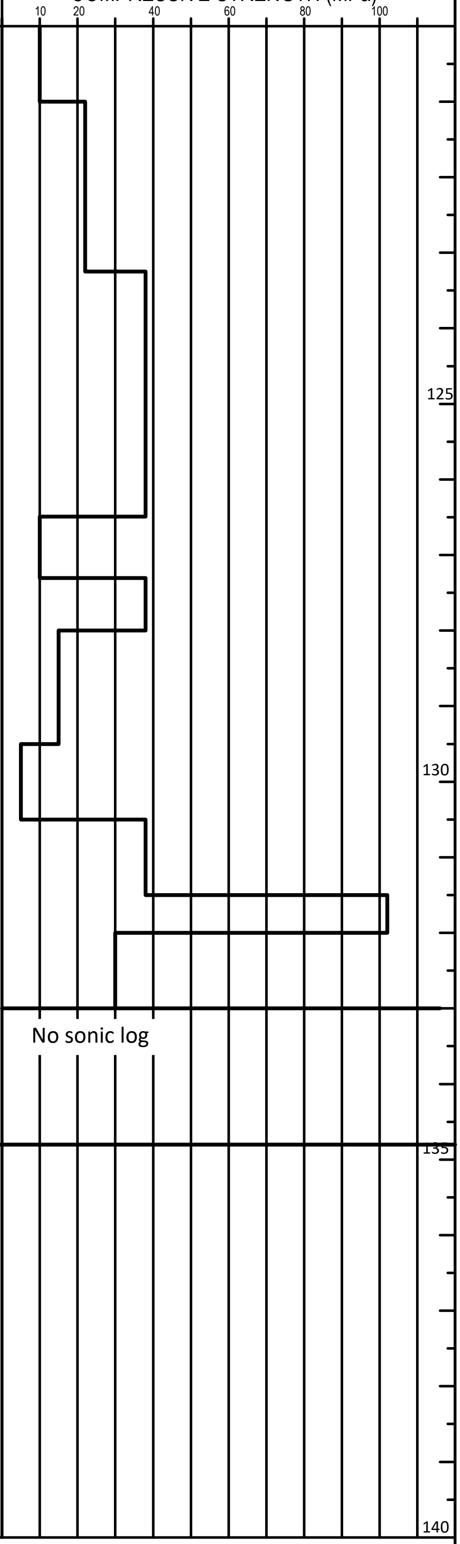
GROUND LEVEL (AHD)
32.88

DRILLING DATE:
19/01/12

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, SILTSTONE, medium grey, fresh, moderately weak to moderately strong, broken core	125			**INDETERMINATE**		
Core loss	125.80					
COAL, fresh, weak	126.82 126.86					
MUDSTONE, dark grey, SILTSTONE, grey, fresh, weak, broken core Core loss Core loss	127.31					
COAL, fresh, weak Core loss	129.66 130					
SILTSTONE, grey, MUDSTONE, dark grey, fresh, mainly weak,	130.59					
END OF HOLE 134.80 m	135 140					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



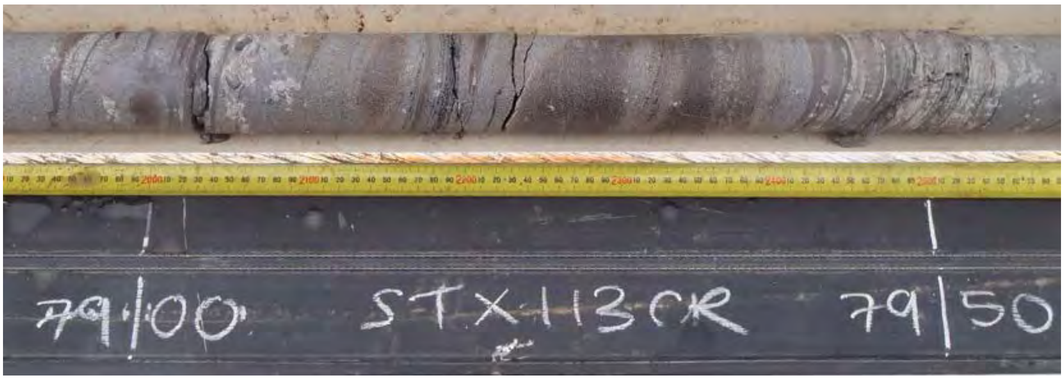
REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist


79.00
STX113CR
79.50


19399
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STX113CR
86.00


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STX113CR
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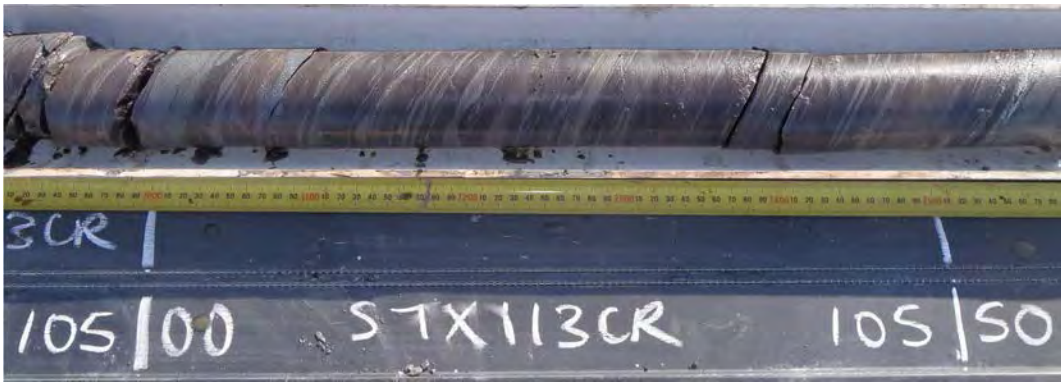
101 | 00 STX113CR 101 | 50


3CR
105 | 00 STX113CR 105 | 50


113 | 00 STX113CR 113 | 50


N 18
123|00
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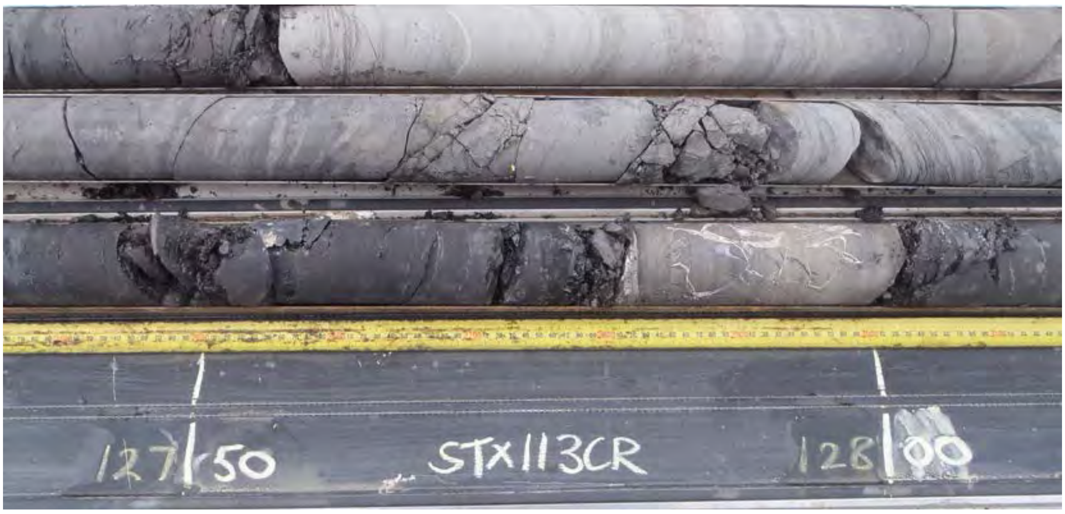

127|50
STX113CR
128|00

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 1 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100	
CLAY, brown					**INDETERMINATE**			**No sonic log**	
		5							5
SAND, brown		6.00							
		10							10
		15							15
CLAY, brown		19.00							
		20							20

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 2 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
CLAY, brown					INDETERMINATE			No sonic log
SAND, brown		22.00						
SILTSTONE, grey, SANDSTONE, grey, fresh		23.54			Base of weathering 23.50			
		25						
		30						
		35						
MUDSTONE, dark grey, SILTSTONE, grey, fresh,		37.00						
		40						

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = 3330e$^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 3 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, dark grey, SILTSTONE, grey, fresh		45 50			**INDETERMINATE**			**No sonic log**
SANDSTONE, grey, fresh		51.00						
COAL, fresh		52.99						
MUDSTONE, grey, fresh		53.50						
SANDSTONE, light grey, fresh		54.64 55						
COAL, fresh		59.69 60						

45

50

55

60

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 774 153.54

N 7 485 901.99

BOREHOLE No: STX120

SHEET 4 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE

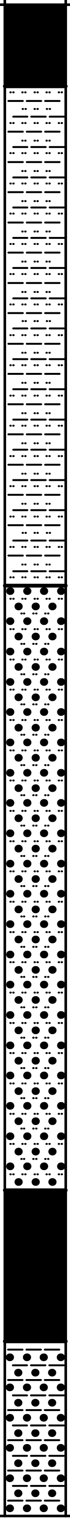
DEPTH:

LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
COAL, fresh					INDETERMINATE			No sonic log
MUDSTONE, dark grey, SILTSTONE, grey, fresh		61.08 65						
SANDSTONE, light grey, SILTSTONE, medium grey, fresh		67.69 70 75						
COAL, fresh		75.69						
SANDSTONE, MUDSTONE, light grey, SILTSTONE, medium grey, fresh		77.69 80						



65

70

75

80

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No:
STX120

SHEET 5 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
34.08

DRILLING DATE:
10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, light grey, SILTSTONE, medium grey, fresh					INDETERMINATE			No sonic log
SHALE, MUDSTONE, fresh		84.96 85						85
SANDSTONE, light grey, SILTSTONE, grey, fresh		87.69 90 95						90 95
SHALE, MUDSTONE, fresh		98.19 100						100

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

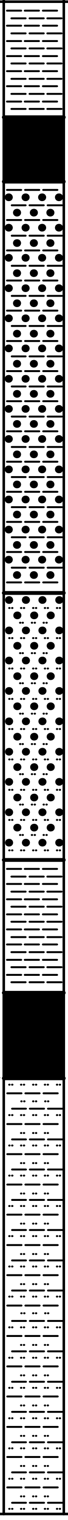
SHEET 6 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, dark grey, fresh					**INDETERMINATE**			**No sonic log**
COAL, fresh		101.53						
SANDSTONE, grey, MUDSTONE, fresh		102.38 105						
SANDSTONE, grey, SILTSTONE, dark grey, fresh		107.82 110						
MUDSTONE, SHALE, fresh		111.35						
COAL, fresh Siderite →		113.11						
MUDSTONE, dark grey, SILTSTONE, grey, fresh Siltstone →		114.24 115 120						

105

110

115

120

REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

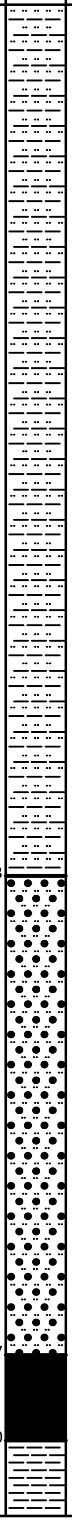
LOCATION
E 774 153.54
N 7 485 901.99

GROUND LEVEL (AHD) 34.08

BOREHOLE No: STX120

SHEET 7 OF 10

DRILLING DATE: 10/03/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, dark grey, SILTSTONE, medium grey, fresh Sandstone →		125 130			INDETERMINATE			No sonic log
SANDSTONE, grey, SILTSTONE, brownish grey, fresh		132.53 135						
COAL, fresh		137.87						
MUDSTONE, fresh		139.00 140						

125
130
135
140

REMARKS:
Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 8 OF 10

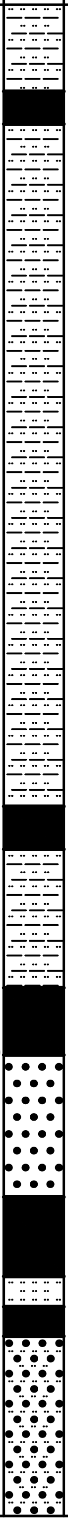
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
MUDSTONE, SILTSTONE, fresh		INDETERMINATE	No sonic log
COAL, fresh	141.15		
MUDSTONE, dark grey, SILTSTONE, grey, fresh	141.58		
	145		
Siderite			
	150		
COAL, fresh	150.61		
MUDSTONE, SILTSTONE, fresh	151.18		
COAL, fresh	153.01		
SANDSTONE, grey, fresh	153.90		
	155		
COAL, fresh	155.78		
SILTSTONE, fresh	156.83		
COAL, fresh	157.23		
SANDSTONE, SILTSTONE, grey, fresh	157.62		
	160		



REMARKS:

Chip hole

N.A. Not Applicable

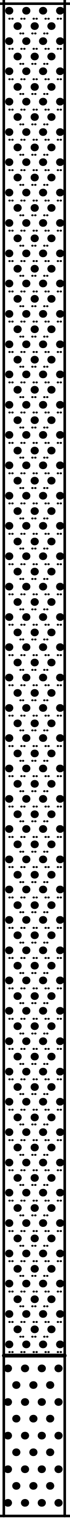
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 774 153.54 N 7 485 901.99	BOREHOLE No: STX120 SHEET 9 OF 10
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 34.08	DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, grey, SILTSTONE, medium grey, fresh	165 170 175			**INDETERMINATE**			**No sonic log** 165 170 175
SANDSTONE, grey, fresh	177.88 180						180



REMARKS:

Chip hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 774 153.54
N 7 485 901.99

BOREHOLE No: STX120

SHEET 10 OF 10

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 34.08

DRILLING DATE: 10/03/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SANDSTONE, grey, fresh	185			**INDETERMINATE**			**No sonic log**
MUDSTONE, dark grey, fresh	188.88						
SANDSTONE, medium grey, fresh	189.86 190 195						
END OF HOLE 197.88 m	200						

REMARKS:

Chip hole

N.A. Not Applicable

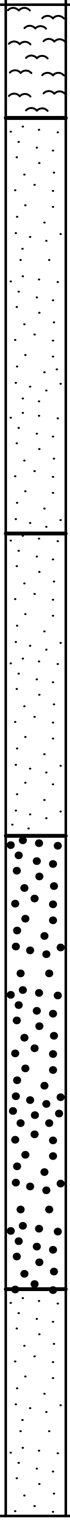
SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

NO CORE PHOTOGRAPHS AVAILABLE

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 772 998.69	BOREHOLE No: STX124
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	N 7 486 388.85 GROUND LEVEL (AHD) 32.41	SHEET 1 OF 4 DRILLING DATE: 20/04/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
SOIL, dark brown					**INDETERMINATE**			No sonic log
CLAY, dark brown		2.00						
		5						5
SILT, light brown		7.00						
		10						10
SAND, light grey		11.00						
		15						15
CLAY, dark grey		17.00						
		20						20

REMARKS:

Cored hole

N.A. Not Applicable

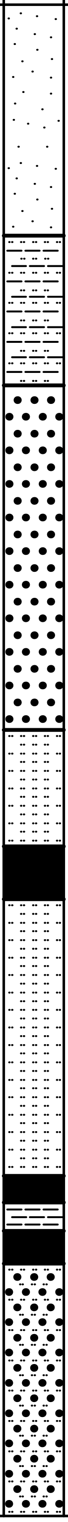
SCALE 1 : 100

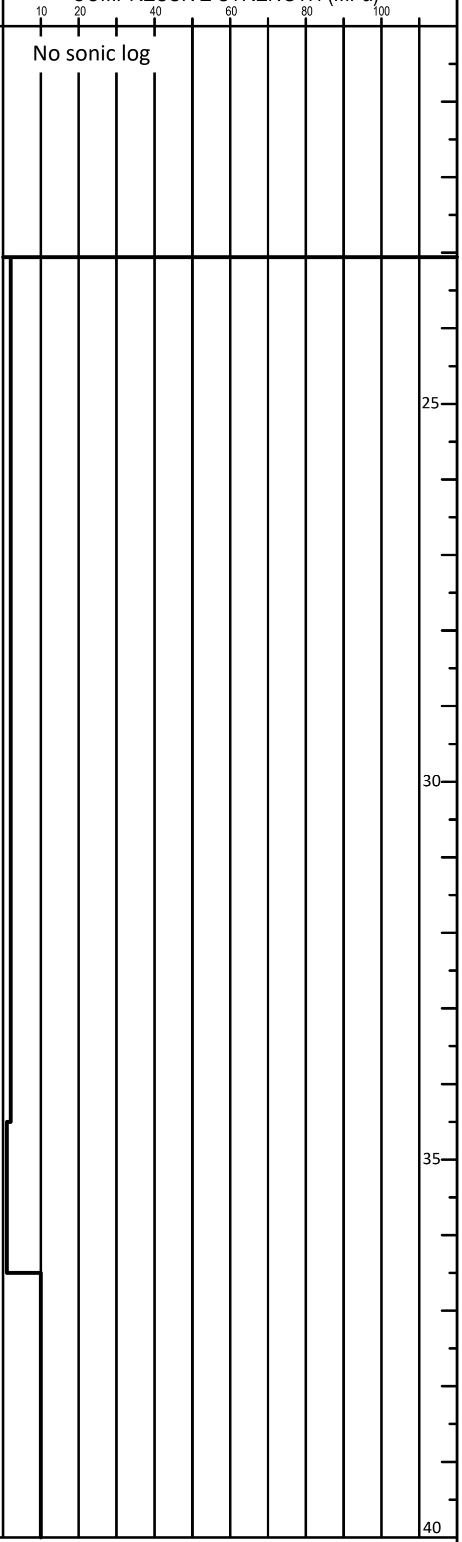
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 772 998.69 N 7 486 388.85	BOREHOLE No: STX124 SHEET 2 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 32.41	DRILLING DATE: 20/04/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
CLAY, dark grey					**INDETERMINATE**			No sonic log
SILTSTONE, brown, MUDSTONE, black, slighty weathered, broken core		23.06						
SANDSTONE, grey, slightly weathered to fresh, weak Core loss		25.04			Base of weathering 26.60			
SILTSTONE, greyish brown, fresh, weak		29.60 30						
COAL, fresh Mudstone		31.14						
SILTSTONE, greyish brown, fresh, broken core Core loss		31.84 35						
COAL, fresh		35.50						
MUDSTONE, weak		35.85						
COAL, fresh Mudstone		36.23						
SILTSTONE, brownish grey, SANDSTONE, light grey, moderately weak, broken core		36.66 40						





REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 998.69
N 7 486 388.85

BOREHOLE No:
STX124

SHEET 3 OF 4

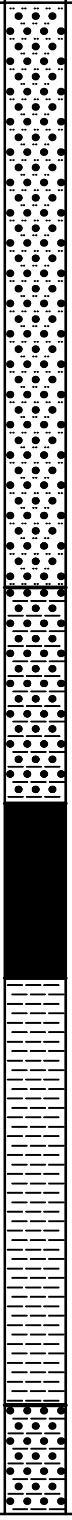
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

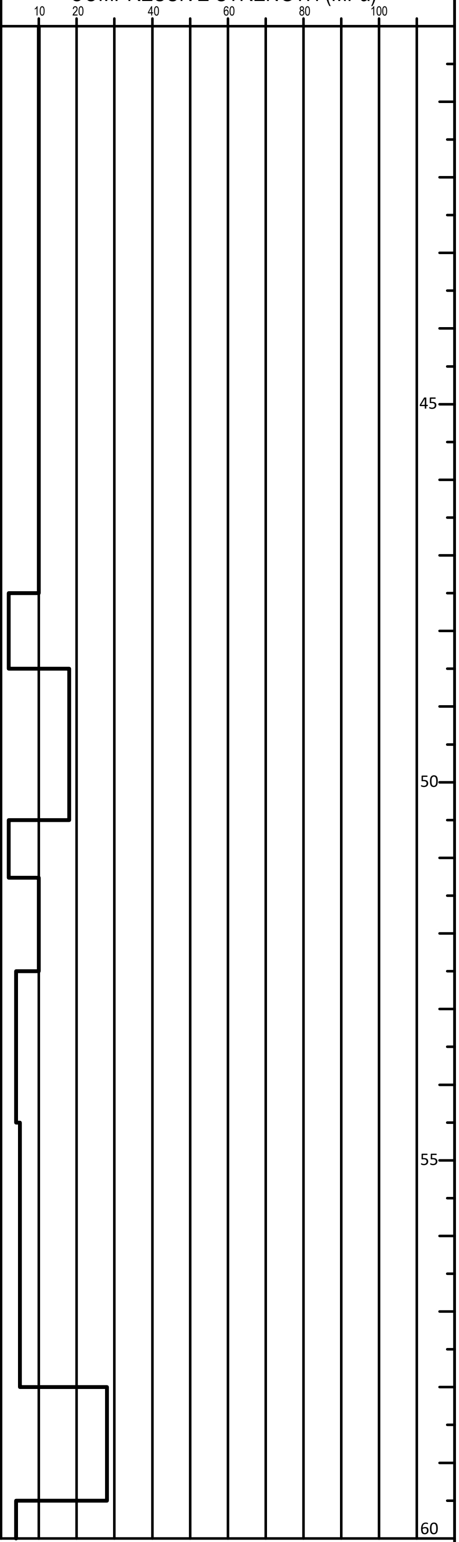
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
32.41

DRILLING DATE:
20/04/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
SILTSTONE, brownish grey, SANDSTONE, grey, fresh, weak, broken core Coal Coal	45 47.74			**INDETERMINATE**			
MUDSTONE, dark grey, SANDSTONE, light grey, fresh, weak, broken core	50 50.60						
COAL, fresh Core loss	52.91						
MUDSTONE, dark grey, weak, broken core Tuff Siltstone	55 58.56						
SANDSTONE, light grey, MUDSTONE, dark grey, weak, broken core Coal Core loss	60						





REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 998.69
N 7 486 388.85

BOREHOLE No:
STX124

SHEET 4 OF 4

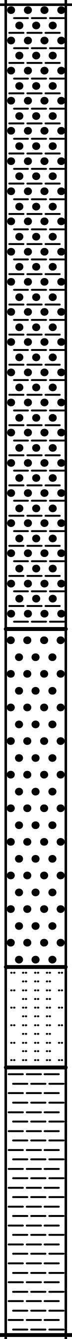
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

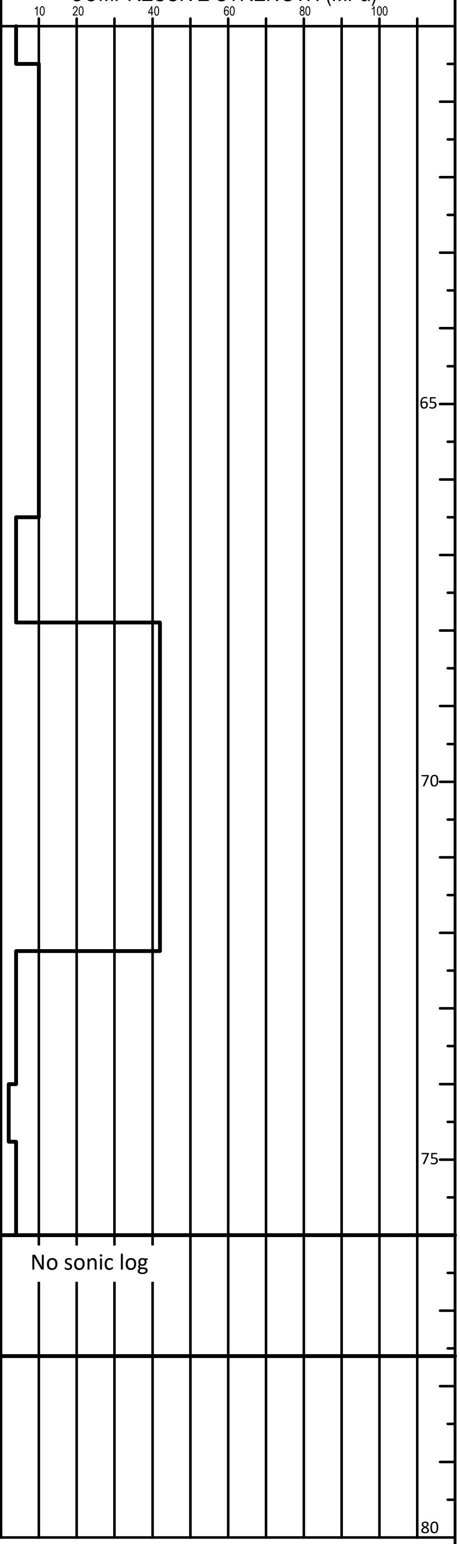
GROUND LEVEL (AHD)
32.41

DRILLING DATE:
20/04/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, light grey, MUDSTONE, dark grey, weak, broken core		65			**INDETERMINATE**		
SANDSTONE, light grey, fresh, moderately weak		68.26 70					
SILTSTONE, brownish grey, fresh, weak		72.73					
Coal Coal							
MUDSTONE, dark grey, weak		74.06 75			← Core loss		
END OF HOLE 77.60 m		80					



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

STX124


24|00
STX124
24|50


33|00
STX124
33|50


39|00
STX124
39|50


42|00
STX124
42|50

STX124


65233
65234
65235
65236
52 50
STX124
53 00


64 00
STX124
64 50


70 50
STX124
71 00


75 50
STX124
76 00

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 954.70
N 7 487 131.70

BOREHOLE No:
STX126B

SHEET 1 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
37.23

DRILLING DATE:
11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
CLAY, brown					INDETERMINATE			No sonic log
		5						5
		10						10
SILTSTONE, dark grey, SANDSTONE, grey, fresh, weak to very weak		11.86			← Base of weathering 11.86			
		15						15
		20						20

REMARKS:
Cored hole

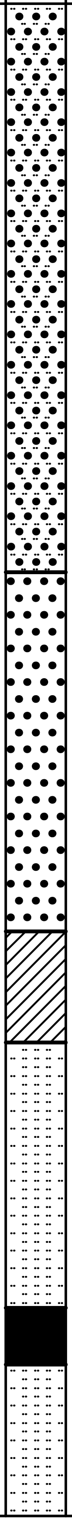
N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 771 954.70 N 7 487 131.70	BOREHOLE No: STX126B SHEET 2 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 37.23	DRILLING DATE: 11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, dark grey, SANDSTONE, light grey, fresh, very weak to moderately weak Coal → Coal → Coal → Core loss → Coal →	25			**INDETERMINATE**			No sonic log
SANDSTONE, grey, fresh, moderately weak	27.52 30 32.27						
Core loss							
SILTSTONE, dark grey, fresh, weak Coal → Coal → Siltstone → Coal →	33.74 35						
COAL, fresh, weak	37.25						
SILTSTONE, dark grey, fresh, very weak Coal	38.00 40						

25
30
35
40

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 954.70
N 7 487 131.70

BOREHOLE No: STX126B

SHEET 3 OF 4

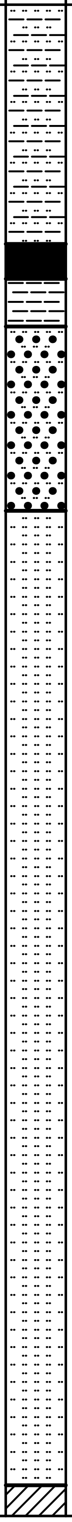
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
MUDSTONE, black, SILTSTONE, grey, moderately weak Coal				**INDETERMINATE**			No sonic log
COAL, fresh, weak	43.17						
MUDSTONE Core loss	43.63						
SILTSTONE, medium grey, SANDSTONE, grey, fresh, weak to very weak	44.26 45						45
SILTSTONE, medium grey, fresh, very weak	46.70 50 55						50 55
Core loss	59.60 60						60



REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 771 954.70 N 7 487 131.70	BOREHOLE No: STX126B SHEET 4 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 37.23	DRILLING DATE: 11/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, medium grey, fresh Core loss		60.75	▨		INDETERMINATE			No sonic log
		62.60						
SANDSTONE, grey, fresh, mainly moderately weak		65	●					
		69.89						
SILTSTONE, medium grey, fresh, very weak		70						
		73.17						
SANDSTONE, grey, fresh, very weak			●					
END OF HOLE 74.60 m		75						
		80						

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist


12.50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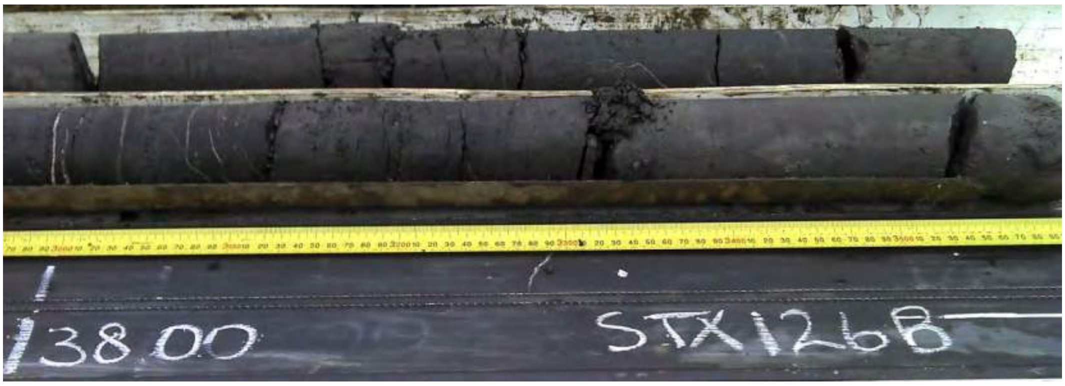
29.00


38.00
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STX126B

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 771 431.56
N 7 487 323.69

BOREHOLE No: STX127

SHEET 1 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
SOIL, brown					**INDETERMINATE**			No sonic log
CLAY, red to brown		4.00						
SANDSTONE, brown, highly weathered		14.47						
SILTSTONE, dark grey, SANDSTONE, grey, fresh, very weak		16.82			← Base of weathering 16.82			
Coal		17.61						
		18.57						
Core loss		19.61						
		20						

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION

E 771 431.56

N 7 487 323.69

BOREHOLE No: STX127

SHEET 2 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

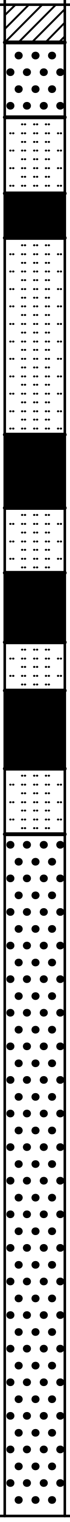
WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 37.23

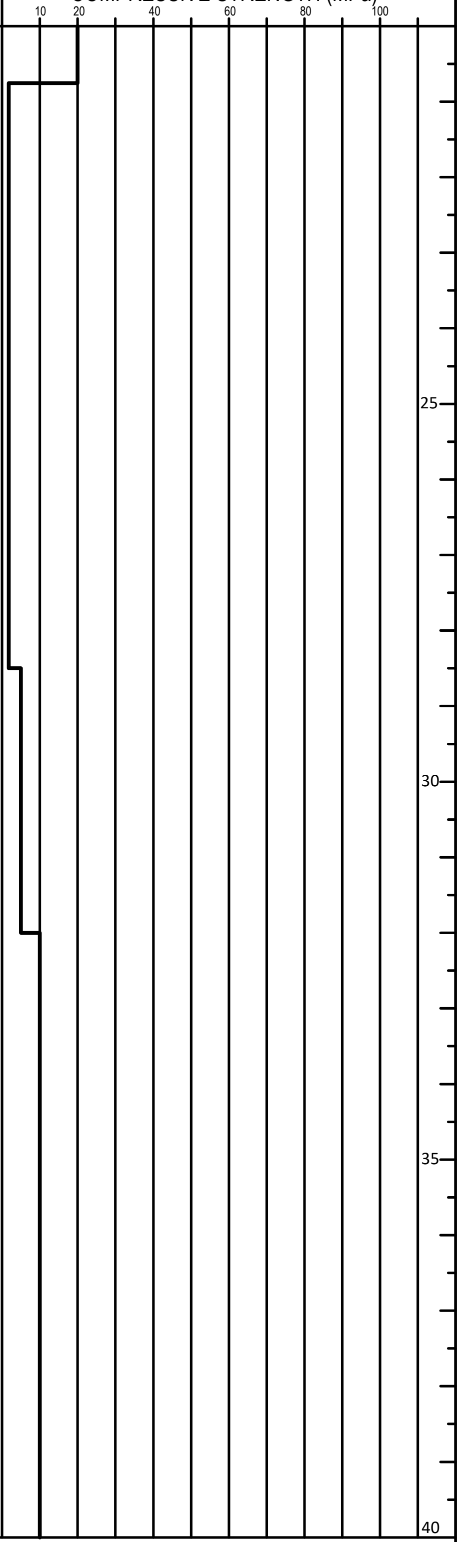
DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES DEPTH	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
Core loss					
SANDSTONE, light grey, fresh, moderately weak Coal	20.50		**INDETERMINATE**		
SILTSTONE, grey, fresh, very weak	21.49				
COAL, fresh, very weak	22.50				
SILTSTONE, dark grey, fresh, very weak	23.09				
	25				
COAL, fresh, very weak	25.69				
SILTSTONE, grey, fresh, very weak Core loss	26.66				
COAL, fresh, very weak	27.51				
SILTSTONE, grey, fresh, very weak	28.44				
COAL, fresh, very weak Core loss	29.08				
	30				
SILTSTONE, grey, fresh, very weak Mudstone	30.11				
SANDSTONE, grey, fresh, moderately weak to very weak	30.98				
	35				
	40				

GRAPHIC LOG



SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

LOCATION
E 771 431.56
N 7 487 323.69

GROUND LEVEL (AHD) 37.23

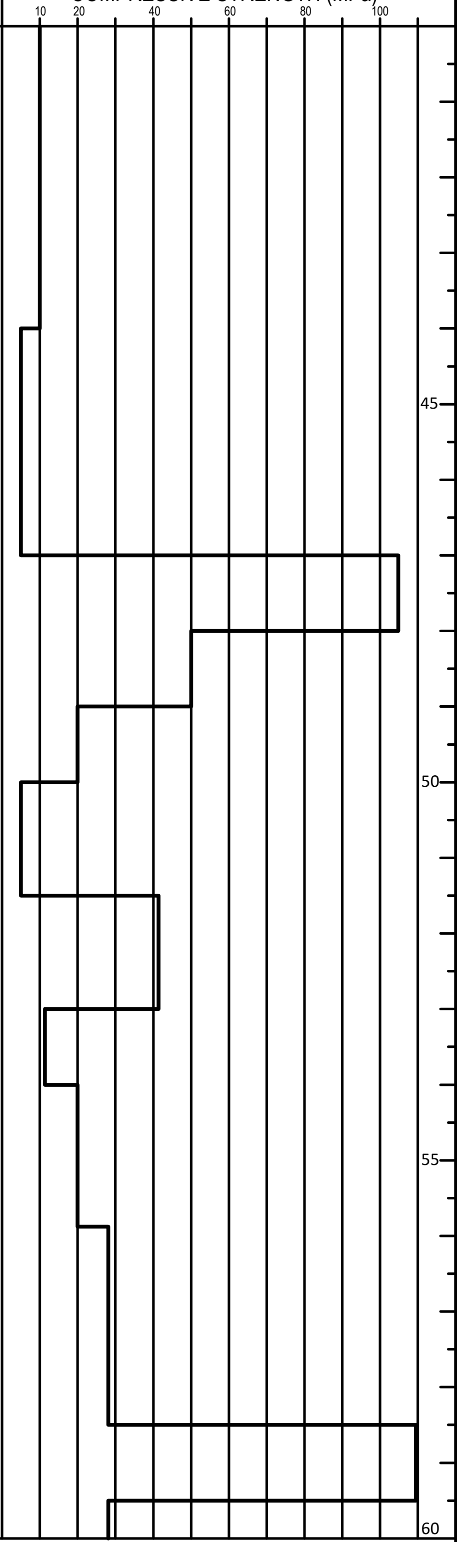
BOREHOLE No: STX127

SHEET 3 OF 4

DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, grey, fresh, very weak to moderately weak	45			**INDETERMINATE**		
SILTSTONE, grey, fresh, very weak	49.67 50					
SANDSTONE, grey, fresh, moderately weak to moderately strong Siltstone →	50.76 55 60					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

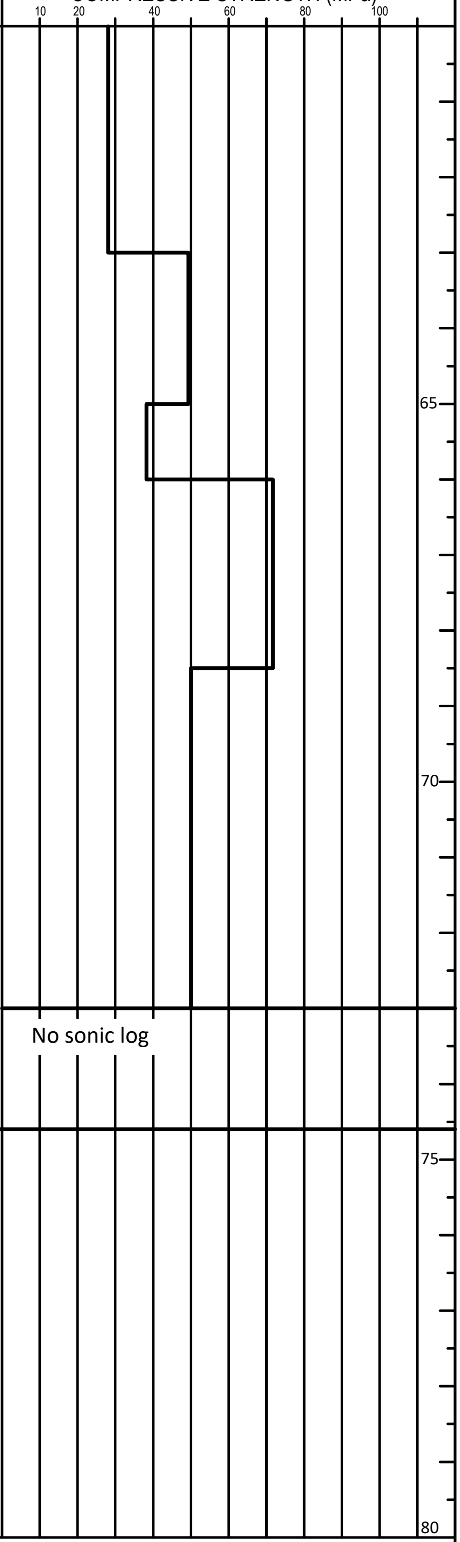
Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 771 431.56 N 7 487 323.69	BOREHOLE No: STX127 SHEET 4 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 37.23	DRILLING DATE: 13/05/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.
SANDSTONE, grey, fresh, moderately strong Siltstone →		65 70			**INDETERMINATE**		
END OF HOLE 74.60 m		75 80					

SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa)



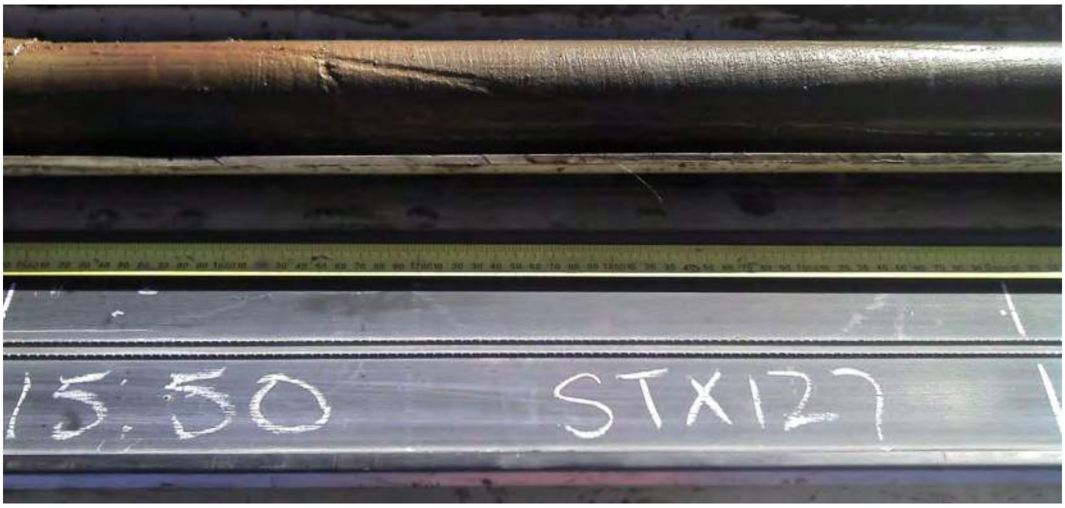
REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

STX127


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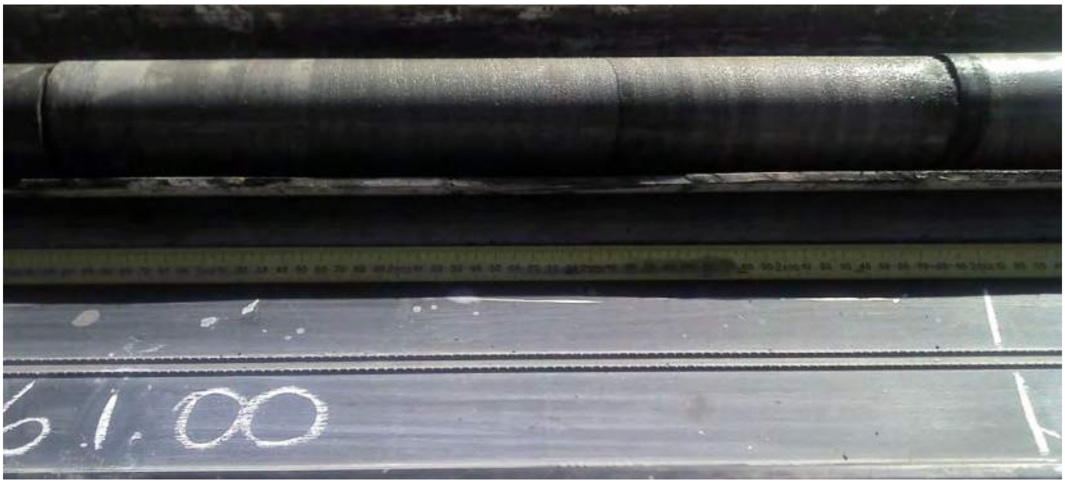
STX1


61.00


71.00
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CLIENT : CENTRAL QUEENSLAND COAL PTY LTD	CORE TYPE: CASING DEPTH:	LOCATION E 772 585.31 N 7 486 943.74	BOREHOLE No: STX132C SHEET 1 OF 4
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT	WATER TABLE DEPTH: LEVEL:	GROUND LEVEL (AHD) 31.50	DRILLING DATE: 04/06/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 20 40 60 80 100
Not logged			▨		N.A.			No sonic log
		5						5
		10						10
		15						15
					Assumed base of weathering 19.40			
COAL		19.40	■		INDETERMINATE			
MUDSTONE		19.80						
		20						20

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT :
CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 585.31
N 7 486 943.74

BOREHOLE No:
STX132C

SHEET 2 OF 4

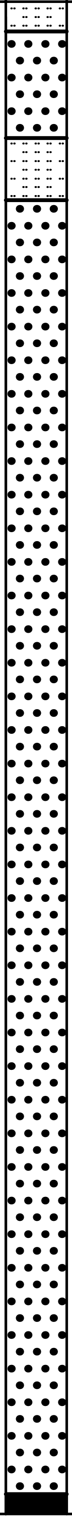
SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD)
31.50

DRILLING DATE:
04/06/11

DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L. / DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, fresh				**INDETERMINATE**			No sonic log
SANDSTONE, grey, fresh, very weak Core loss Coal	20.40						
SILTSTONE, fresh, very weak	21.81						
SANDSTONE, grey, fresh, weak Core loss Coal Mudstone Coal Coal	22.63 25 30 35						25 30 35
COAL	39.74 40						40



REMARKS:
Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY:
Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 585.31
N 7 486 943.74

BOREHOLE No: STX132C

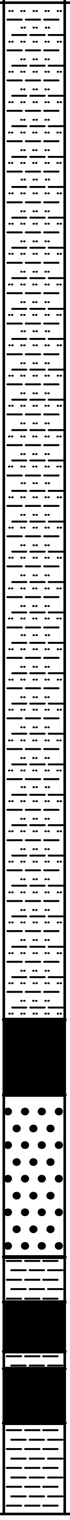
SHEET 3 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 31.50

DRILLING DATE: 04/06/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	DURABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
Mudstone							
SANDSTONE, MUDSTONE, grey, fresh, weak to very weak				**INDETERMINATE**			No sonic log
Coal							
Coal		45					
Coal							
Coal							
Coal		50					
Core loss							
COAL, fresh, very weak		53.46					
SANDSTONE, grey, fresh, very weak		54.60					
		55					
MUDSTONE, grey, weak		56.60					
COAL, fresh, weak		57.20					
MUDSTONE, grey, weak		57.85					
COAL, fresh, weak		58.08					
MUDSTONE, grey fresh, very weak		58.80					
		60					

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

CLIENT : CENTRAL QUEENSLAND COAL PTY LTD

CORE TYPE:

CASING DEPTH:

LOCATION
E 772 585.31
N 7 486 943.74

BOREHOLE No: STX132C

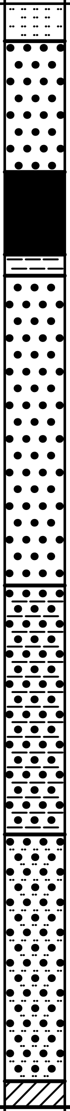
SHEET 4 OF 4

SITE LOCATION / PURPOSE : NEXT TO BRUCE HIGHWAY, GEOTECHNICAL ASSESSMENT

WATER TABLE
DEPTH:
LEVEL:

GROUND LEVEL (AHD) 31.50

DRILLING DATE: 04/06/11



DESCRIPTION OF CORE ROCK TYPE, COLOUR, GRAIN SIZE	METRES R.L.	METRES DEPTH	GRAPHIC LOG	DUR-ABILITY %	STRUCTURES JOINTS, BEDDING, VEINS, SEAMS, CRUSHED ZONES, FAULTS	FRAC. PER METRE	R.Q.D.	SONIC DERIVED UNIAXIAL COMPRESSIVE STRENGTH (MPa) 10 20 40 60 80 100
SILTSTONE, weak					INDETERMINATE			No sonic log
SANDSTONE, grey, fresh, moderately weak		60.50						
COAL, weak Mudstone → Mudstone →		62.23						
MUDSTONE		63.32						
SANDSTONE, grey, fresh, weak to very weak Coal → Siltstone → Calcite →		63.60 65						65
MUDSTONE, grey, SANDSTONE, light grey, fresh, weak to very weak		67.70 70						70
SANDSTONE, light grey, SILTSTONE, grey, fresh, weak Coal → Core loss		71.14			Slickensides			
END OF HOLE 74.60 m		75 80						75 80

REMARKS:

Cored hole

N.A. Not Applicable

SCALE 1 : 100

Sonic derived uniaxial compressive strength UCS = $3330e^{-0.0499t}$, where t = interval transit time (reciprocal of velocity) in microseconds per foot. Durability test : shake in water for 20 secs and assess, then immerse in water for 2 hrs and estimate percent disintegration.

LOGGED BY: Geologist

STX132C


42.50
STX132


132 02
163.00
STX132


165.00
STX


72.00
STX132


7350
STX132

APPENDIX

C

NEW BOREHOLE DATA

CORE LOG SHEET

Hole No: STX1903G

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863
Sheet: 1 of 16

Position: E773392.670 N7486730.310 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 32.722 m AHD
Rig Type: UDR650
Mounting: Truck
Driller: Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**
Bit Condition:
Contractor: Waratah Coal
Date Started: 28/8/19
Date Completed: 2/9/19
Logged By: AD
Checked By:

Coring

Method	Fluid	TCR (%)	RQD (%)
Rotary Air Drilling		100	0
4C		100	0
		100	0
		100	0
		100	0

RL (m AHD): 32, 31, 30, 29, 28, 27, 26, 25, 24, 23
Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

Depth	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components; ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Defect Description: Additional Data; DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
	Sandy CLAY: brown, fine to coarse grained sand, grass roots, MPS 2 LL 40 P75 50	0.00: grass roots
0.56m	Sandy CLAY: brown, fine to coarse grained sand, trace fine to coarse grained, sub-rounded gravel, tree root at 0.8m, MPS 15 LL 40 P75 60	0.56: tree root at 0.8m
1.77m	GYPSUM: white, MPS 1 LL 20 P75 80	
1.81m	Sandy CLAY: grey mottled dark-brown, orange becoming grey mottled black, red, white, fine to medium grained sand, with gypsum and manganese nodules, MPS 2 LL 35 P75 80	1.81: with gypsum and manganese nodules
7.59m	Sandy CLAY: grey mottled dark-brown, orange, black, white, fine to medium grained sand, gypsum mottles, MPS 2 LL 35 P75 75	7.59: gypsum mottles
8.40m	Sandy CLAY: grey mottled dark-brown, orange, black, white, fine to medium grained sand, gypsum mottles, MPS 2 LL 40 P75 60	8.40: gypsum mottles

Weathering | Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH) | Average Natural Defect Spacing (mm) (20 60 200 600 2000) | Visual

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽ Water Level on date shown
▶ water inflow
◀ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

STX1903G

Core Photographs

4C core Box 1

4C core Box 2

4C core Box 3

4C core Box 4

STX1903G

Core Photographs

4C core Box 5

4C core Box 6

4C core Box 7

4C core Box 8

STX1903G

Core Photographs

4C core Box 9

4C core Box 10

4C core Box 11

4C core Box 12

STX1903G

Core Photographs

HQ core Box 1

HQ core Box 2

HQ core Box 3

HQ core Box 4

STX1903G

Core Photographs

HQ core Box 5

HQ core Box 6

HQ core Box 7

HQ core Box 8

STX1903G

Core Photographs

HQ core Box 9

HQ core Box 10

HQ core Box 11

HQ core Box 12

STX1903G

Core Photographs

HQ core Box 13

HQ core Box 14

HQ core Box 15

HQ core Box 16

STX1903G

Core Photographs


HQ core Box 17


HQ core Box 18


HQ core Box 19


HQ core Box 20

STX1903G

Core Photographs

HQ core Box 21

HQ core Box 22

HQ core Box 23

HQ core Box 24

STX1903G

Core Photographs

HQ core Box 25

HQ core Box 26

HQ core Box 27

HQ core Box 28

CORE LOG SHEET

Hole No: STX1904G

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863
Sheet: 1 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: / **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 / **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**

Coring: Method – Air Drilling; 4C

TCR (%)	RQD (%)
100	0
100	0
100	0
100	0

RL (m AHD): 36, 35, 34, 33, 32, 31, 30, 29, 28, 27
Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

Depth	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components; ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Additional Data: DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
0.90m	Sandy Gravelly CLAY: brown, fine to coarse grained, sub-rounded gravel, fine to coarse grained sand, MPS 65 LL 30 P75 40	
1.85m	Sandy Gravelly CLAY: brown, fine to medium grained, sub-rounded gravel, fine to coarse grained sand, MPS 30 LL 30 P75 45	
3.11m	Sandy CLAY: brown, fine to coarse grained sand, MPS 2 LL 35 P75 80	
4.25m	Sandy CLAY: pale-grey mottled orange, fine grained sand, MPS 1 LL 30 P75 75	
4.41m	COBBLE/BOULDER: brown mottled orange	
5.65m	Sandy CLAY: pale-grey mottled orange, brown, fine to medium grained sand, MPS 1 LL 35 P75 60	
6.45m	Sandy CLAY: brown-grey, fine to medium grained sand, MPS 1 LL 40 P75 70	6.45: with peaty laminations
7.50m	CLAY: grey, dark-grey, black, with peaty laminations, MPS 1 LL 55 P75 100	
9.76m	CLAY: brown-grey mottled orange, trace fine grained sand, MPS 1 LL 45 P75 90	
	CORE LOSS 0.40m (9.76-10.16)	

Weathering | Estimated Strength Is(50) MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH | Average Natural Defect Spacing (mm): 20 60 200 600 2000 | Visual

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶	water inflow
◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

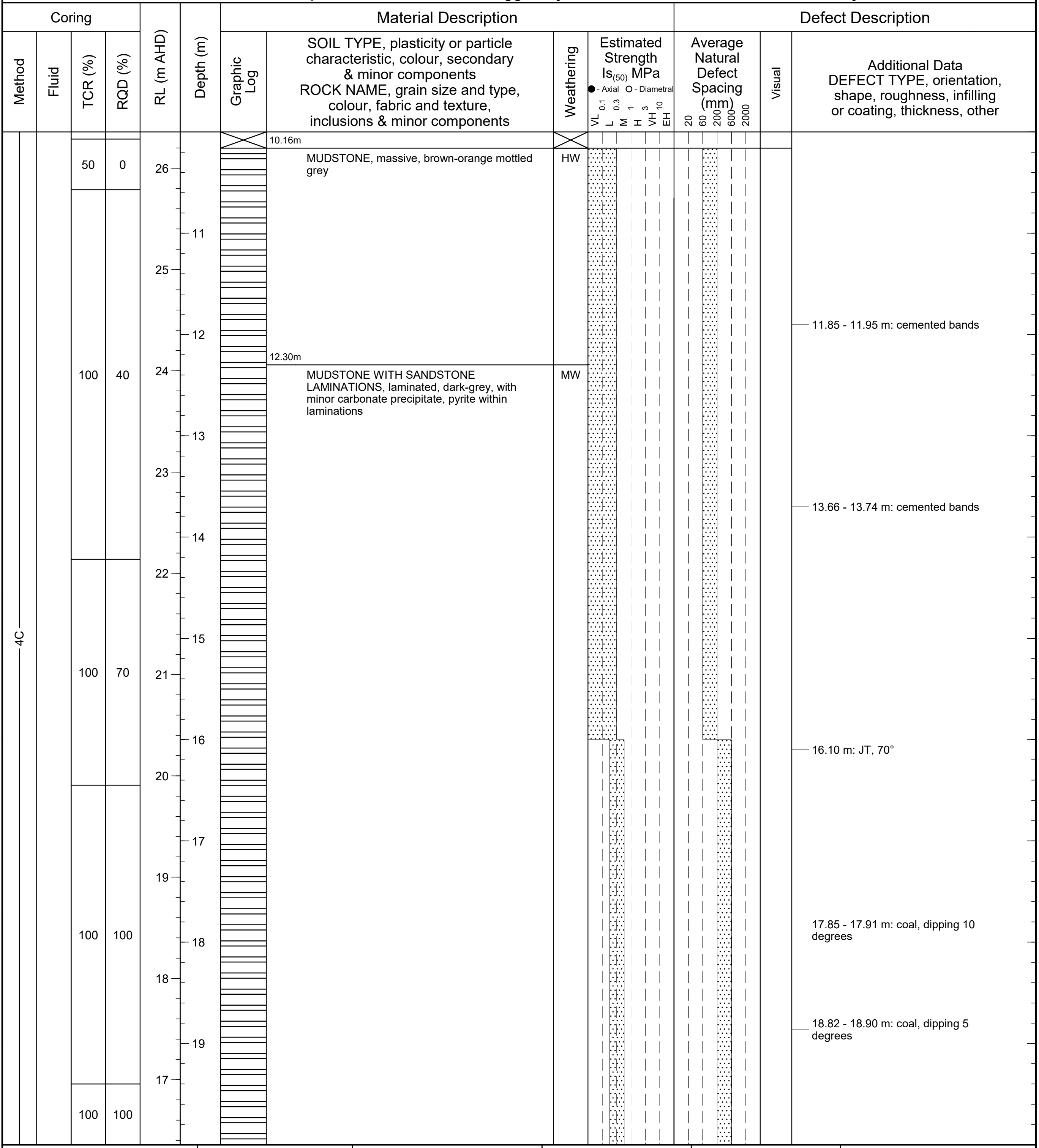
CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

Job No: M30863
Sheet: 2 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**



Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

10.16m
MUDSTONE, massive, brown-orange mottled grey

12.30m
MUDSTONE WITH SANDSTONE LAMINATIONS, laminated, dark-grey, with minor carbonate precipitate, pyrite within laminations

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

11.85 - 11.95 m: cemented bands

13.66 - 13.74 m: cemented bands

16.10 m: JT, 70°

17.85 - 17.91 m: coal, dipping 10 degrees

18.82 - 18.90 m: coal, dipping 5 degrees

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶	water inflow
◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

Job No: M30863
Sheet: 3 of 11

Position: E772389.090 N7487158.620 55 MGA94		**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650		**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter:	**Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19	**Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**

Method	TCR (%)	RQD (%)
4C	100	100
HQ3	100	100
HQ3	100	100
HQ3	100	100
HQ3	100	99

RL (m AHD): 16, 15, 14, 13, 12, 11, 10, 9, 8, 7
Depth (m): 21, 22, 23, 24, 25, 26, 27, 28, 29

Depth	Material Description	Weathering
20.16m		
20.42m	COAL, massive, black, with sub-vertical carbonate veins	SW
20.76m	CARBONACEOUS MUDSTONE, massive, dark-brown, black	HW to MW
21.46m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, dark-grey, grey, bioturbation, bedding at 10 degrees, pyrite within laminations	SW
21.78m	MUDSTONE, laminated, dark-grey	
22.63m	SANDSTONE, fine grained, laminated, grey, bedding at 15 degrees	F
22.78m	SANDSTONE, fine grained, massive, grey	
23.30m	SANDSTONE, fine grained, laminated, grey, bedding at 15 degrees	
23.54m	CARBONACEOUS SILTSTONE, massive, black	
23.78m	SILTSTONE, massive, dark-grey	
24.47m	SANDSTONE, fine grained, grey, soft sediment deformation	
24.74m	COAL, massive, black	
24.85m		
25.03m	CARBONACEOUS SILTSTONE, massive, dark-grey	
	SILTSTONE, dark-grey, coal inclusions	
25.33m	CARBONACEOUS SILTSTONE, massive, black	
25.90m	SILTSTONE, laminated, dark-grey	
26.02m	CARBONACEOUS MUDSTONE, massive, black	
26.36m	COAL, massive, black, multiple calcite veins at 90 degrees	
26.50m	CARBONACEOUS SILTSTONE, massive, black	
27.64m	SILTSTONE, massive, dark-grey	
27.80m	CARBONATE VEIN, pale-grey, grey	
28.80m	SILTSTONE, laminated, dark-grey, bedding at 15 degrees	
28.97m	CARBONACEOUS SILTSTONE, massive, black	
29.93m	SILTSTONE, massive, dark-grey	

Defect Description — Additional Data (DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other)

- 20.56 m: DB
- 20.72 m: DB
- 20.89 m: DB
- 20.91 m: DB
- 21.10 m: DB
- 21.76 - 21.86 m: multiple calcite veins, 90°
- 22.52 m: DB
- 22.53 - 22.62 m: multiple calcite veins, 90°
- 23.32 m: DB
- 23.64 m: DB
- 25.00 m: JT, 75°, CU
- 25.29 m: DB
- 25.44 m: DB
- 26.18 m: JT, 50°, PR
- 26.31 - 26.34 m: multiple drill breaks
- 26.50 m: DB
- 26.76 m: JT, 75°, PR, healed
- 27.43 m: JT, 55°, PR, RF
- 29.06 m: JT, 55°, PR, RF

Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH
Average Natural Defect Spacing (mm): 20 60 200 600 2000

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

Job No: M30863
Sheet: 4 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**

Coring

Method	Fluid	TCR (%)	RQD (%)
HQ3		100	99
		100	99
		97	97
		100	100
		100	100

RL (m AHD): 6, 5, 4, 3, 2, 1, 0, -1, -2, -3
Depth (m): 31, 32, 33, 34, 35, 36, 37, 38, 39

Material Description

Depth	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering
30.03m	COAL, massive, black *(continued)*	F
	SILTSTONE	
30.50m		
30.71m	CARBONACEOUS SILTSTONE, black	
	SILTSTONE, dark-grey, with minor sandstone laminations	
31.60m	SANDSTONE, laminated, grey, with siltstone laminations	
32.15m	SILTSTONE, dark-grey, with minor sandstone laminations	
33.01m		
33.23m	CORE LOSS 0.22m (33.01-33.23)	
33.41m	SANDSTONE, laminated, dark-grey, with siltstone laminations	
	SILTSTONE, massive, dark-grey	
33.81m	COAL, black, with carbonaceous siltstone laminations	
34.79m	SILTSTONE, dark-grey, with minor laminations at 15 degrees	
35.06m	SILTSTONE, massive, dark-grey	
37.52m		
37.63m	COAL, black	
37.90m	SILTSTONE, dark-grey	
	INTERLAMINATED COAL AND CARBONACEOUS SILTSTONE, black, dark-grey, laminations at 10 degrees	
38.24m	SILTSTONE, dark-grey, bioturbation, rare coal inclusions, soft sediment deformation	

Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral: VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

Defect Description

Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 30.15 m: JT, 45°, PR, S
- 30.58 - 30.62 m: coal
- 30.75 m: DB
- 31.01 m: JT, 75°, PR, S
- 31.30 m: DB
- 31.47 - 31.60 m: VN, 80°, IR, carbonate
- 31.86 m: VN, 75°, PR, S
- 31.94 m: JT, 60°, PR
- 32.06 m: DB
- 32.13 - 32.16 m: SM, 30°
- 32.37 m: DB
- 32.75 - 32.78 m: SM, 30°
- 32.84 m: JT, 50°, PR, healed
- 33.34 m: DB
- 33.37 m: DB
- 33.47 m: DB
- 33.56 m: DB
- 33.77 m: DB
- 34.32 m: DB
- 34.60 m: DB
- 34.74 - 34.78 m: DB
- 35.04 m: DB
- 35.27 m: VN, 35°
- 35.65 m: VN, 50°
- 35.95 m: VN, 40°
- 36.36 m: DB
- 36.71 m: DB
- 36.87 - 37.12 m: thermally altered zone, carbonate zone
- 37.54 m: DB
- 37.64 m: DB
- 37.94 m: DB
- 38.07 m: DB
- 38.22 m: DB
- 38.35 m: JT, 50°, PR, healed
- 38.40 m: DB
- 38.65 m: JT, 50°, PR, healed
- 38.68 m: DB
- 38.94 m: DB
- 39.39 m: DB
- 39.57 m: JT, 45°, PR, RF
- 39.64 m: JT, 45°, PR, RF
- 39.78 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►—	water inflow
—◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

Cardno

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

Job No: M30863
Sheet: 5 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: / **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 / **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**

Coring: Method HQ3. Fluid.

TCR (%)	RQD (%)
100	100
100	100
97	97
100	100

RL (m AHD): -4, -5, -6, -7, -8, -9, -10, -11, -12, -13
Depth (m): 41, 42, 43, 44, 45, 46, 47, 48, 49

Material Description

Depth to base	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering
40.90m	SILTSTONE, dark-grey, bioturbation, rare coal inclusions, soft sediment deformation *(continued)*	F
41.34m	SANDSTONE, fine to medium grained, grey, soft sediment deformation	
42.19m	SILTSTONE, black, dark-grey, minor laminations, minor coal inclusions	
43.46m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey, laminations at 5-10 degrees	
44.62m	SANDSTONE, fine to medium grained, grey, with rare siltstone laminations, laminations at 15-20 degrees	
44.82m	INTERLAMINATED SANDSTONE AND CARBONACEOUS SILTSTONE, fine grained, laminated, grey, black, laminations at 5-10 degrees	
45.13m	COAL, black	
46.15m	SILTSTONE, dark-grey	
47.65m	INTERBEDDED SANDSTONE AND SILTSTONE, grey, dark-grey	
48.54m	SANDSTONE, medium grained, massive, grey	
48.67m	SILTSTONE	
48.90m	COAL	
49.52m	INTERLAMINATED SILTSTONE AND SANDSTONE, fine grained, laminated, dark-grey, grey, fining upward, laminations at 15 and 5 degrees	
	SANDSTONE, fine to medium grained, grey, minor laminations, fining upwards	

Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 40.03 m: DB
- 40.49 m: DB
- 40.50 - 40.68 m: thermally altered zone, carbonate veins
- 40.68 m: DB
- 41.50 m: DB
- 41.60 m: DB
- 41.82 m: DB
- 42.89 m: VN, IR, carbonate
- 42.86 - 42.94 m: thermally altered zone
- 42.94 m: DB
- 43.08 m: DB
- 43.46 m: DB
- 44.63 m: JT, 40°, PR, RF
- 45.20 - 45.34 m: rubbly core
- 45.57 m: DB
- 45.96 m: SZ, 60°, PR, POL
- 46.33 m: DB
- 46.39 m: DB
- 46.48 m: DB
- 46.66 m: SZ, 40°, CU
- 46.76 - 46.79 m: multiple spider webbing veins
- 47.16 m: DB
- 47.40 m: DB
- 47.47 - 47.57 m: thermally altered zone, minor carbonate veining
- 48.13 m: VN, 55°, PR
- 49.17 - 49.35 m: SZmultiple reverse faults, 60°, PR
- 49.51 m: DB
- 49.78 m: JT, 66°, PR, RF
- 49.93 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
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WATER

- ▽ Water Level on date shown
- ▶ water inflow
- ◀ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
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DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
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FL	Foliation
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PLANARITY

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COATING

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VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

Cardno

CORE LOG SHEET

Hole No: STX1904G

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863
Sheet: 6 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter:	**Bit Type:** / **Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19	**Date Completed:** 22/9/19 / **Logged By:** AD	**Checked By:**

Coring

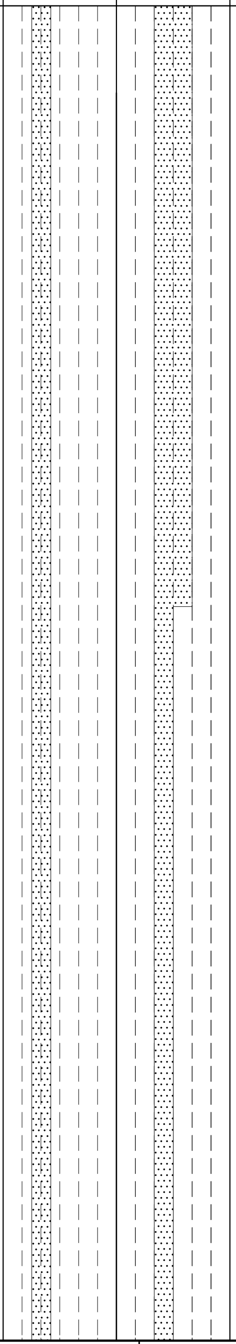
Method	Fluid	TCR (%)	RQD (%)
HQ3		100	100
		100	100
		99	99
		100	10

RL (m AHD): -14, -15, -16, -17, -18, -19, -20, -21, -22, -23

Depth (m): 51, 52, 53, 54, 55, 56, 57, 58, 59

Material Description

Depth to base	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering
50.87m	SANDSTONE, fine to medium grained, grey, minor laminations, fining upwards *(continued)*	F
51.00m	COAL, black	
51.28m	SILTSTONE, massive, dark-grey, black, minor carbonaceous	
52.24m	SANDSTONE, fine grained, laminated, grey, dark-grey, with siltstone laminations	
52.70m	SILTSTONE, laminated, dark-grey	
53.79m	INTERLAMINATED SILTSTONE AND SANDSTONE, fine grained, laminated, dark-grey, grey, sub-horizontal laminations	
54.53m	SANDSTONE, fine to medium grained, laminated, grey, with minor silty laminations	
54.66m	COAL, black, minor sub-vertical calcite veins	
55.37m	SILTSTONE, massive, black, dark-grey, carbonaceous at top of unit	
57.02m	SANDSTONE, fine grained, laminated, grey, rare silty laminations	
	SILTSTONE, laminated, grey, dark-grey, with minor sandstone laminations	



Defect Description

Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 50.11 m: DB
- 50.40 - 50.50 m: minor calcite veining, IR
- 50.89 m: VN, 65°, ST
- 51.32 m: SZ, 55°, PR, SL
- 51.33 m: DB
- 51.63 - 51.69 m: thermally altered zone, minor carbonate veining
- 51.97 m: DB
- 52.50 m: DB
- 52.56 m: DB
- 52.58 m: DB
- 52.64 m: JT, 45°, PR, RF
- 53.39 m: DB
- 53.72 - 53.79 m: thermally altered zone, minor carbonate veining
- 54.52 m: DB
- 54.70 m: DB
- 54.75 m: DB
- 54.78 m: DB
- 55.06 m: DB
- 55.06 - 55.20 m: SZ, 60°, PR, multiple shearing planes
- 55.29 m: DB
- 55.32 m: DB
- 55.62 m: DB
- 55.79 m: DB
- 55.94 m: DB
- 56.08 m: SZ, 45°, PR
- 56.28 m: DB
- 56.43 m: SZ, 55°, PR
- 56.83 m: SZ, 45°
- 57.11 m: SZ, 55°, PR
- 57.13 - 57.16 m: core loss
- 57.38 m: SZ, 80°, PR
- 57.51 - 57.57 m: rubbly core
- 57.65 m: JT, 40°, PR, S
- 57.78 m: DB
- 57.96 m: DB
- 58.07 m: DB
- 58.08 - 58.17 m: thermally altered zone
- 58.18 m: VN, 20°, PR
- 58.27 - 58.31 m: SM, 10°, PR
- 58.36 - 58.46 m: SZ, rubbly core
- 58.60 m: DB
- 58.69 m: VN, 50°, PR
- 58.81 - 58.90 m: coal lamination
- 58.90 - 60.00 m: SZ, multiple faults at 65 and 45 degrees
- 59.60 m: SM, 30°, PR

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ▶ water inflow
- ◀ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremely Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

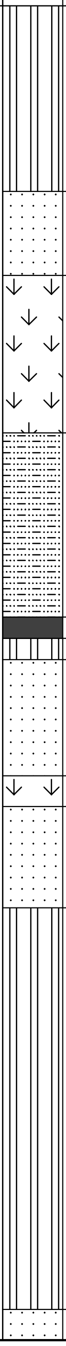
Job No: M30863
Sheet: 7 of 11

Position: E772389.090 N7487158.620 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 36.358 m AHD
Rig Type: UDR650
Mounting: Truck
Driller: Waratah Coal
Casing Diameter:
Bit Type:
Bit Condition:
Contractor: Waratah Coal
Date Started: 18/9/19
Date Completed: 22/9/19
Logged By: AD
Checked By:

Method	Fluid	TCR (%)	RQD (%)
HQ3		100	10
		100	76
		100	99
		100	100
		100	100

RL (m AHD): -24, -25, -26, -27, -28, -29, -30, -31, -32, -33

Depth (m): 61, 62, 63, 64, 65, 66, 67, 68, 69

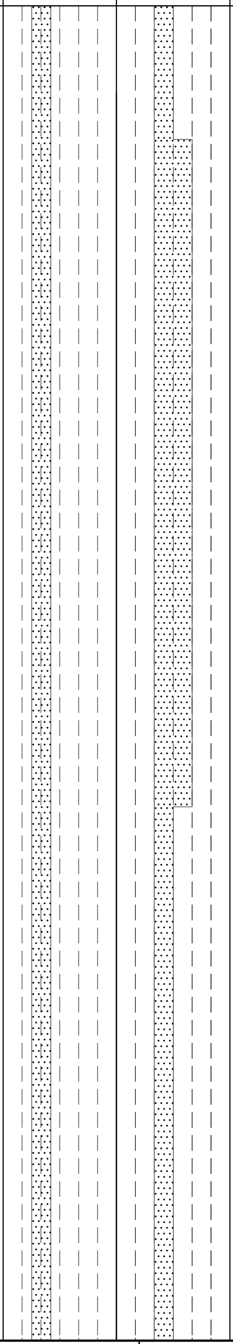


Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

Depth	Description	Weathering
61.39m	SILTSTONE, laminated, grey, dark-grey, with minor sandstone laminations *(continued)*	F
62.02m	SANDSTONE, fine grained, laminated, grey, with minor silty laminations	
63.20m	CARBONACEOUS SILTSTONE, black, with coal laminations	
64.58m	INTERLAMINATED SILTSTONE AND SANDSTONE, fine grained, laminated, dark-grey, grey	
64.74m	COAL, black	
64.90m	SILTSTONE, dark-grey	
65.77m	SANDSTONE, fine grained, laminated, grey, dark-grey, with silty laminations	
66.00m	CARBONACEOUS SILTSTONE, black, with minor coal laminations	
66.76m	SANDSTONE, grey, with minor silty laminations	
69.77m	SILTSTONE, laminated, dark-grey	

Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH
Average Natural Defect Spacing (mm): 20 60 200 600 2000
Visual



Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 60.00 - 60.22 m: SZ, rubbly core
- 60.28 m: SZ, 60°, PR
- 60.33 - 60.43 m: thermally altered zone, calcite veining
- 60.50 - 61.37 m: SZ, plastic overturning of beds and faulting at 65 and 45 degrees
- 61.76 m: VN, 10°
- 62.40 m: DB
- 62.50 m: DB
- 62.55 m: DB
- 63.00 m: DB
- 63.18 m: SZ, 45°, PR
- 63.33 m: JT, 45°
- 63.48 - 63.92 m: thermally altered zone, calcite veining
- 63.92 - 64.90 m: SZ, faulting, brecciation, plastic deformation
- 64.90 - 65.54 m: thermally altered zone, partially brecciated by carbonate veins
- 66.05 m: SZ, 60°, PR
- 66.23 - 66.25 m: rubbly core
- 66.26 m: VN, 15°, carbonate
- 66.53 m: DB
- 66.54 m: DB
- 66.60 m: SZ, 50°, PR
- 66.62 m: DB
- 66.72 m: DB
- 66.87 m: DB
- 66.89 m: DB
- 67.03 m: DB
- 66.95 - 67.19 m: SZ, faults at 65 and 45 degrees
- 67.20 - 67.51 m: thermally altered zone, carbonate veins
- 68.20 m: DB
- 67.52 - 69.23 m: SZ, faults at 70 and 45 degrees, plastic deformation, minor carbonate veining
- 68.40 m: DB
- 68.58 m: DB
- 68.71 m: DB
- 68.78 m: DB
- 69.02 - 69.07 m: multiple drill breaks
- 69.38 m: VN, 50°, PR
- 69.48 - 69.60 m: SZ, soft sediment deformation
- 69.83 m: SZ, 45°

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ▶ water inflow
- ◀ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

Job No: M30863
Sheet: 8 of 11

Position: E772389.090 N7487158.620 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 36.358 m AHD
Rig Type: UDR650
Mounting: Truck
Driller: Waratah Coal
Casing Diameter:
Bit Type:
Bit Condition:
Contractor: Waratah Coal
Date Started: 18/9/19
Date Completed: 22/9/19
Logged By: AD
Checked By:

Coring

Method: HQ3

TCR (%)	RQD (%)
100	100
100	100
100	100
100	100

RL (m AHD): -34, -35, -36, -37, -38, -39, -40, -41, -42, -43

Depth (m): 71, 72, 73, 74, 75, 76, 77, 78, 79

Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

Depth	Description	Weathering
71.40m	SANDSTONE, fine grained, grey, with siltstone laminations *(continued)*	F
72.30m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey	
73.31m	SANDSTONE, fine to medium grained, grey	
	SILTSTONE, dark-grey, with rare sandstone laminations	

Estimated Strength Is(50) MPa ● - Axial ○ - Diametral: VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 70.01 m: SZ, 65°, ST
- 70.10 m: SZ, 65°, CU
- 70.86 m: SZ, 45°, PR, plastic deformation
- 71.03 m: DB
- 71.04 - 71.10 m: thermally altered zone, minor carbonate veins
- 71.11 m: DB
- 71.39 m: DB
- 71.70 m: DB
- 72.07 m: DB
- 72.09 m: SZ, 45°, PR
- 72.53 m: DB
- 72.68 m: DB
- 72.97 m: DB
- 73.31 m: SZ, 50°, PR
- 73.36 m: SZ, 30°, PR
- 73.51 m: DB
- 73.77 m: DB
- 74.34 m: DB
- 74.50 m: DB
- 75.00 m: DB
- 75.55 m: DB
- 75.57 m: DB
- 75.65 m: DB
- 75.78 m: DB
- 75.85 m: DB
- 75.90 - 76.30 m: multiple sub-vertical veins
- 76.35 - 76.36 m: SZ, 45°, PR, fault breccia
- 76.39 m: VN, 45°, PR
- 76.47 m: DB
- 76.60 m: DB
- 76.83 m: VN, 40°, PR
- 76.93 m: VN, 45°, UN
- 77.01 m: DB, 40°, PR
- 77.22 m: VN, 45°, PR
- 77.30 m: DB
- 77.28 - 77.54 m: thermally altered zone
- 77.41 m: DB
- 77.63 m: DB
- 77.88 m: DB
- 78.43 m: DB
- 78.62 - 78.66 m: multiple veins, 65°, PR
- 78.66 m: DB
- 78.95 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1904G

Job No: M30863
Sheet: 9 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**

Coring

Method	Fluid	TCR (%)	RQD (%)
HQ3		100	100
		100	100
		100	100
		100	100

RL (m AHD): -44, -45, -46, -47, -48, -49, -50, -51, -52, -53

Depth (m): 81, 82, 83, 84, 85, 86, 87, 88, 89

Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

SILTSTONE, dark-grey, with rare sandstone laminations *(continued)*

Weathering: F

Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 80.58 m: DB
- 81.04 m: DB
- 81.05 m: VN, 60°, PR
- 81.73 m: DB
- 82.09 m: DB
- 82.34 m: VN, 60°, CU
- 82.61 m: DB
- 82.71 - 82.83 m: thermally altered zone, carbonate veining
- 82.85 m: DB
- 82.93 m: DB
- 83.13 m: DB
- 83.57 m: DB
- 83.73 m: VN, 50°, ST, multiple
- 83.83 m: DB
- 84.07 m: VN, 55°, PR
- 84.38 m: DB
- 84.46 m: DB
- 84.57 m: VN, 40°, PR
- 84.68 m: VN, 60°, PR
- 85.17 m: DB
- 85.36 m: DB
- 85.80 m: DB
- 85.90 m: SZ, 70°, PR
- 86.71 m: VN, 50°, PR
- 86.80 m: JT, 50°, PR, RF
- 86.93 - 87.10 m: thermally altered zone, carbonate veining
- 87.13 - 87.25 m: SZ, faulting at 70 and 40 degrees
- 87.45 m: DB
- 87.53 m: DB
- 87.62 m: DB
- 87.70 m: DB
- 87.88 - 87.95 m: sandstone bed
- 88.06 m: DB
- 88.10 m: VN, 50°, PR
- 88.40 m: SZ, 45°, UN
- 88.55 m: DB
- 88.83 m: SZ, 50°, PR, SL
- 88.92 m: DB
- 89.34 m: SZ, 45°, PR, S
- 89.94 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶	water inflow
◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863

Hole No: STX1904G

Sheet: 10 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**

Coring: Method HQ3

TCR (%)	RQD (%)
100	100
100	70
100	97
100	100
100	100
100	100

RL (m AHD): -54, -55, -56, -57, -58, -59, -60, -61, -62, -63

Depth (m): 91, 92, 93, 94, 95, 96, 97, 98, 99

Material Description (SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components; ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components) — Weathering: F

Depth	Description
to 90.39m	SILTSTONE, dark-grey, with rare sandstone laminations *(continued)*
90.39m – 90.60m	SANDSTONE, medium grained, laminated, grey, with siltstone laminations and gravel sized inclusions
90.60m – 91.60m	SANDSTONE, fine grained, massive, grey, with minor siltstone at base of unit
91.60m – 97.63m	INTERBEDDED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey
97.63m – 97.80m	SANDSTONE, medium to coarse grained, massive, dark-grey
97.80m – 99.56m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey
99.56m – 99.93m	SANDSTONE, fine grained, laminated, grey, laminated at 5 degrees

Defect Description (Additional Data: DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other)

- 90.87 - 90.88 m: VN, IR
- 91.04 m: DB
- 91.61 m: DB
- 91.64 - 91.68 m: rubbly core
- 91.66 m: SZ, 60°, PR
- 91.75 - 92.28 m: thermally altered zone
- 92.00 - 92.25 m: rubbly core
- 91.80 - 92.50 m: multiple veins, 80°, PR, carbonate
- 92.61 m: DB
- 92.98 m: DB
- 93.32 m: tuff
- 93.61 m: DB
- 94.74 m: DB
- 94.74 - 94.78 m: tuff
- 94.78 m: DB
- 95.15 m: DB
- 96.03 m: DB
- 96.60 m: DB
- 97.17 m: DB
- 97.80 - 98.28 m: thermally altered zone, minor sub-vertical carbonate veins
- 98.09 m: DB
- 98.29 m: DB
- 98.61 m: DB
- 98.95 - 99.15 m: bioturbation
- 99.93 m: DB

Estimated Strength Is(50) MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH
Average Natural Defect Spacing (mm): 20 60 200 600 2000
Visual

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremely High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

Cardno

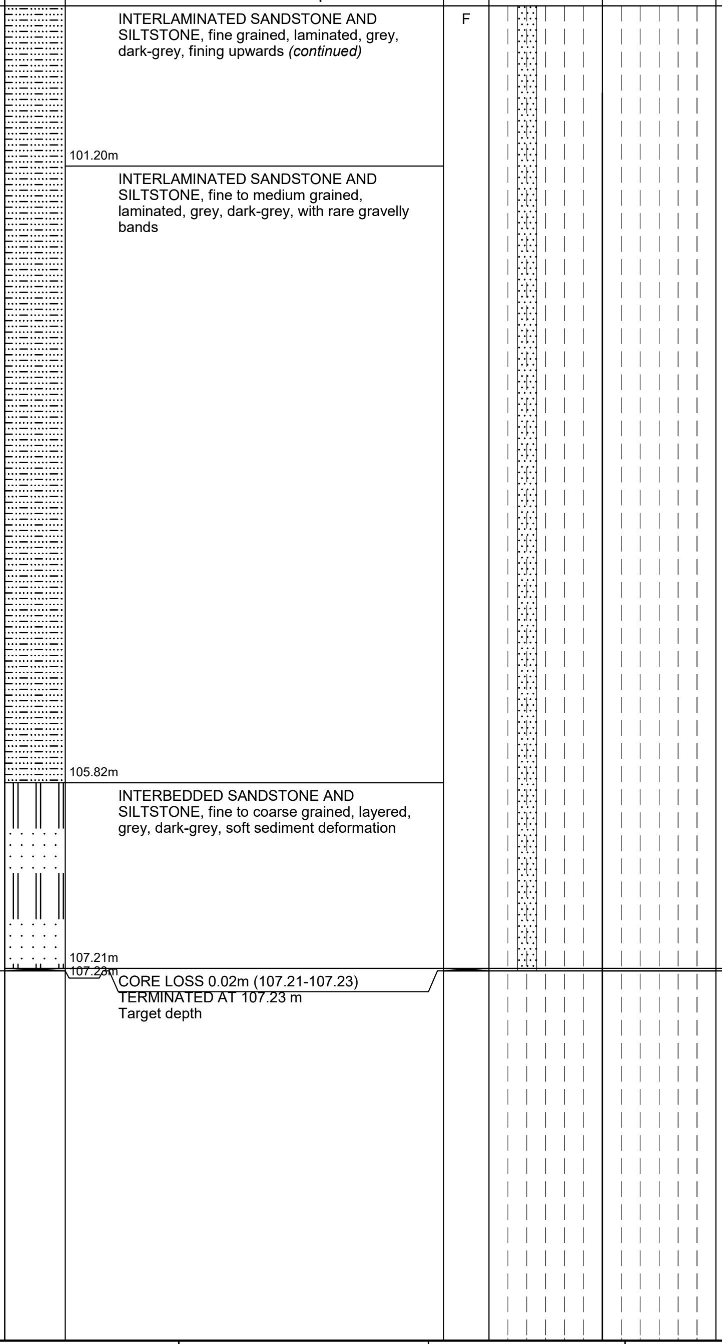
CORE LOG SHEET

Client: CQ Coal
Project: Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863

Hole No: STX1904G

Sheet: 11 of 11

Position: E772389.090 N7487158.620 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 36.358 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: / **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 18/9/19 / **Date Completed:** 22/9/19	**Logged By:** AD	**Checked By:**



Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
HQ3		100	100	-64 to -66	to 101.20m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey, fining upwards *(continued)*	F	100.54 m: DB 101.05 - 101.08 m: tuff 101.15 m: DB
					101.20m – 105.82m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine to medium grained, laminated, grey, dark-grey, with rare gravelly bands		101.74 - 101.80 m: gravelly band 102.26 m: fluid escape structures
		100	100	-66 to -69				103.64 m: DB 104.37 - 104.41 m: gravelly band
		99	99	-69 to -71	105.82m – 107.21m	INTERBEDDED SANDSTONE AND SILTSTONE, fine to coarse grained, layered, grey, dark-grey, soft sediment deformation		105.90 - 106.07 m: fluid escape structures
					107.21m – 107.23m	CORE LOSS 0.02m (107.21-107.23)		
					107.23m	TERMINATED AT 107.23 m Target depth		

RL (m AHD): -64, -65, -66, -67, -68, -69, -70, -71, -72, -73
Depth (m): 101, 102, 103, 104, 105, 106, 107, 108, 109

DRILLING	
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER
- Water Level on date shown
- ► water inflow
- ◄ water outflow

ROCK QUALITY DESCRIPTIONS	
RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH	
EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING	
FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE	
JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY	
CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS	
VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING	
CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS	
X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

STX1904G

Core Photographs

4C core Box 1

4C core Box 2

4C core Box 3

4C core Box 4

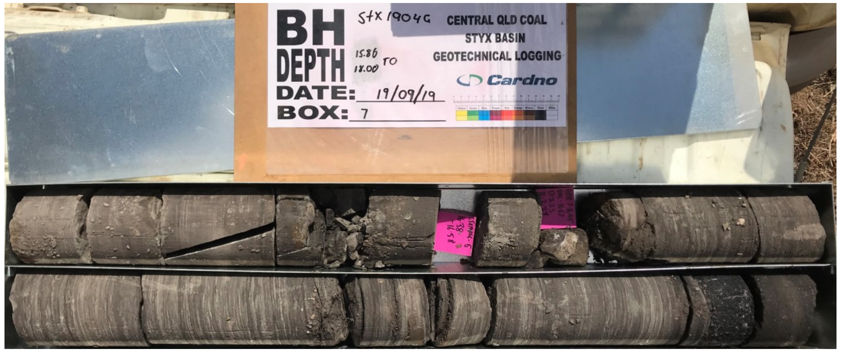
STX1904G

Core Photographs

4C core Box 5

4C core Box 6

4C core Box 7



4C core Box 8

STX1904G

Core Photographs

4C core Box 9

STX1904G

Core Photographs

HQ core Box 1

HQ core Box 2

HQ core Box 3

HQ core Box 4

STX1904G

Core Photographs

HQ core Box 5

HQ core Box 6

HQ core Box 7

HQ core Box 8

STX1904G

Core Photographs

HQ core Box 9

HQ core Box 10

HQ core Box 11

HQ core Box 12

STX1904G

Core Photographs

HQ core Box 13

HQ core Box 14

HQ core Box 15

HQ core Box 16

STX1904G

Core Photographs

HQ core Box 17

HQ core Box 18

HQ core Box 19

HQ core Box 20

STX1904G

Core Photographs

HQ core Box 21

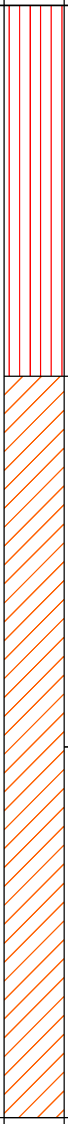
BOREHOLE LOG SHEET

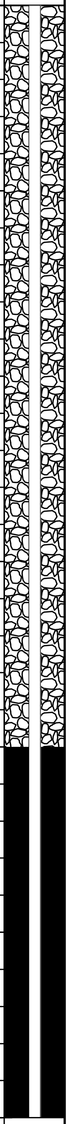
Client: Central Queensland Coal Pty Ltd
Project: Styx Basin Permeability Testing
Location: Styx Basin
Job No: M30863

Hole No: STX1901B

Sheet: 1 of 1

Position: E772356.260 N7489012.160 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 31.849 m AHD
Rig Type: Truck Mounted Drill Rig
Mounting: Truck
Driller: Waratah Coal
Casing Diameter:
Contractor:
Date Started: 18/8/19
Date Completed: 18/8/19
Logged By: AD
Checked By: AW





Drilling				Sampling & Testing			Material Description						
Method	Resistance	Casing	Water	Sample or Field Test	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
Rotary Air Drilling			Not Encountered		31.5 31.0	0.5		CH	CLAY: dark-red-brown, trace fine grained sand, MPS 1 LL 65 P75 95	D	St		
					30.5 30.0	1.00m 1.0 1.5		SC	Clayey SAND: fine to coarse grained, pale-red-brown, MPS 2 LL 45 P75 25		D		
					29.5 29.0	2.00m 2.0 2.5		SC	Clayey SAND: fine to coarse grained, pale-red-brown, MPS 2 LL 45 P75 30 Bentonite Seal				
					28.5	3.00m 3.0 3.5			TERMINATED AT 3.00 m Target depth Open ended PVC aproximatly 100mm in diameter was installed and sealed with bentonite and backfilled with hand compacted earth. PVC joins where cemented and secured with screws during installation. Stickup of aproximatly 500mm was cut and capped with an end cap.				

METHOD

EX	Excavator bucket
R	Ripper
HA	Hand auger
PT	Push tube
SON	Sonic drilling
AH	Air hammer
PS	Percussion sampler
AS	Short spiral auger
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller

PENETRATION

VE	Very Easy (No Resistance)
E	Easy
F	Firm
H	Hard
VH	Very Hard (Refusal)

WATER

- ▽ Water Level on Date shown
- ▶ water inflow
- ◀ water outflow

FIELD TESTS

SPT	- Standard Penetration Test
HP	- Hand/Pocket Penetrometer
DCP	- Dynamic Cone Penetrometer
PSP	- Perth Sand Penetrometer
MC	- Moisture Content
PBT	- Plate Bearing Test
IMP	- Borehole Impression Test
PID	- Photoionisation Detector
VS	- Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES

B	- Bulk disturbed sample
D	- Disturbed sample
ES	- Environmental sample
U	- Thin wall tube 'undisturbed'

MOISTURE

D	- Dry
M	- Moist
W	- Wet
PL	- Plastic limit
LL	- Liquid limit
w	- Moisture content

SOIL CONSISTENCY

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard

RELATIVE DENSITY

VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CARDNO 2.01.6 LIB.GLB Log CARDNO NON-CORED M30863_STYX_OPEN END PERMEABILITY.GPJ <<DrawingFile>> 04/10/2019 10:56 10.0.000 Datgel AGS RTA, Photo, Monitoring Tools

STX1901B

0.00 – 1.00m

1.00 – 2.00m

2.00 – 3.00m

BOREHOLE LOG SHEET

Client: Central Queensland Coal Pty Ltd
Project: Styx Basin Permeability Testing
Location: Styx Basin

Hole No: STX1901C

Job No: M30863
Sheet: 1 of 2

Position: E772380.060 N7489009.460 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 30.408 m AHD

Rig Type: Truck Mounted Drill Rig
Mounting: Truck
Driller: Waratah Coal

Casing Diameter:
Contractor:

Date Started: 18/8/19
Date Completed: 18/8/19
Logged By: AD
Checked By: AW

Drilling				Sampling & Testing			Material Description						
Method	Resistance	Casing	Water	Sample or Field Test	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
Rotary Air Drilling			Not Encountered					CH	CLAY: dark-brown, trace fine grained sand, MPS 1 LL 70 P75 95	D	St		
						1.00m		SC	Clayey SAND: fine to coarse grained, red-brown, MPS 2 LL 45 P75 25		D		
						3.00m		SC	Clayey SAND: fine to medium grained, pale-brown, MPS 2 LL 45 P75 15				
						4.00m		SC	Clayey SAND: fine to medium grained, pale-brown, MPS 2 LL 45 P75 30				
						7.00m		SC	Clayey SAND: fine to medium grained, pale-brown, MPS 2 LL 45 P75 20				

METHOD

EX	Excavator bucket
R	Ripper
HA	Hand auger
PT	Push tube
SON	Sonic drilling
AH	Air hammer
PS	Percussion sampler
AS	Short spiral auger
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller

PENETRATION

VE	Very Easy (No Resistance)
E	Easy
F	Firm
H	Hard
VH	Very Hard (Refusal)

WATER

▽ Water Level on Date shown
▶ water inflow
◀ water outflow

FIELD TESTS

SPT -	Standard Penetration Test
HP -	Hand/Pocket Penetrometer
DCP -	Dynamic Cone Penetrometer
PSP -	Perth Sand Penetrometer
MC -	Moisture Content
PBT -	Plate Bearing Test
IMP -	Borehole Impression Test
PID -	Photoionisation Detector
VS -	Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES

B -	Bulk disturbed sample
D -	Disturbed sample
ES -	Environmental sample
U -	Thin wall tube 'undisturbed'

MOISTURE

D -	Dry
M -	Moist
W -	Wet
PL -	Plastic limit
LL -	Liquid limit
w -	Moisture content

SOIL CONSISTENCY

VS -	Very Soft
S -	Soft
F -	Firm
St -	Stiff
VSt -	Very Stiff
H -	Hard

RELATIVE DENSITY

VL -	Very Loose
L -	Loose
MD -	Medium Dense
D -	Dense
VD -	Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Central Queensland Coal Pty Ltd
Project: Styx Basin Permeability Testing
Location: Styx Basin

Hole No: STX1901C

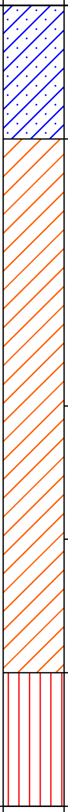
Job No: M30863
Sheet: 2 of 2

Position: E772380.060 N7489009.460 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 30.408 m AHD
Rig Type: Truck Mounted Drill Rig
Mounting: Truck
Driller: Waratah Coal
Casing Diameter:
Contractor:
Date Started: 18/8/19
Date Completed: 18/8/19
Logged By: AD
Checked By: AW

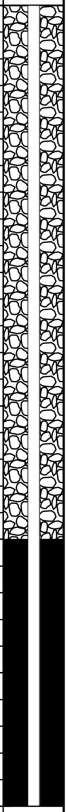
Method	Resistance	Casing	Water	Sample or Field Test	RL (m AHD)	Depth (m)	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
Rotary Air Drilling			Not Encountered		20		SC	Clayey SAND: fine to medium grained, pale-brown, MPS 2 LL 45 P75 20 *(continued)*	D	D	
					19	11.00m	CI	Sandy CLAY: brown, fine to coarse grained sand, with fine grained, sub-rounded gravel, MPS 3 LL 45 P75 35		St	RESIDUAL SOIL
					17	13.00m	CI	Sandy CLAY: brown mottled dark-grey, fine to coarse grained sand, MPS 2 LL 45 P75 65		VSt	
						14.00m	CI	Bentonite Seal			
					15	15.00m	CH	CLAY: black, dark-grey, with fine to medium grained sand, MPS 1 LL 65 P75 85			
					14	16.00m		TERMINATED AT 16.00 m Target depth Open ended PVC aproximatly 100mm in diameter was installed and sealed with bentonite and backfilled with hand compacted earth. PVC joins where cemented and secured with screws during installation. Stickup of aproximatly 500mm was cut and capped with an end cap.			

RL scale (m AHD): 20, 19, 18, 17, 16, 15, 14, 13, 12, 11
Depth scale (m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Graphic Log:



Monitoring Well Details:



METHOD
- EX Excavator bucket
- R Ripper
- HA Hand auger
- PT Push tube
- SON Sonic drilling
- AH Air hammer
- PS Percussion sampler
- AS Short spiral auger
- AD/V Solid flight auger: V-Bit
- AD/T Solid flight auger: TC-Bit
- HFA Hollow flight auger
- WB Washbore drilling
- RR Rock roller

PENETRATION
- VE Very Easy (No Resistance)
- E Easy
- F Firm
- H Hard
- VH Very Hard (Refusal)

WATER
- ▽ Water Level on Date shown
- ▶ water inflow
- ◀ water outflow

FIELD TESTS
- SPT - Standard Penetration Test
- HP - Hand/Pocket Penetrometer
- DCP - Dynamic Cone Penetrometer
- PSP - Perth Sand Penetrometer
- MC - Moisture Content
- PBT - Plate Bearing Test
- IMP - Borehole Impression Test
- PID - Photoionisation Detector
- VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
- B - Bulk disturbed sample
- D - Disturbed sample
- ES - Environmental sample
- U - Thin wall tube 'undisturbed'

MOISTURE
- D - Dry
- M - Moist
- W - Wet
- PL - Plastic limit
- LL - Liquid limit
- *w* - Moisture content

SOIL CONSISTENCY
- VS - Very Soft
- S - Soft
- F - Firm
- St - Stiff
- VSt - Very Stiff
- H - Hard

RELATIVE DENSITY
- VL - Very Loose
- L - Loose
- MD - Medium Dense
- D - Dense
- VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

STX1901C

0.00 – 1.00m

1.00 – 2.00m

2.00 – 3.00m

3.00 – 4.00m

4.00 – 5.00m

5.00 – 6.00m

STX1901C

6.00 – 7.00m

7.00 – 8.00m

8.00 – 9.00m

9.00 – 10.00m

10.00 – 11.00m

11.00 – 12.00m

STX1901C

6.00 – 7.00m

7.00 – 8.00m

8.00 – 9.00m

9.00 – 10.00m

10.00 – 11.00m

11.00 – 12.00m

STX1901C

12.00 – 13.00m

13.00 – 14.00m

14.00 – 15.00m

15.00 – 16.00m

BOREHOLE LOG SHEET

Client: Central Queensland Coal Pty Ltd
Project: Styx Basin Permeability Testing
Location: Styx Basin

Hole No: STX1902B

Job No: M30863
Sheet: 1 of 1

Position: E774639.490 N7485931.900 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 29.857 m AHD

Rig Type: Truck Mounted Drill Rig
Mounting: Truck
Driller: Waratah Coal

Casing Diameter:
Contractor:

Date Started: 18/8/19
Date Completed: 18/8/19
Logged By: AD
Checked By: AW

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
Rotary Air Drilling			Not Encountered			0.00–3.00		CI	Sandy CLAY: dark-brown to brown, fine to medium grained sand, MPS 1 LL 45 P75 75	D to M	St	RESIDUAL SOIL	
						3.00m–4.00		CI	Sandy CLAY: brown mottled grey, orange becoming pale-brown mottled grey, orange, fine grained sand, MPS 1 LL 40 P75 80				
						4.00m–5.00			Bentonite Seal				
						5.00m–6.00m		CL	Sandy CLAY: pale-brown mottled orange, fine to coarse grained sand, with fine grained, sub-rounded gravel, MPS 3 LL 35 P75 50	D	VSt		

TERMINATED AT 6.00 m
Target depth
Open ended PVC aproximatly 100mm in diameter was installed and sealed with bentonite and backfilled with hand compacted earth.
PVC joins where cemented and secured with screws during installation.
Stickup of aproximatly 500mm was cut and capped with an end cap.

METHOD

EX	Excavator bucket
R	Ripper
HA	Hand auger
PT	Push tube
SON	Sonic drilling
AH	Air hammer
PS	Percussion sampler
AS	Short spiral auger
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller

PENETRATION

VE	Very Easy (No Resistance)
E	Easy
F	Firm
H	Hard
VH	Very Hard (Refusal)

WATER

- ▽ Water Level on Date shown
- ▶ water inflow
- ◀ water outflow

FIELD TESTS

SPT	Standard Penetration Test
HP	Hand/Pocket Penetrometer
DCP	Dynamic Cone Penetrometer
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MC	Moisture Content
PBT	Plate Bearing Test
IMP	Borehole Impression Test
PID	Photoionisation Detector
VS	Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES

B	Bulk disturbed sample
D	Disturbed sample
ES	Environmental sample
U	Thin wall tube 'undisturbed'

MOISTURE

D	Dry
M	Moist
W	Wet
PL	Plastic limit
LL	Liquid limit
w	Moisture content

SOIL CONSISTENCY

VS	Very Soft
S	Soft
F	Firm
St	Stiff
VSt	Very Stiff
H	Hard

RELATIVE DENSITY

VL	Very Loose
L	Loose
MD	Medium Dense
D	Dense
VD	Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CARDNO 2.01.6 LIB.GLB Log CARDNO NON-CORED M30863_STYX_OPEN END PERMEABILITY.GPJ <<DrawingFile>> 04/10/2019 10:56 10.0.000 Datgel AGS RTA, Photo, Monitoring Tools

STX1902B

0.00 – 1.00m

1.00 – 2.00m

2.00 – 3.00m

3.00 – 4.00m

4.00 – 5.00m

5.00 – 6.00m

BOREHOLE LOG SHEET

Client: Central Queensland Coal Pty Ltd
Project: Styx Basin Permeability Testing
Location: Styx Basin

Hole No: STX1902C

Job No: M30863
Sheet: 1 of 2

Position: E774622.800 N7485923.470 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 29.808 m AHD
Rig Type: Truck Mounted Drill Rig
Mounting: Truck
Driller: Waratah Coal
Casing Diameter:
Contractor:
Date Started: 18/8/19
Date Completed: 18/8/19
Logged By: AD
Checked By: AW

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
Rotary Air Drilling			Not Encountered		29 28	1 2		CI	Sandy CLAY: dark-brown to brown, fine to medium grained sand, MPS 1 LL 45 P75 75	D	St	RESIDUAL SOIL	
					27 26	2.00m 3 4		CI	Sandy CLAY: pale-brown to brown, fine to coarse grained sand, MPS 2 LL 45 P75 70				
					25 24 23 22 21 20	4.00m 5 6 7 8 9		CI	Sandy CLAY: brown mottled grey, orange, fine to coarse grained sand, MPS 2 LL 45 P75 50		St to VSt		

METHOD

EX	Excavator bucket
R	Ripper
HA	Hand auger
PT	Push tube
SON	Sonic drilling
AH	Air hammer
PS	Percussion sampler
AS	Short spiral auger
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller

PENETRATION

VE	Very Easy (No Resistance)
E	Easy
F	Firm
H	Hard
VH	Very Hard (Refusal)

WATER

- ▽ Water Level on Date shown
- ▶ water inflow
- ◀ water outflow

FIELD TESTS

SPT	- Standard Penetration Test
HP	- Hand/Pocket Penetrometer
DCP	- Dynamic Cone Penetrometer
PSP	- Perth Sand Penetrometer
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PBT	- Plate Bearing Test
IMP	- Borehole Impression Test
PID	- Photoionisation Detector
VS	- Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

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B	- Bulk disturbed sample
D	- Disturbed sample
ES	- Environmental sample
U	- Thin wall tube 'undisturbed'

MOISTURE

D	- Dry
M	- Moist
W	- Wet
PL	- Plastic limit
LL	- Liquid limit
w	- Moisture content

SOIL CONSISTENCY

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard

RELATIVE DENSITY

VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CARDNO 2.01.6 LIB.GLB Log CARDNO NON-CORED M30863_STYX_OPEN END PERMEABILITY.GPJ <<DrawingFile>> 04/10/2019 10:56 10.0.000 Datgel AGS RTA, Photo, Monitoring Tools

BOREHOLE LOG SHEET

Client: Central Queensland Coal Pty Ltd
Project: Styx Basin Permeability Testing
Location: Styx Basin

Hole No: STX1902C

Job No: M30863
Sheet: 2 of 2

Position: E774622.800 N7485923.470 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 29.808 m AHD
Rig Type: Truck Mounted Drill Rig
Mounting: Truck
Driller: Waratah Coal
Casing Diameter:
Contractor:
Date Started: 18/8/19
Date Completed: 18/8/19
Logged By: AD
Checked By: AW

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	RL (m AHD)	Depth (m)	Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
Rotary Air Drilling			Not Encountered		19	11.00m	▨	CI	Sandy CLAY: brown mottled grey, orange, fine to coarse grained sand, MPS 2 LL 45 P75 50 *(continued)*	D	St to VSt	RESIDUAL SOIL	
					18	12.00m	▥	CH	CLAY: dark-grey to black, with fine grained sand, MPS 1 LL 65 P75 85		St	EXTREMELY WEATHERED	
					17	14.00m	▨	CI	CLAY: grey, with fine grained sand, MPS 1 LL 50 P75 90		VSt		
					15, 14	16.00m	▨	CI	CLAY: pale-brown, with fine grained sand, MPS 1 LL 50 P75 90				
					13, 12	18.00m	▨	CI	CLAY: dark-grey to grey, with fine grained sand, MPS 1 LL 50 P75 90 Bentonite Seal				■
					11, 10				TERMINATED AT 18.00 m Target depth Open ended PVC aproximatly 100mm in diameter was installed and sealed with bentonite and backfilled with hand compacted earth. PVC joins where cemented and secured with screws during installation. Stickup of aproximatly 500mm was cut and capped with an end cap.				

METHOD

EX	Excavator bucket
R	Ripper
HA	Hand auger
PT	Push tube
SON	Sonic drilling
AH	Air hammer
PS	Percussion sampler
AS	Short spiral auger
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller

PENETRATION

VE	Very Easy (No Resistance)
E	Easy
F	Firm
H	Hard
VH	Very Hard (Refusal)

WATER

- Water Level on Date shown
- water inflow
- water outflow

FIELD TESTS

SPT	Standard Penetration Test
HP	Hand/Pocket Penetrometer
DCP	Dynamic Cone Penetrometer
PSP	Perth Sand Penetrometer
MC	Moisture Content
PBT	Plate Bearing Test
IMP	Borehole Impression Test
PID	Photoionisation Detector
VS	Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES

B	Bulk disturbed sample
D	Disturbed sample
ES	Environmental sample
U	Thin wall tube 'undisturbed'

MOISTURE

D	Dry
M	Moist
W	Wet
PL	Plastic limit
LL	Liquid limit
w	Moisture content

SOIL CONSISTENCY

VS	Very Soft
S	Soft
F	Firm
St	Stiff
VSt	Very Stiff
H	Hard

RELATIVE DENSITY

VL	Very Loose
L	Loose
MD	Medium Dense
D	Dense
VD	Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

STX1902C

0.00 – 1.00m

1.00 – 2.00m

2.00 – 3.00m

3.00 – 4.00m

4.00 – 5.00m

5.00 – 6.00m

STX1902C

6.00 – 7.00m

7.00 – 8.00m

8.00 – 9.00m

9.00 – 10.00m

10.00 – 11.00m

11.00 – 12.00m

STX1902C

12.00 – 13.00m

13.00 – 14.00m

14.00 – 15.00m

15.00 – 16.00m

16.00 – 18.00m

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 2 of 16

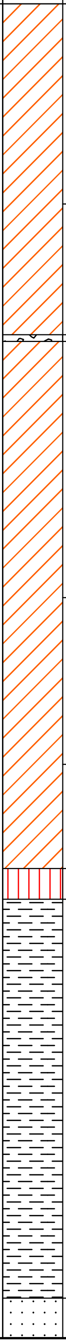
Position: E773392.670 N7486730.310 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 32.722 m AHD
Rig Type: UDR650
Mounting: Truck
Driller: Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**
Bit Condition:
Contractor: Waratah Coal
Date Started: 28/8/19
Date Completed: 2/9/19
Logged By: AD
Checked By:

Coring

Method	Fluid	TCR (%)	RQD (%)
4C		100	0
		100	0
		100	0
		65	0
		100	100

RL (m AHD): 22, 21, 20, 19, 18, 17, 16, 15, 14, 13

Depth (m): 11, 12, 13, 14, 15, 16, 17, 18, 19



Material Description / Defect Description

Depth	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
	Sandy CLAY: grey mottled dark-brown, orange, black, white, fine to medium grained sand, gypsum mottles, MPS 2 LL 40 P75 60 *(continued)*		
11.50m	Sandy CLAY: grey mottled dark-brown, orange, white, fine to coarse grained sand, with fine grained, rounded gravel, gypsum mottles, MPS 3 LL 40 P75 55		11.50: gypsum mottles
12.48m			
12.53m	Clayey GRAVEL: medium to coarse, rounded to sub-rounded, orange-brown, with fine to coarse grained sand, MPS 60 LL 40 P75 15 Sandy CLAY: grey mottled dark-brown, orange, white, fine to coarse grained sand, with fine grained, rounded gravel, gypsum mottles, MPS 3 LL 40 P75 55		12.53: gypsum mottles
14.45m	Sandy CLAY: grey mottled dark-brown, orange, white, fine to coarse grained sand, with fine to medium grained, sub-rounded gravel, gravel in bands, MPS 20 LL 40 P75 55		14.45: gravel in bands
15.70m	CLAY: grey mottled brown, LL 45 P75 100		
16.48m	CLAY: black, LL 70 P75 100		
16.71m	Sandy SILT: orange-brown, fine to coarse grained sand, trace fine grained, sub-rounded gravel, clayey bands, MPS 3 LL 35 P75 35	HW	16.71: clayey bands 18.00 - 19.27 m: core loss
19.70m			

Estimated Strength $Is_{(50)}$ MPa: ● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

DRILLING		WATER	ROCK STRENGTH		DEFECT TYPE		PLANARITY		COATING	
AD/V	Solid flight auger: V-Bit	Water Level on date shown	EH	Extremly High	JT	Joint	CU	Curved	CN	Clean
AD/T	Solid flight auger: TC-Bit	water inflow	VH	Very High	SZ	Sheared zone	DIS	Discontinuous	SN	Stained
HFA	Hollow flight auger	water outflow	H	High	BP	Bedding Parting	IR	Irregular	VNR	Veneer (thin or patchy)
WB	Washbore drilling		M	Medium	SM	Seam	PR	Planar	CT	Coating (up to 1mm)
RR	Rock roller		L	Low	FL	Foliation	ST	Stepped		
PQ	Rotary core (85mm)		VL	Very Low	VN	Vein	UN	Undulose		
HQ	Rotary core (63.5mm)				CL	Cleavage				
NMLC	Rotary core (51.94mm)				CS	Crushed Seam				
DT	Diatube concrete coring				FZ	Fracture Zone				
PT	Push tube				DL	Drift Lift				
PS	Percussion sampling				HB	Handing Break				
SON	Sonic drilling				DB	Drilling Break				
AH	Air hammer									

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 3 of 16

Position: E773392.670 N7486730.310 55 MGA94
Angle from Horizontal: 90°
Surface Elevation: 32.722 m AHD
Rig Type: UDR650
Mounting: Truck
Driller: Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**
Bit Condition:
Contractor: Waratah Coal
Date Started: 28/8/19
Date Completed: 2/9/19
Logged By: AD
Checked By:

Coring

Method: 4C (to 26.3 m), HQ3 (from 26.3 m)

Run	TCR (%)	RQD (%)
to 22.3 m	100	100
22.3 - 26.3 m	100	100
26.3 - 27.3 m	100	100
27.3 m -	100	100

RL (m AHD): 12, 11, 10, 9, 8, 7, 6, 5, 4, 3
Depth (m): 21, 22, 23, 24, 25, 26, 27, 28, 29

Material Description

Depth	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering
	SANDSTONE, fine to medium grained, orange-brown mottled grey, black, massive, carbonaceous wisps bedding 5-30 degrees *(continued)*	HW MW
24.75m	BRECCIA, brown mottled orange	HW to MW
25.37m	MUDSTONE, fine grained, dark-grey, massive, fining upwards	SW
27.10m	SANDSTONE, fine grained, grey-dark-grey, minor sub-horizontal beds	F
27.52m	SANDSTONE, medium grained, grey, bedded, with sandstone beds	
29.35m	SILTSTONE, dark-grey, minor sub-horizontal laminations	

Estimated Strength Is(50) MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH
Average Natural Defect Spacing (mm): 20 60 200 600 2000
Visual

Defect Description

Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 20.29 m: DB
- 21.04 m: DB
- 21.04 - 21.14 m: silicate cemented layer
- 21.16 m: DB
- 21.38 - 21.41 m: ignimbrite
- 21.53 - 21.58 m: ignimbrite
- 21.87 - 21.97 m: ignimbrite
- 21.99 - 22.03 m: carbonaceous seam
- 22.28 - 22.30 m: carbonaceous seam
- 23.09 m: carbonaceous lens, 15°
- 23.22 - 23.27 m: rubbly core, 10°
- 23.30 m: carbonaceous lens, 15°
- 23.42 m: carbonaceous lens, 10°
- 23.64 m: carbonaceous lens, 15°
- 23.91 - 23.97 m: carbonate cemented layer
- 24.09 m: carbonaceous lens, 15°
- 24.17 - 24.28 m: carbonate cemented layer
- 24.68 m: DB
- 25.27 m: SZ, 45°, UN, SL
- 25.48 m: carbonaceous inclusion
- 26.25 m: SZ, 50°, UN, SL
- 26.43 m: DB
- 26.65 m: DB
- 26.73 - 26.76 m: weathered seam
- 26.84 m: DB
- 27.10 m: carbonaceous whisp
- 27.87 - 27.89 m: tuff
- 28.64 - 28.66 m: mudstone

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863

Hole No: STX1903G

Sheet: 4 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Method	Fluid	TCR (%)	RQD (%)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
HQ3		100	100	30.37m	SILTSTONE, dark-grey, minor sub-horizontal laminations *(continued)*	F	30.00 - 30.07 m: tuff
		100	100	31.50m	SILTSTONE, grey, irregular sandstone beds		31.21 m: DB
				32.62m	SILTSTONE, dark-grey, sandstone laminations at 15 degrees, soft sediment deformation, bioturbation		31.64 m: DB 31.92 - 31.98 m: multiple db
				32.88m	SANDSTONE, fine grained, grey, bedded, with siltstone laminations at 5 degrees		32.88 m: DB
				33.02m	HORNFELS, brown, massive		33.02 m: DB
				33.37m	SANDSTONE, fine grained, grey, massive		
				33.90m	SILTSTONE, dark-grey, sandstone laminations at 5 degrees, soft sediment deformation, bioturbation		33.46 m: bioturbation
				34.12m	SANDSTONE, medium grained, grey, siltstone wisps at 10 degrees		
				34.27m	HORNFELS, brown, siltstone and sandstone laminations		
		100	100	35.26m	SANDSTONE, fine to medium grained, grey-dark-grey, massive, with siltstone laminations at 5-10 degrees		
				35.56m	SANDSTONE, fine to medium grained, grey		35.32 m: JT, 60°, UN, RF
				36.40m	SILTSTONE, dark-grey, laminated, with sandstone laminations at 5 degrees		36.00 m: DB 36.17 m: DB 36.20 m: VN, IR
		100	100	39.16m	SANDSTONE, fine to medium grained, grey, dark-grey, with abundant siltstone, bioturbation, soft sediment deformation throughout		37.55 m: BP, 10° 37.65 m: DB 37.62 - 37.76 m: tuffaceous 37.76 m: DB 38.56 m: DB 38.98 m: VN, calcite 38.98 - 39.09 m: carbonaceous laminations, 10°
		100	100		SANDSTONE, fine to medium grained, grey, massive		39.62 m 39.91 m: BP, 10°

RL (m AHD): 2, 1, 0, -1, -2, -3, -4, -5, -6, -7
Depth (m): 31, 32, 33, 34, 35, 36, 37, 38, 39

Estimated Strength Is(50) MPa: ● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH
Average Natural Defect Spacing (mm): 20 60 200 600 2000
Visual

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
►	water inflow
◄	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 5 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring — Method: HQ3; Weathering: F

TCR (%)	RQD (%)
100	100
100	100
100	100
100	100

RL (m AHD)	Depth (m)
-8	
	41
-9	
	42
-10	
	43
-11	
	44
-12	
	45
-13	
	46
-14	
	47
-15	
	48
-16	
	49
-17	

Material Description

Depth (m)	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components
	SANDSTONE, fine to medium grained, grey, massive *(continued)*
43.00m	HORNFELS, brown, minor carbonate veining
43.27m	SANDSTONE, medium to coarse grained, grey, irregular coal beds
43.58m	SANDSTONE, medium to coarse grained, grey, tuffaceous sandstone clasts
44.25m	SANDSTONE, fine to medium grained, grey, minor bedding at 5 degrees, minor crossbedding
46.58m	
46.72m	INTERLAMINATED TUFF, SANDSTONE, SILTSTONE, brown, dark-grey, irregular bedding
	SANDSTONE, fine grained, grey, carbonaceous siltstone wisps and lenses, increasing with depth
47.66m	SANDSTONE, fine grained, grey, minor carbonaceous wisps and gravel inclusions
48.14m	SANDSTONE, fine grained, dark-grey, laminated, sub-horizontal to 15 degrees siltstone laminations, tuff beds, soft sediment deformation
48.97m	CARBONACEOUS SILTSTONE, dark-grey, laminated, sandstone laminations fining upward, tuff laminations

Defect Description

Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 40.02 m: DB
- 40.68 m: DB
- 41.66 m: DB
- 42.55 - 42.84 m: carbonaceous laminations, 10°
- 43.01 m: DB
- 43.20 m: DB
- 43.27 m: carbonaceous seam, 30°
- 43.34 - 43.35 m: carbonaceous seam, 35°
- 43.97 m: DB
- 46.57 m: DB
- 46.68 m: DB
- 46.98 m: DB
- 48.01 m: DB
- 48.14 m: DB
- 48.34 m: no water
- 49.13 - 49.17 m: irregular carbonate veining
- 49.87 m: DB

Estimated Strength Is(50) MPa: ● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH
Average Natural Defect Spacing (mm): 20 60 200 600 2000

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

Cardno

CORE LOG SHEET

Hole No: STX1903G

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863
Sheet: 6 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring: Method | Fluid | TCR (%) | RQD (%) | RL (m AHD) | Depth (m)

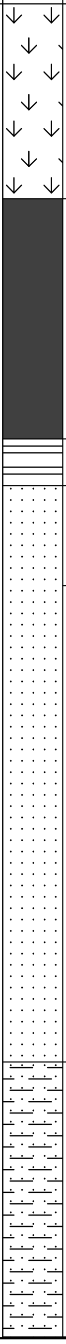
Material Description: Graphic Log | SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components | Weathering | Estimated Strength Is$_{(50)}$ MPa (● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH) | Average Natural Defect Spacing (mm) (20 60 200 600 2000) | Visual

Defect Description: Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

Method: HQ3

TCR (%)	RQD (%)
100	100
100	100
100	100
100	100

RL (m AHD)	Depth (m)
-18	51
-19	52
-20	53
-21	54
-22	55
-23	56
-24	57
-25	58
-26	59
-27	



Base depth	Description	Weathering
51.46m	CARBONACEOUS SILTSTONE, dark-grey, laminated, sandstone laminations fining upward, tuff laminations *(continued)*	F
53.26m	COAL, black, irregular carbonate veining trending 80 degrees	
53.61m	MUDSTONE, dark-grey, laminated, bedding at 10 degrees	
54.36m	SANDSTONE, fine grained, grey, massive, carbonaceous wisps	
57.93m	SANDSTONE, fine to medium grained, grey, massive	
59.99m	INTERBEDDED CARBONACEOUS SILTSTONE AND COAL, dark-grey, black, bedded	

Defect Description:

- 50.17 m: BP, 15°
- 50.25 m: DB
- 50.37 m: DB
- 50.67 m: DB
- 50.93 m: DB
- 51.46 m: DB
- 51.86 m: DB
- 53.18 m: DB
- 53.25 - 53.27 m: rubbly core
- 53.33 - 53.53 m: multiple spider webbing fractures, 30°
- 54.20 m: DB
- 54.53 m: DB
- 54.60 m: DB
- 55.31 - 55.32 m: carbonaceous wisps, 5°
- 55.77 - 55.83 m: gravelly band
- 55.91 m: siltstone lamination, 25°
- 57.04 m: tuff lamination
- 57.09 - 57.10 m: carbonaceous wisps, 15°
- 57.95 m: DB
- 58.00 m: DB
- 58.21 m: DB
- 58.35 m: SZ, 60°, UN, SL
- 58.70 m: DB
- 58.83 m: DB
- 58.94 m: DB
- 59.19 m: DB
- 59.39 m: SZ, 60°, UN, SL
- 59.49 m: DB
- 59.69 m: SZ, 50°, UN, SL
- 59.86 m: SZ, 50°, UN, SL

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶	water inflow
◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 7 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring: Method HQ3

TCR (%)	RQD (%)
100	100
100	100
100	100
100	100
100	100

RL (m AHD): -28, -29, -30, -31, -32, -33, -34, -35, -36, -37

Depth (m): 61, 62, 63, 64, 65, 66, 67, 68, 69

Weathering: F

Estimated Strength Is(50) MPa ● - Axial ○ - Diametral: VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Depth	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components
60.08m	HORNFELS, dark-brown, soft sediment deformation, minor carbonate *(continued)*
60.25m	SILTSTONE, dark-grey, sub-horizontal laminations
	SILTSTONE, dark-grey, massive, carbonaceous inclusions, soft sediment deformation
61.68m	SILTSTONE, dark-grey, laminated, horizontal sandstone laminations
62.17m	INTERBEDDED SANDSTONE AND HORNFELS, dark-brown, bedded
62.31m	SILTSTONE, dark-grey, laminated, sub-horizontal sandstone laminations and minor beds
63.05m	SANDSTONE, grey, dark-grey, laminated, abundant siltstone laminations bedding at 5-10 degrees
67.45m	COAL, black, irregular calcite veining at 90 degrees
67.55m	INTERBEDDED CARBONACEOUS SILTSTONE AND SANDSTONE, fine grained, black, dark-grey, grey, laminated, bioturbation, soft sediment deformation, sub-horizontal laminations
69.17m	COAL, black, irregular calcite veining at 90 degrees
69.28m	HORNFELS, dark-brown
69.38m	COAL, black, minor calcite veining
69.77m	CARBONACEOUS SILTSTONE, black

Defect Description — Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

60.08 - 60.15 m: DB
60.42 m: SZ, 60°, UN, SL
60.84 m: SZ, 65°, UN, SL
60.92 m: DB
61.36 m: VN, 45°, UN, calcite
61.94 m: SZ, 60°, healed
62.55 m: DB
62.70 - 62.74 m: tuff
62.77 m: DB
63.10 - 63.50 m: tuff
63.44 m: DB
64.56 m: DB
67.20 m: DB
67.27 m: VN, 25°, UN, healed calcite
67.38 - 67.45 m: tuffaceous
67.68 m: DB
67.75 m: VN, 60°, UN, healed calcite
67.97 m: DB
69.75 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

Water Level on date shown
water inflow
water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

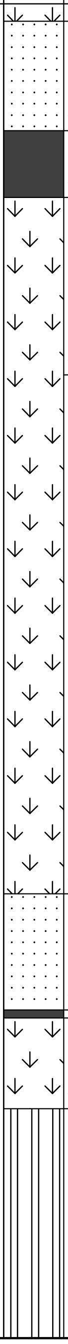
CORE LOG SHEET

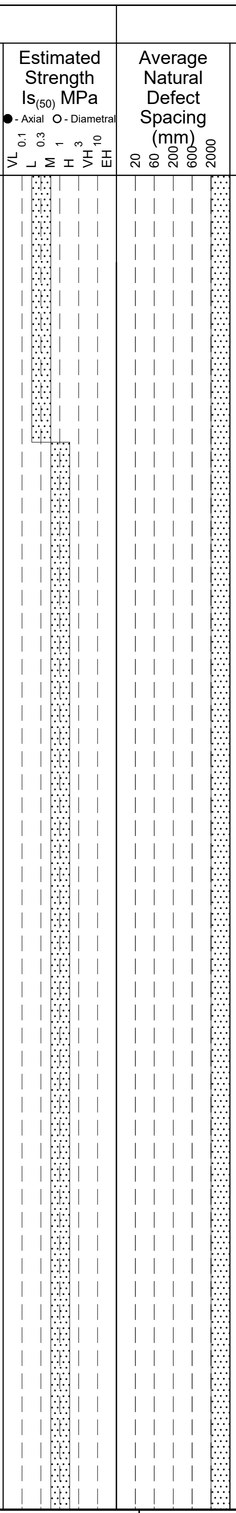
Hole No: STX1903G

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863
Sheet: 8 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring: Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Material Description: SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Defect Description: Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
HQ3		100	100	-38	70.13m – 70.95m	SANDSTONE, fine grained, grey, laminated, siltstone laminations at 5 degrees	F	
				-39	70.95m – 71.45m	COAL, black, minor calcite veining		71.24 m: DB 71.35 - 71.38 m: tuff 71.47 m: DB
					71.45m – 72.78m	CARBONACEOUS SILTSTONE, black, massive, carbonaceous wisps		72.00 m: DB 72.40 m: VN, 60°, calcite
		100	100	-40 to -44	72.78m – 76.67m	CARBONACEOUS SILTSTONE, dark-grey, dark-brown, black, laminated, sandstone and hornfels laminations, soft sediment deformation, becoming more heat affected with depth		72.81 m: DB 74.18 m: DB 74.75 m: DB 75.35 m: SZ, 60°, UN, healed calcite 75.50 m: SZ, 55°, PR, healed calcite 75.93 m: DB 76.52 m: SZ, 60°, UN, calcite
		100	100		76.67m – 77.54m	SANDSTONE, medium grained, grey, massive, with siltstone laminations and wisps		77.01 m: BP, 10°, UN
				-45	77.54m – 77.60m	COAL, black, massive, minor calcite veining at 90 degrees		77.61 m: DB
					77.60m – 78.28m	CARBONACEOUS SILTSTONE, black, massive		77.67 m: DB 77.82 m: DB 77.90 m: SZ, 55°, PR, healed calcite
		100	100	-46 to -47	78.28m –	SILTSTONE, dark-grey, laminated, sub-horizontal sandstone laminations		79.08 - 79.16 m: irregular calcite veining 79.42 m: DB





DRILLING		WATER		ROCK STRENGTH		DEFECT TYPE		PLANARITY		COATING	
AD/V	Solid flight auger: V-Bit	▽	Water Level on date shown	EH	Extremly High	JT	Joint	CU	Curved	CN	Clean
AD/T	Solid flight auger: TC-Bit	▶—	water inflow	VH	Very High	SZ	Sheared zone	DIS	Discontinuous	SN	Stained
HFA	Hollow flight auger	—◀	water outflow	H	High	BP	Bedding Parting	IR	Irregular	VNR	Veneer (thin or patchy)
WB	Washbore drilling			M	Medium	SM	Seam	PR	Planar	CT	Coating (up to 1mm)
RR	Rock roller			L	Low	FL	Foliation	ST	Stepped		
PQ	Rotary core (85mm)			VL	Very Low	VN	Vein	UN	Undulose		

DRILLING (cont.)		ROCK QUALITY DESCRIPTIONS		ROCK WEATHERING		DEFECT TYPE (cont.)		ROUGHNESS		INFILL MATERIALS	
HQ	Rotary core (63.5mm)	RQD	Rock Quality Designation (%)	FR	Fresh	CL	Cleavage	VR	Very Rough	X	Carbonaceus
NMLC	Rotary core (51.94mm)	TCR	Total Core Recovery (%)	SW	Slightly Weathered	CS	Crushed Seam	RF	Rough	MU	Unidentified minteral
DT	Diatube concrete coring			DW	Distinctly Weathered	FZ	Fracture Zone	S	Smooth	MS	Secondary mineral
PT	Push tube			MW	Moderately Weathered	DL	Drift Lift	SL	Slockensided	KT	Chlorite
PS	Percussion sampling			HW	Highly Weathered	HB	Handing Break	POL	Polished	CA	Calcite
SON	Sonic drilling			XW	Extremly Weathered	DB	Drilling Break			Fe	Iron Oxide
AH	Air hammer									Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Hole No: STX1903G

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin
Job No: M30863
Sheet: 9 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring: Method | Fluid | TCR (%) | RQD (%) | RL (m AHD) | Depth (m)

Material Description: Graphic Log | SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components | Weathering | Estimated Strength Is(50) MPa (● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH)

Defect Description: Average Natural Defect Spacing (mm) (20 60 200 600 2000) | Visual | Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

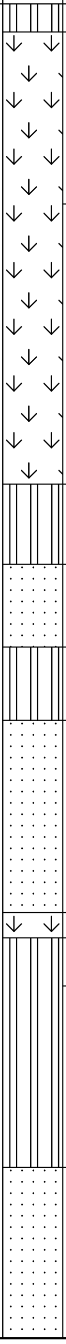
Method: HQ3

TCR (%)	RQD (%)
100	100
100	100
100	100
100	100

RL (m AHD): -48, -49, -50, -51, -52, -53, -54, -55, -56, -57

Depth (m): 81, 82, 83, 84, 85, 86, 87, 88, 89

Weathering: F



Depth	Material Description
80.21m	INTERBEDDED COAL AND CARBONACEOUS SILTSTONE, black, bedded
81.50m	CARBONACEOUS SILTSTONE, black, dark-brown, dark-grey, laminated, with sub-horizontal sandstone laminations and thermally altered beds
83.60m	SILTSTONE, dark-grey, dark-brown, laminated, with sub-horizontal sandstone laminations and thermally altered beds
84.20m	SANDSTONE, fine grained, grey, dark-grey, laminated, with sub-horizontal siltstone laminations
84.82m	SILTSTONE, dark-grey, laminated, with sub-horizontal sandstone laminations
85.37m	SANDSTONE, fine grained, grey, laminated, with sub-horizontal siltstone laminations
86.81m	
87.00m	CARBONACEOUS SILTSTONE, black, massive, with minor coal wisps
	SILTSTONE, dark-grey, massive
87.36m	SILTSTONE, dark-grey, laminated, with sandstone laminations and soft sediment deformation
88.72m	SANDSTONE, fine grained, grey, laminated, with sub-horizontal siltstone laminations and soft sediment deformation

Additional Data:
- 80.22 - 80.30 m: irregular calcite veining, 90°
- 80.37 - 80.77 m: JT, 90°, IR, healed
- 81.50 m: DB
- 81.59 m: DB
- 81.76 m: DB
- 81.90 m: DB
- 82.72 m: DB
- 83.05 m: VN, 80°, ST, calcite
- 83.39 m: DB
- 84.01 m: DB
- 85.01 m: SZ, 45°, CU, healed
- 85.10 m: SZ, 45°, CU, healed
- 85.46 m: DB
- 85.97 m: DB
- 86.08 m: VN, 15°, IR, 3 mm, calcite
- 86.70 m: DB
- 86.96 - 86.97 m: coal lamination
- 87.07 m: SZ, 50°, UN, POL
- 87.32 m: SZ, 70°, CU, POL
- 87.75 m: coal lens, 30°
- 88.31 m: SZ, 50°, UN, healed

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶—	water inflow
—◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremely High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Hole No: STX1903G

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Job No: M30863
Sheet: 10 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

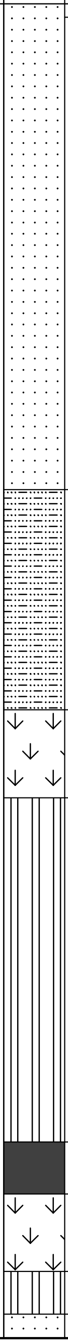
Coring

Method: HQ3

TCR (%)	RQD (%)
100	100
100	100
100	100
100	100
98	98

RL (m AHD): -58, -59, -60, -61, -62, -63, -64, -65, -66, -67

Depth (m): 91, 92, 93, 94, 95, 96, 97, 98, 99



Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

Depth	Description	Weathering
90.10m	SANDSTONE, fine to medium grained, grey, laminated, with minor siltstone laminations at 5-10 degrees and tuffaceous bands	F
93.64m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, dark-grey, laminated, sub-horizontal laminations, minor thermally altered bands	
95.29m	CARBONACEOUS SILTSTONE, black, massive, with minor coal wisps	
95.95m	SILTSTONE, dark-grey, laminated, with sandstone laminations at 5-10 degrees, soft sediment deformation, bioturbation	
98.53m	COAL, black, massive, minor carbonate veins at 90 degrees	
98.92m	CARBONACEOUS SILTSTONE, black, massive, with minor coal wisps	
99.50m	SILTSTONE, dark-grey, laminated, sub-horizontal sandstone laminations, bioturbation	
99.82m		

Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral: VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 91.20 m: DB
- 91.20 - 91.34 m: VN, 90°, IR, 2 mm, calcite
- 92.00 m: DB
- 93.70 m: VN, 45°, IR, 3 mm, calcite
- 93.75 m: JT, 45°, healed
- 94.90 m: DB
- 96.08 m: SZ, 55°, PR, healed
- 96.90 - 96.96 m: coal
- 96.93 m: DB
- 97.54 m: DB
- 99.06 m: SZ, 45°, UN, POL, calcite
- 99.14 m: SZ, 45°, UN, POL, calcite
- 99.69 m: DB
- 99.82 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 11 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring: Method HQ3; TCR (%) / RQD (%): 98 / 98; 100 / 100; 100 / 100; 100 / 100

RL (m AHD): -68, -69, -70, -71, -72, -73, -74, -75, -76, -77
Depth (m): 101, 102, 103, 104, 105, 106, 107, 108, 109

Weathering: F

Estimated Strength Is(50) MPa: ● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

	SANDSTONE, fine grained, grey, dark-grey, laminated, sub-horizontal siltstone laminations *(continued)*
100.73m	CARBONACEOUS SILTSTONE, dark-grey, black, bedded, with coal beds
101.12m	COAL, black, bedded, with carbonaceous siltstone beds
102.82m	SILTSTONE, dark-grey, horizontal laminations
103.02m	COAL, black, irregular calcite veining
103.19m	CORE LOSS 0.03m (103.19-103.22)
103.22m	SILTSTONE, dark-grey, massive
103.93m	SANDSTONE, fine grained, grey, laminated, sub-horizontal siltstone laminations
104.22m	SILTSTONE, dark-grey, bedded, tuffaceous beds
105.03m	TUFF, dark-brown, brecciated by carbonate veining
105.26m	CARBONACEOUS SILTSTONE, black, massive
105.82m	COAL, black
106.02m	SILTSTONE, dark-grey, massive
107.52m	SANDSTONE, fine to medium grained, laminated, grey, minor sub-horizontal to 10 degree siltstone laminations
108.95m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, dark-grey, grey, soft sediment deformation
109.75m	

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 100.04 m: DB
- 100.41 m: DB
- 100.73 - 100.80 m: coal with irregular calcite veining
- 101.70 m: JT, 90°, UN, healed
- 102.91 m: SZ, 45°, UN, POL
- 103.23 m: SZ, 30°, UN, POL
- 103.33 m: SZ, 70°, UN, SL
- 104.94 m: SZ, 50°, UN, SL
- 105.27 m: SZ, 65°, UN, POL
- 105.35 m: SZ, 70°, UN, POL
- 105.95 m: DB
- 106.21 m: DB
- 106.45 m: SZ, 60°, PR, healed
- 107.28 m: DB
- 107.51 m: DB
- 108.52 m: SZ, 65°, PR, plastic deformation

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ▶— water inflow
- —◀ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 12 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring

Method	Fluid	TCR (%)	RQD (%)
HQ3		100	100
		100	100
		100	100
		100	100

RL (m AHD): -78, -79, -80, -81, -82, -83, -84, -85, -86, -87

Depth (m): 111, 112, 113, 114, 115, 116, 117, 118, 119

Material Description

Depth	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering
	SILTSTONE, laminated, dark-grey, tuffaceous beds, sub-horizontal sandstone laminations *(continued)*	F
111.65m	SANDSTONE, fine to medium grained, massive, grey, with carbonaceous wisps and gravel bands	
112.04m	CARBONACEOUS SILTSTONE, laminated, black, with coal wisps and laminations, soft sediment deformation	
112.62m	COAL, bedded, black, with minor calcite veining at 90 degrees	
113.96m	CARBONACEOUS SILTSTONE, laminated, black, with coal wisps and laminations, soft sediment deformation	
114.42m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey, soft sediment deformation	
114.90m	CARBONACEOUS SILTSTONE, black, minor horizontal laminations and coal lensing	
115.24m 115.30m	SANDSTONE, fine grained, laminated, grey, siltstone laminations	
115.44m	SILTSTONE, massive, grey	
	CARBONACEOUS SILTSTONE, black, tuffaceous bands, soft sediment deformation	
116.07m	SILTSTONE, massive, dark-grey	
116.72m	COAL, black, minor calcite veining at 90 degrees	
116.98m	SILTSTONE, massive, dark-grey, minor irregular carbonaceous inclusions	
118.01m	SANDSTONE, fine grained, massive, grey, with minor siltstone laminations	
118.62m	SILTSTONE, laminated, dark-grey, dark-brown, with tuffaceous beds and irregular coal laminations	
119.19m	SANDSTONE, fine grained, grey, siltstone and minor gravel inclusions, soft sediment deformation	
119.95m		

Estimated Strength $Is_{(50)}$ MPa ● - Axial ○ - Diametral: VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 111.64 m: DB
- 111.92 - 111.97 m: minor coarse gravel sized clasts
- 112.04 - 112.06 m: coal
- 112.08 m: SZ, 40°, UN, S
- 112.62 m: DB
- 112.78 m: DB
- 112.93 - 113.00 m: carbonaceous siltstone
- 113.20 - 113.95 m: JT, 90°, UN, RF
- 114.08 m: DB
- 115.00 m: coal lamination
- 115.24 m: DB
- 115.70 - 115.85 m: irregular carbonate veining
- 116.71 m: DB
- 117.30 m: SZ, 45°, UN, SL

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶	water inflow
◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 13 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring

Method	Fluid	TCR (%)	RQD (%)
HQ3		100	100
		100	100
		100	100
		100	100
		100	100

RL (m AHD): -88, -89, -90, -91, -92, -93, -94, -95, -96, -97

Depth (m): 121, 122, 123, 124, 125, 126, 127, 128, 129

Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

Depth	Description	Weathering
119.99m 120.13m	MUDSTONE, massive, brown, weathered tuff COAL, massive, black *(continued)*	F
120.95m	CARBONACEOUS MUDSTONE, laminated, dark-grey, black, with coal wisps	
122.60m	SANDSTONE, fine grained, laminated, grey, with siltstone laminations at 5-10 degrees	
123.25m	CARBONACEOUS SILTSTONE, black, soft sediment deformation	
123.37m	COAL, black, with calcite veining at 90 degrees	
124.04m	SILTSTONE, massive, black, dark-grey, with tuffaceous bands	
124.45m	SANDSTONE, fine to medium grained, massive, grey, with carbonaceous wisps and irregular siltstone laminations	
124.63m	SILTSTONE, laminated, dark-grey, with sandstone laminations at 10 degrees, soft sediment deformation	
125.15m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, laminated, grey, dark-grey, sub-horizontal bedding	
125.36m	COAL, black	
125.63m	CARBONACEOUS SILTSTONE, black, with coal lenses	
126.00m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, grey, dark-grey, soft	
126.17m	sediment deformation	
	CARBONACEOUS SILTSTONE, black, with coal lenses	
126.62m	COAL, black	
127.24m	CARBONACEOUS SILTSTONE, black, with coal lenses	
128.10m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, grey, dark-grey, soft sediment deformation	
128.46m	SILTSTONE, massive, dark-grey	
128.81m	INTERLAMINATED SANDSTONE AND SILTSTONE, fine grained, grey, dark-grey, soft sediment deformation	
129.46m	SILTSTONE, massive, dark-grey, becoming carbonaceous	
129.71m	COAL, black, calcite veining at 90 degrees	
	CARBONACEOUS SILTSTONE, black, with coal lenses	

Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 119.99 - 120.23 m: rubbly core
- 120.47 m: JT, 50°, PR, S
- 120.54 m: DB
- 120.80 m: DB
- 120.93 m: JT, 50°, PR, S
- 122.65 m: JT, 50°, PR, S
- 122.84 m: DB
- 123.04 m: DB
- 123.15 m: VN, 55°, ST, calcite
- 123.27 m: SZ, 40°, PR, POL, calcite
- 124.68 m: DB
- 125.18 m: DB
- 125.37 m: DB
- 126.00 m: DB
- 126.50 m: DB
- 126.74 m: DB
- 126.96 m: SZ, 40°, CU, SL
- 127.31 m: DB
- 127.99 m: DB
- 128.52 m: DB
- 128.63 - 128.73 m: multiple veins, 45°, clay
- 129.46 m: DB
- 129.73 m: DB
- 129.91 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

Cardno

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 14 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring: Method HQ3; TCR (%) / RQD (%): 100 / 100 (all runs)

RL (m AHD): -98 to -107; Depth (m): 131 to 139

Weathering: F

Depth	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components; ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components
130.16m – 130.91m	COAL, black, calcite veining at 90 degrees
130.91m – 131.20m	CARBONACEOUS SILTSTONE, black, with coal lenses
131.20m – 133.09m	SANDSTONE, fine grained, laminated, grey, with horizontal to sub-horizontal siltstone laminations, minor bioturbation
133.09m – 135.15m	SANDSTONE, medium grained, grey, with minor sub-horizontal to 20 degree siltstone laminations and wisps, minor irregular carbonaceous inclusions
135.15m – 135.57m	SANDSTONE, fine grained, grey, with irregular carbonaceous inclusions
135.57m – 137.10m	SANDSTONE, fine to medium grained, grey, with rare sub-horizontal silty wisps, bioturbation
137.10m – 139.56m	SANDSTONE, fine to medium grained, grey, with minor silty wisps and laminations, with minor gravelly bands, bioturbation
139.56m – 139.94m	SILTSTONE, laminated, dark-grey, with horizontal to sub-horizontal sandstone laminations

Estimated Strength $Is_{(50)}$ MPa (● - Axial ○ - Diametral): VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Defect Description – Additional Data: DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other
- 130.06 m: DB
- 130.13 m: DB
- 130.20 - 130.70 m: multiple joints, 90°, UN, RF
- 130.93 m: DB
- 131.29 m: DB
- 132.93 m: DB
- 134.00 m: DB
- 135.04 m: DB
- 137.44 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER
- ▽ Water Level on date shown
- ► water inflow
- ◄ water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceous
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 15 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**

Coring

Method	Fluid	TCR (%)	RQD (%)
HQ3		100	100
		100	100
		100	100
		100	100

RL (m AHD): -108, -109, -110, -111, -112, -113, -114, -115, -116, -117
Depth (m): 141, 142, 143, 144, 145, 146, 147, 148, 149

Material Description

SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components
ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components

Depth	Description	Weathering
140.10m	CONGLOMERATE, fine to medium grained, grey, with sandstone matrix *(continued)*	F
140.52m	SANDSTONE, fine to medium grained, grey, with sub-horizontal siltstone laminations	
	SILTSTONE, dark-grey, with minor sandstone, soft sediment deformation	
143.44m	SILTSTONE, laminated, dark-grey, with sandstone laminations at 10 degrees, tuffaceous bands	
147.30m	SILTSTONE, dark-grey, minor laminations, with rare sandstone laminations and tuffaceous bands	

Estimated Strength Is(50) MPa: ● - Axial ○ - Diametral; VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Natural Defect Spacing (mm): 20 60 200 600 2000

Visual

Defect Description

Additional Data
DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other

- 140.47 m: DB
- 140.66 m: VN, 45°, PR, calcite
- 141.87 m: VN, 45°, PR, calcite
- 141.89 m: VN, 45°, PR, calcite
- 141.90 m: DB
- 143.56 m: DB
- 144.23 m: VN, 20°, IR, calcite
- 144.32 m: DB
- 145.45 m: VN, 10°, PR, calcite
- 146.15 m: VN, 20°, PR, 4 mm, carbonate
- 146.20 m: JT, 30°, PR, RF
- 146.31 m: VN, 30°, PR, calcite
- 147.28 m: DB
- 148.11 m: VN, 50°, PR, 3 mm, carbonate
- 148.36 m: DB
- 148.44 m: DB
- 149.91 m: DB

DRILLING

AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

▽	Water Level on date shown
▶—	water inflow
—◀	water outflow

ROCK QUALITY DESCRIPTIONS

RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH

EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING

FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE

JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY

CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS

VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING

CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS

X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

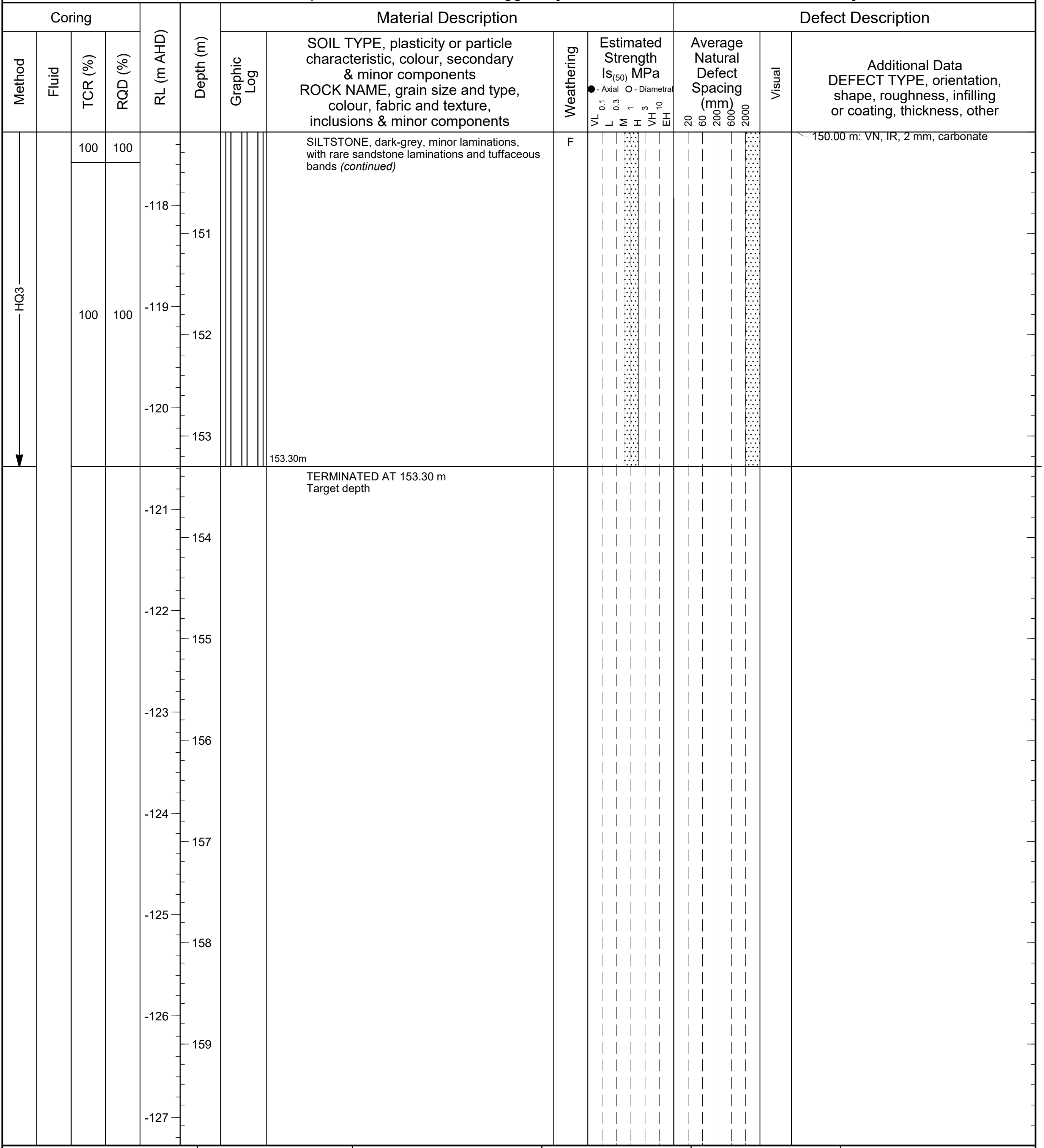
CORE LOG SHEET

Client: Central Queensland Coal
Project: CQ Coal Styx Basin Geotechnical Investigation
Location: Styx Basin

Hole No: STX1903G

Job No: M30863
Sheet: 16 of 16

Position: E773392.670 N7486730.310 55 MGA94	**Angle from Horizontal:** 90°	**Surface Elevation:** 32.722 m AHD
Rig Type: UDR650	**Mounting:** Truck	**Driller:** Waratah Coal
Casing Diameter: 0.1016/101.6 **Bit Type:**	**Bit Condition:**	**Contractor:** Waratah Coal
Date Started: 28/8/19 **Date Completed:** 2/9/19	**Logged By:** AD	**Checked By:**



SILTSTONE, dark-grey, minor laminations, with rare sandstone laminations and tuffaceous bands *(continued)*

150.00 m: VN, IR, 2 mm, carbonate

TERMINATED AT 153.30 m
Target depth

DRILLING	
AD/V	Solid flight auger: V-Bit
AD/T	Solid flight auger: TC-Bit
HFA	Hollow flight auger
WB	Washbore drilling
RR	Rock roller
PQ	Rotary core (85mm)
HQ	Rotary core (63.5mm)
NMLC	Rotary core (51.94mm)
DT	Diatube concrete coring
PT	Push tube
PS	Percussion sampling
SON	Sonic drilling
AH	Air hammer

WATER

- ▽ Water Level on date shown
- ► water inflow
- ◄ water outflow

ROCK QUALITY DESCRIPTIONS	
RQD	Rock Quality Designation (%)
TCR	Total Core Recovery (%)

ROCK STRENGTH	
EH	Extremly High
VH	Very High
H	High
M	Medium
L	Low
VL	Very Low

ROCK WEATHERING	
FR	Fresh
SW	Slightly Weathered
DW	Distinctly Weathered
MW	Moderately Weathered
HW	Highly Weathered
XW	Extremly Weathered

DEFECT TYPE	
JT	Joint
SZ	Sheared zone
BP	Bedding Parting
SM	Seam
FL	Foliation
VN	Vein
CL	Cleavage
CS	Crushed Seam
FZ	Fracture Zone
DL	Drift Lift
HB	Handing Break
DB	Drilling Break

PLANARITY	
CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

ROUGHNESS	
VR	Very Rough
RF	Rough
S	Smooth
SL	Slockensided
POL	Polished

COATING	
CN	Clean
SN	Stained
VNR	Veneer (thin or patchy)
CT	Coating (up to 1mm)

INFILL MATERIALS	
X	Carbonaceus
MU	Unidentified minteral
MS	Secondary mineral
KT	Chlorite
CA	Calcite
Fe	Iron Oxide
Qz	Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

APPENDIX

D

LABORATORY TEST DATA

Cardno (Qld) Pty Ltd
ABN 57 051 074 992
Mackay Laboratory

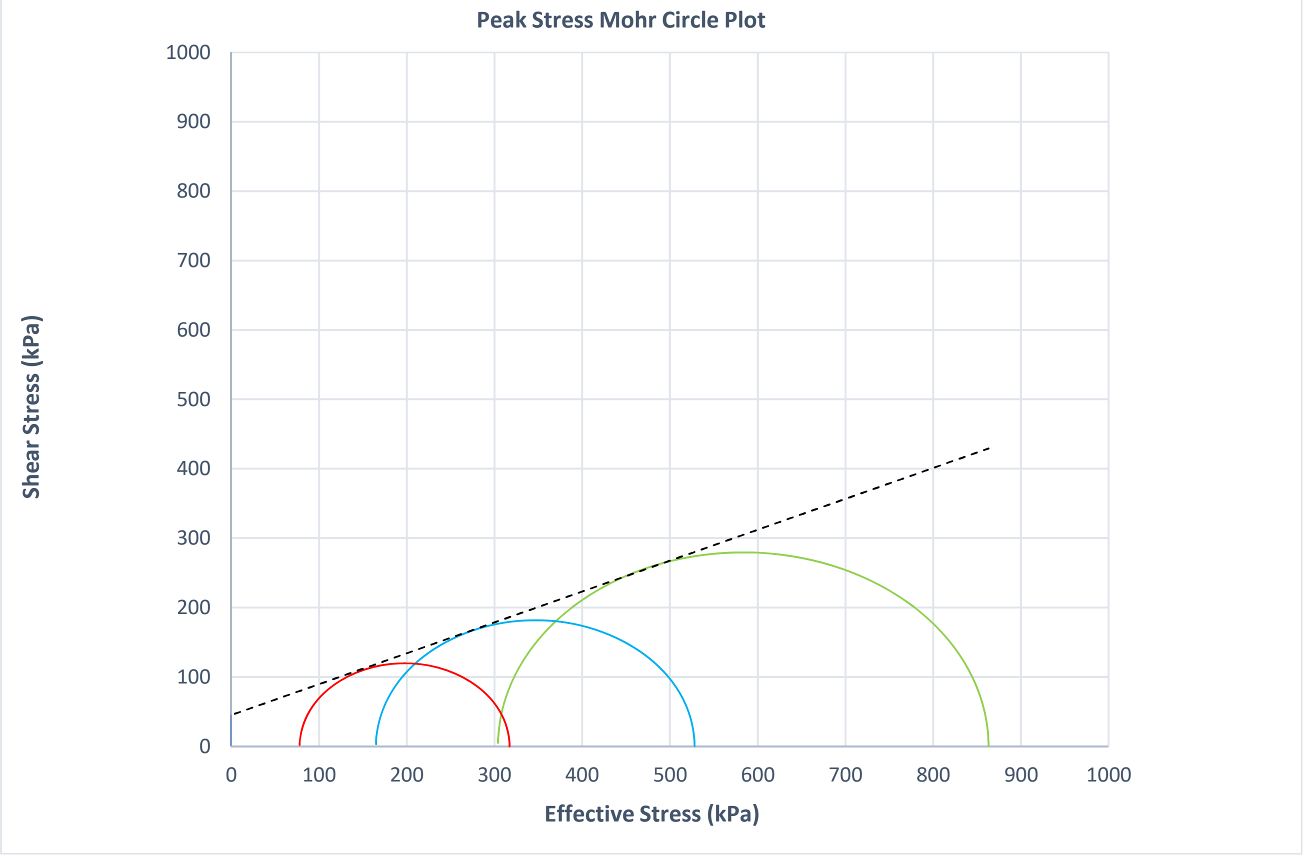
71 Maggiolo Drive
Paget, QLD 4740
P.O.Box 759, Mackay, QLD 4740

Tel: 07 4952 5255
Email: soils@cardno.com.au
Web: www.cardno.com.au

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5324A**
Address:	**Level 17, 240 Queen Street, Brisbane, Q**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1903G 1, Depth 11.48-11.63m**		**Page 1**

Date Sampled:	2/09/2019	Sample Number:	19-5324A
Date Tested:	26/11/2019	Material Description:	Brown Clay
Sampled By:	Sampled by Client	Initial Wet Density:	2.15 t/m^3
Initial Sample Height:	128.4 mm	Initial Dry Density:	1.95 t/m^3
Initial Sample Diameter:	102.4 mm	L/D Ratio:	1.3 :1
Initial Moisture:	10.5 %	Skempton's B Response:	0.96 %
Final Moisture:	13.1 %	Sample Type:	Core
Sampling Method:	As Received		
Moisture Method:	AS 1289.2.1.1	Strain Rate %/min:	0.033 0.021 0.020



Effective Cohesion C' (kPa): 45.0
Effective Angle of Friction ϕ' (Degrees): 24.0
Failure Criteria: Peak Deviator Stress

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

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71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

GEO-QF-GR 105 G
(07/17)

Sheet 1 of 7

Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5325A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	08-Nov-19
MATERIAL:	Sandstone	**CHECKED BY:**	DH	**DATE:**	09-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

		Sample Details	
		Borehole:	STX1903G
		Sample number:	3
		Depth from (m):	20.75
		Depth to (m):	21.00
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	206.8
Measurement:	Displacement Transducer	**Diameter (mm):**	100.9
		Moisture Content (%):	9.0
Rate of Loading (MPa/min):	0.46	**Mass of Sample (g):**	3664.0
Time to Failure (min):	10.15	**Dry Density (t/m3):**	2.03
Test Duration (min):	10.25	**Wet Density (t/m3):**	2.22

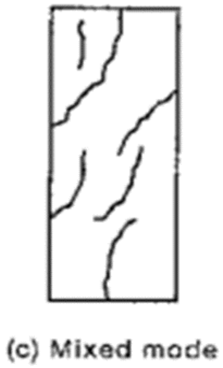
Intact Strength

	Confining Pressure (MPa)	Maximum Principal Stress (MPa):	Axial Strain (%)
Stage 1	0.5	2.2	1.21
Stage 2	1	3.1	3.22
Stage 3	1.5	3.9	9.52

Residual Strength

	Confining Pressure (MPa)	Median Axial Stress (MPa)	
Residual Stress 1			
Residual Stress 2			
Residual Stress 3			
Residual Stress 4			
Residual Stress 5			

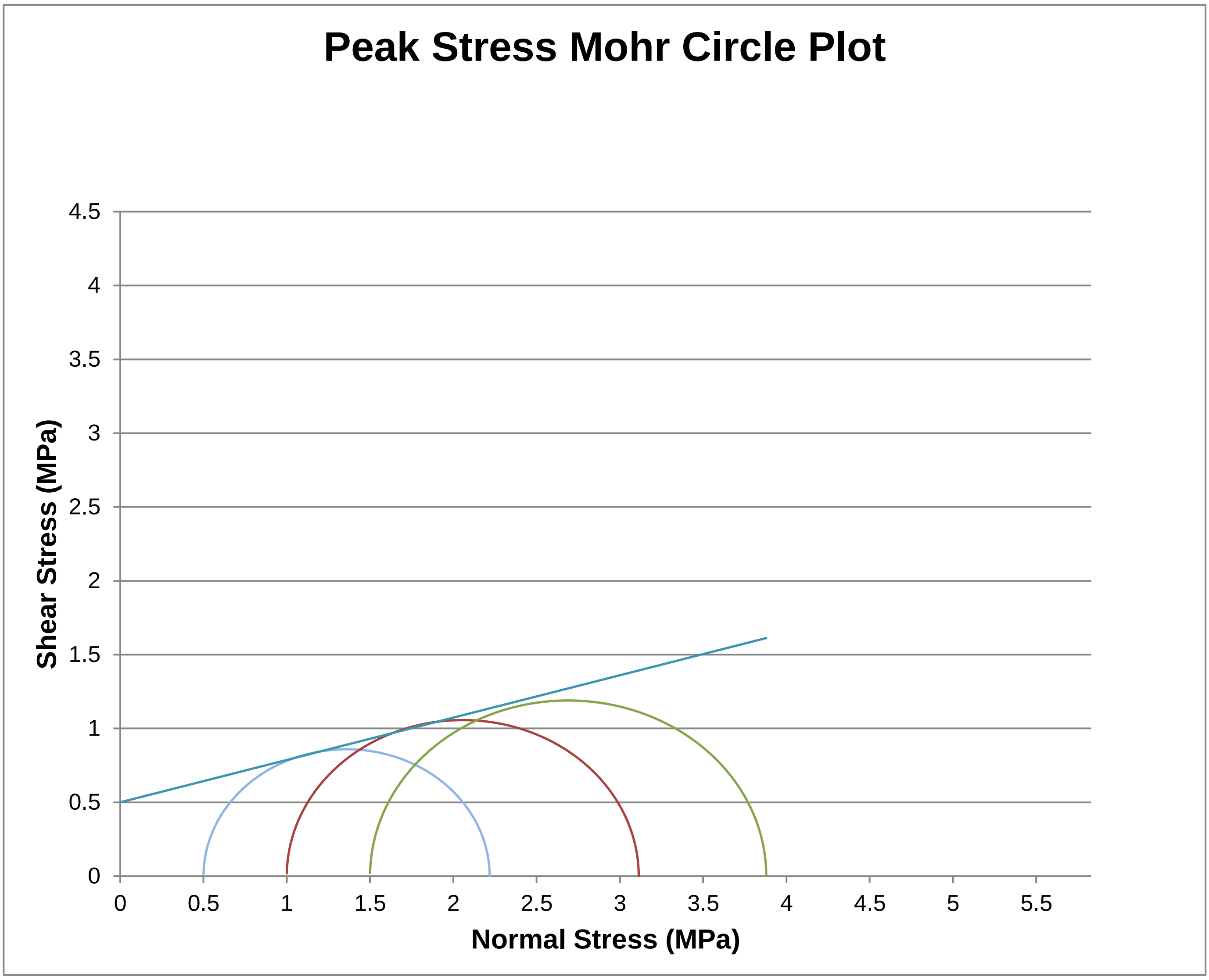
Dominant structural features with respect to core axis

Before Photo	After Photo	Failure Diagram
		

Comments: Testing was done at Room Temperature.

APPROVED SIGNATORY

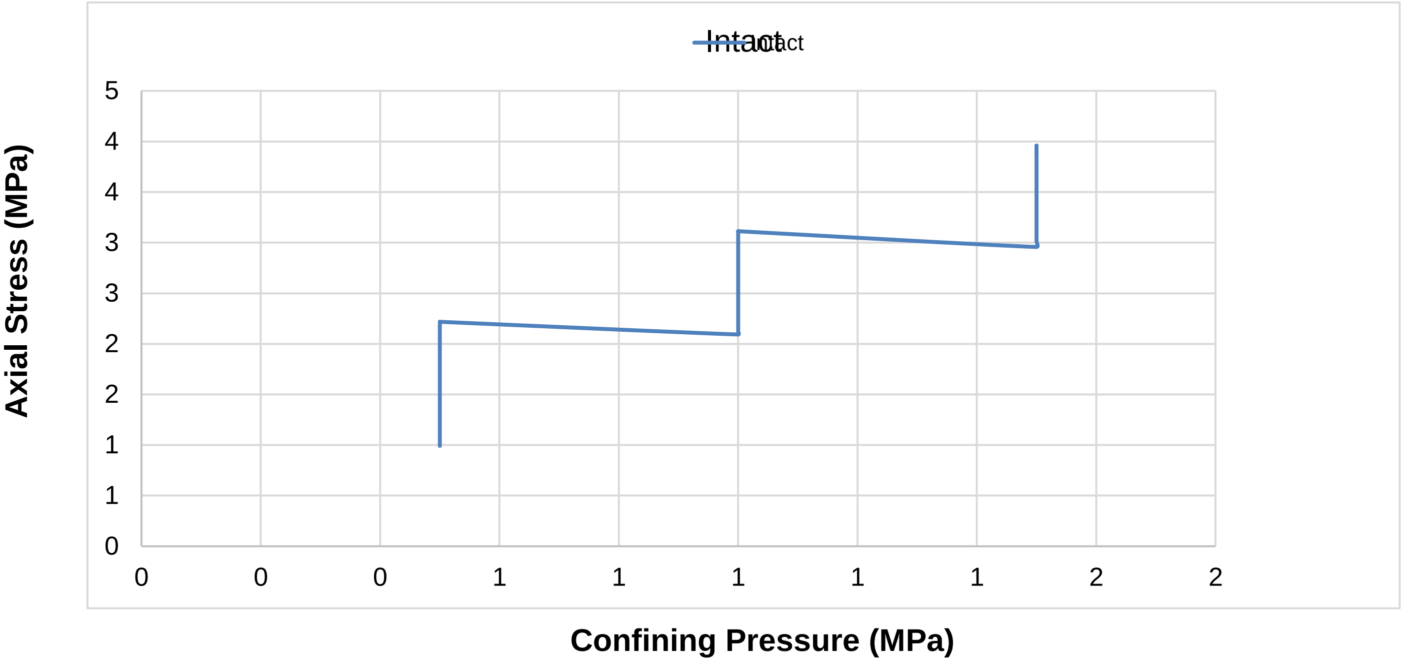
Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

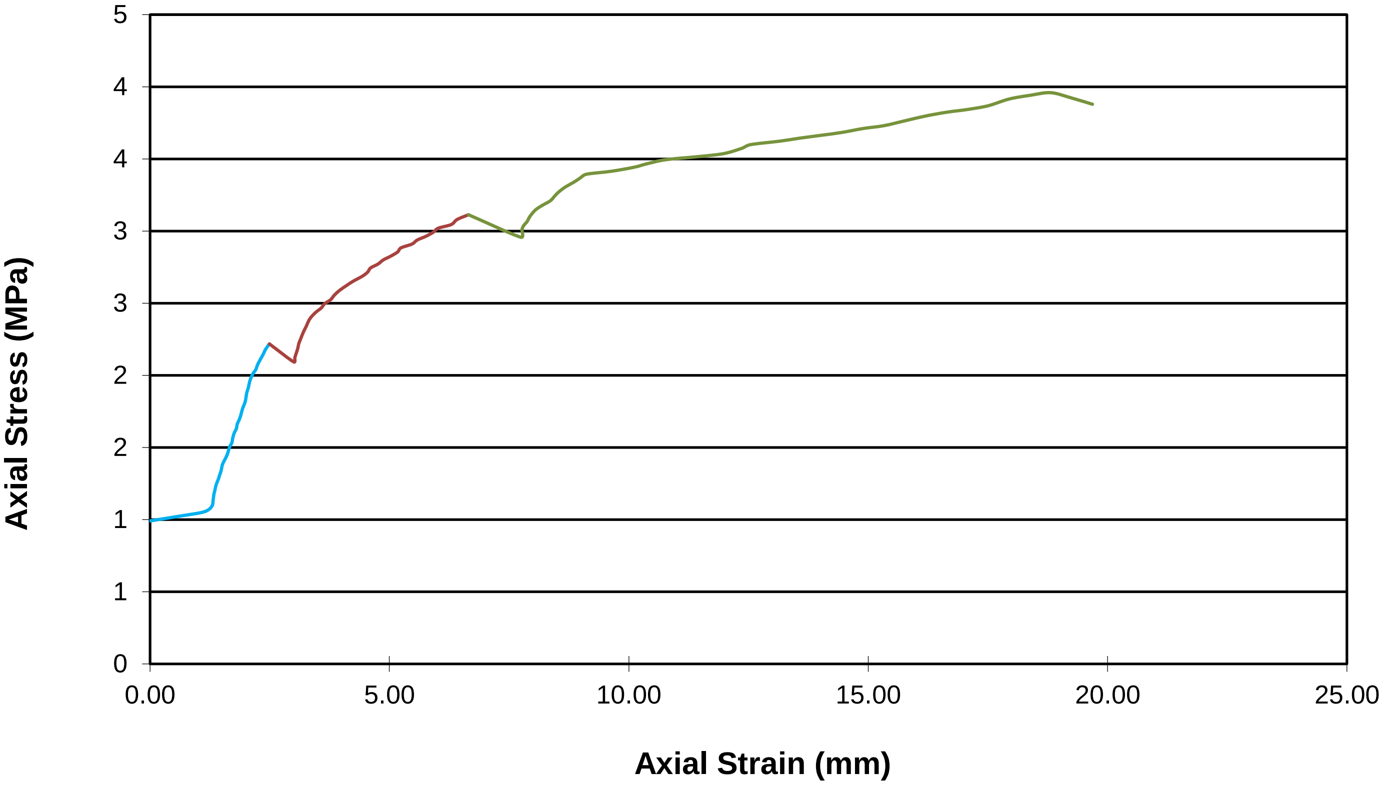


Estimated Peak Envelope	
Angle	16.0 °
Cohesion	0.5 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5325A

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5325A





GEO-QF-GR 105 G
(07/17)

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 3 Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5328A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	08-Nov-19
MATERIAL:	Mudstone	**CHECKED BY:**	DH	**DATE:**	09-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

Sample Details			
Borehole:	STX1903G	**Sample number:**	6
Depth from (m):	25.60	**Depth to (m):**	25.88

Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	209.3
Measurement:	Displacement Transducer	**Diameter (mm):**	101.1
		Moisture Content (%):	11.6
Rate of Loading (MPa/min):	0.45	**Mass of Sample (g):**	3839.0
Time to Failure (min):	9.01	**Dry Density (t/m3):**	2.05
Test Duration (min):	9.22	**Wet Density (t/m3):**	2.28

Intact Strength			
	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.5	2.9	0.67
Stage 2	1	3.7	1.13
Stage 3	1.5	4.3	2.20

Residual Strength			
	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1			
Residual Stress 2			
Residual Stress 3			
Residual Stress 4			
Residual Stress 5			

Dominant structural features with respect to core axis

Before Photo	**After Photo**	**Failure Diagram**
		

Comments: Testing was done at Room Temperature.

APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

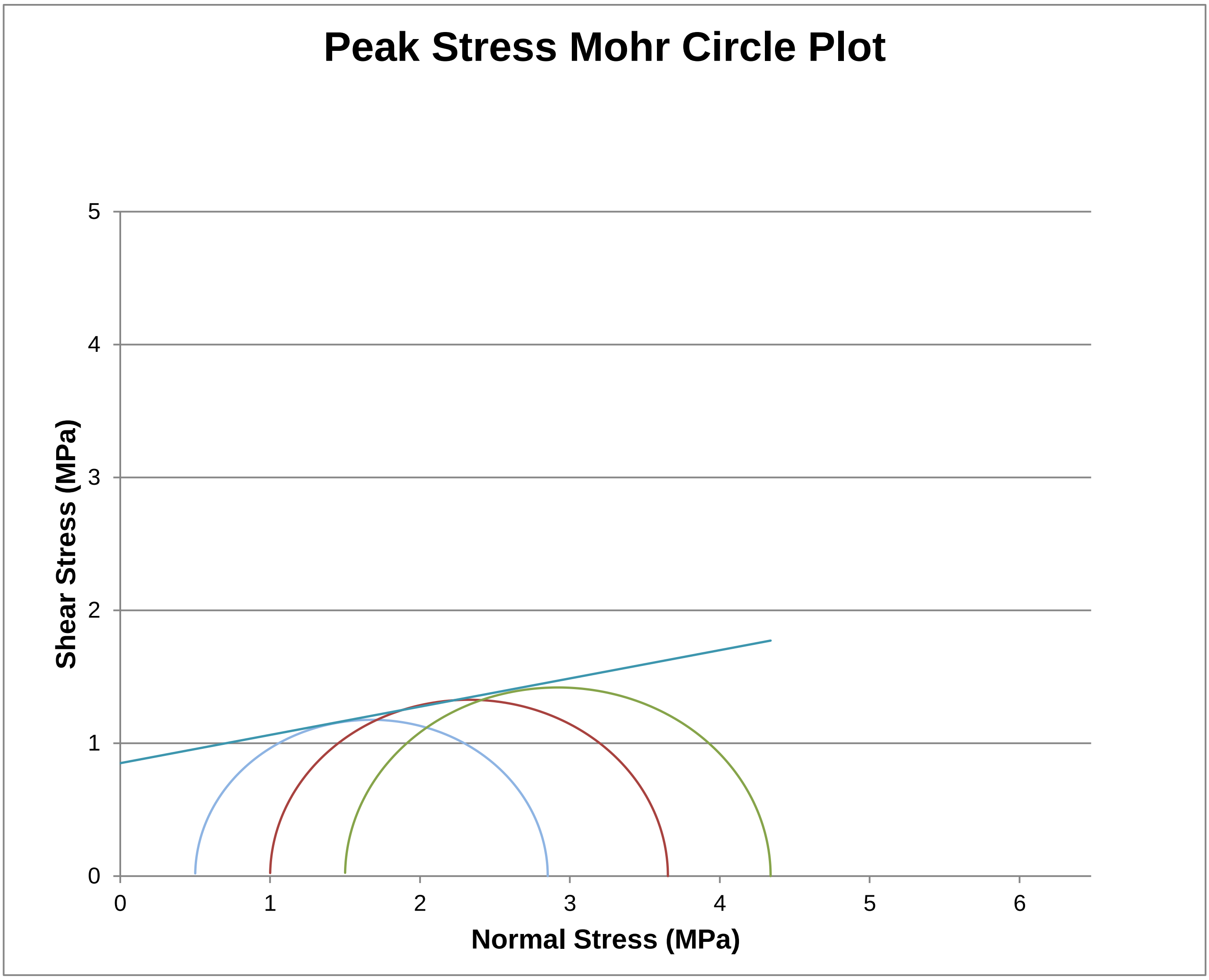
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 2 of 3

Mackay Laboratory



Estimated Peak Envelope	
Angle	12.0 °
Cohesion	0.9 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5328A

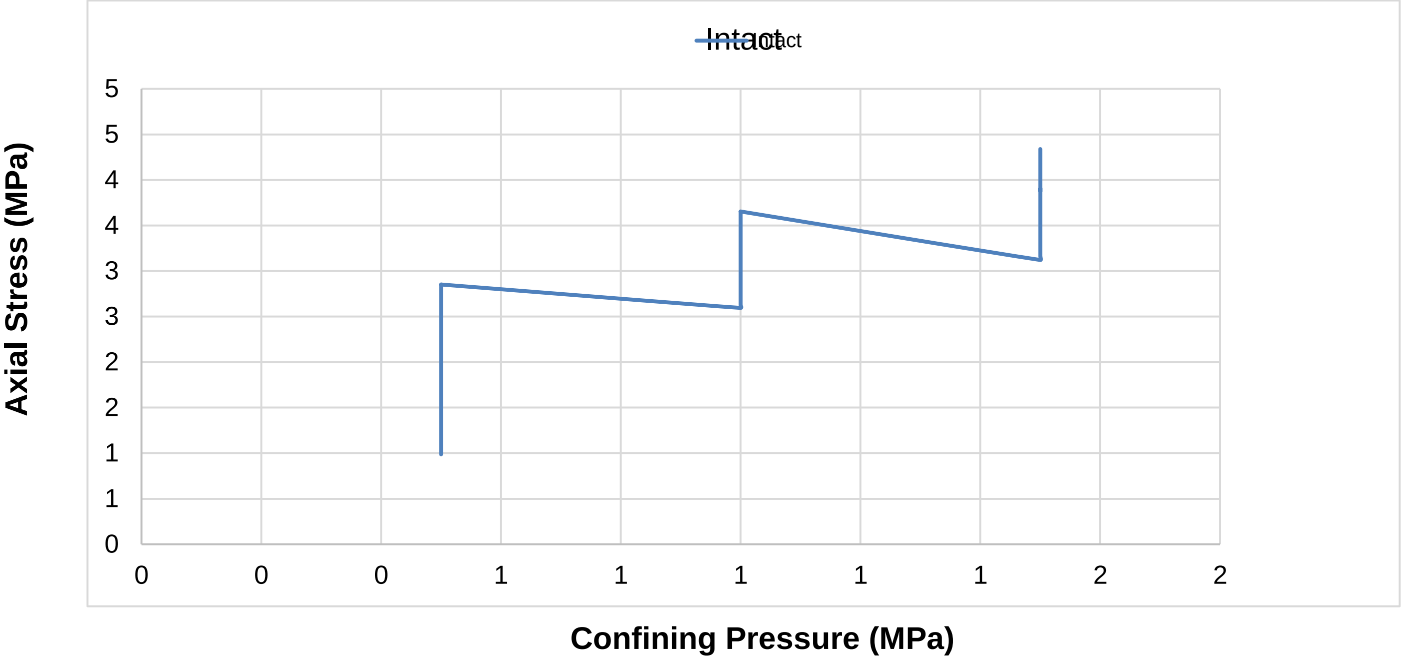
CARDNO (QLD) PTY LTD

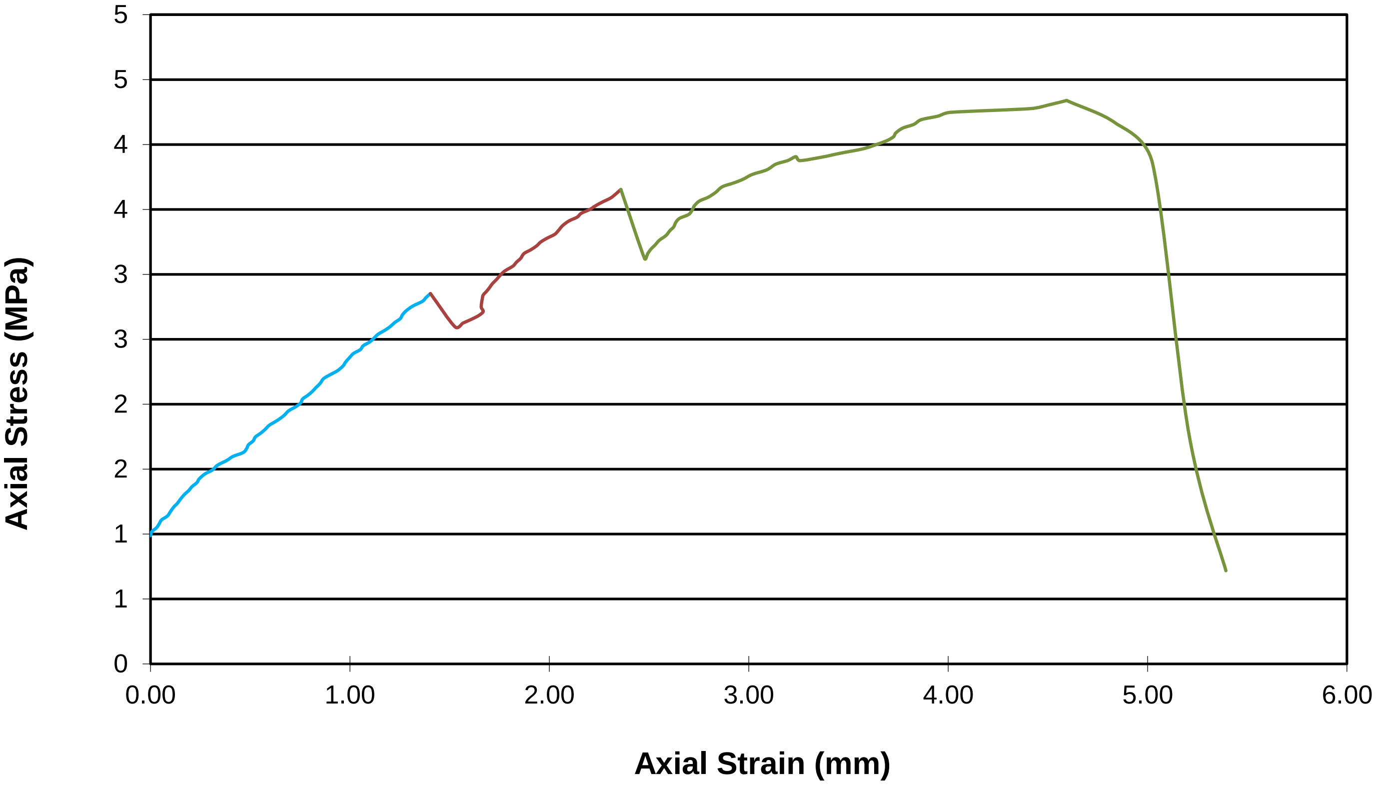
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 3 of 3 Mackay Laboratory

LAB REF NO: 19-5328A





CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 7 Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5356A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Interlaminated Sandstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	D7012-14 Method A; D4543			**CLIENT REF:**	-

Seam: -

Sample Details			
Borehole:	STX1903G	**Sample number:**	UCS-34
Depth from (m):	40.68	**Depth to (m):**	40.84

Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	125.4
Measurement:	Displacement Transducer	**Diameter (mm):**	60.8
		Moisture Content (%):	6.3
Rate of Loading (MPa/min):	13.20	**Mass of Sample (g):**	859.2
Time to Failure (min):	4.02	**Dry Density (t/m3):**	2.22
Test Duration (min):	4.18	**Wet Density (t/m3):**	2.36

Intact Strength			
	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	9.0	0.40
Stage 2	1.5	17.4	2.31
Stage 3	3	24.8	4.09

Residual Strength		
	Confining Pressure (MPa)	**Median Axial Stress (MPa)**
Residual Stress 1	3	23.2
Residual Stress 2	1.5	18.4
Residual Stress 3	0.75	12.8
Residual Stress 4	0.5	9.6
Residual Stress 5	0.25	6.8

Dominant structural features with respect to core axis

Before Photo	**After Photo**	**Failure Diagram**
		 (c) Mixed mode

Comments: Testing was done at Room Temperature.

NATA
WORLD RECOGNISED ACCREDITATION

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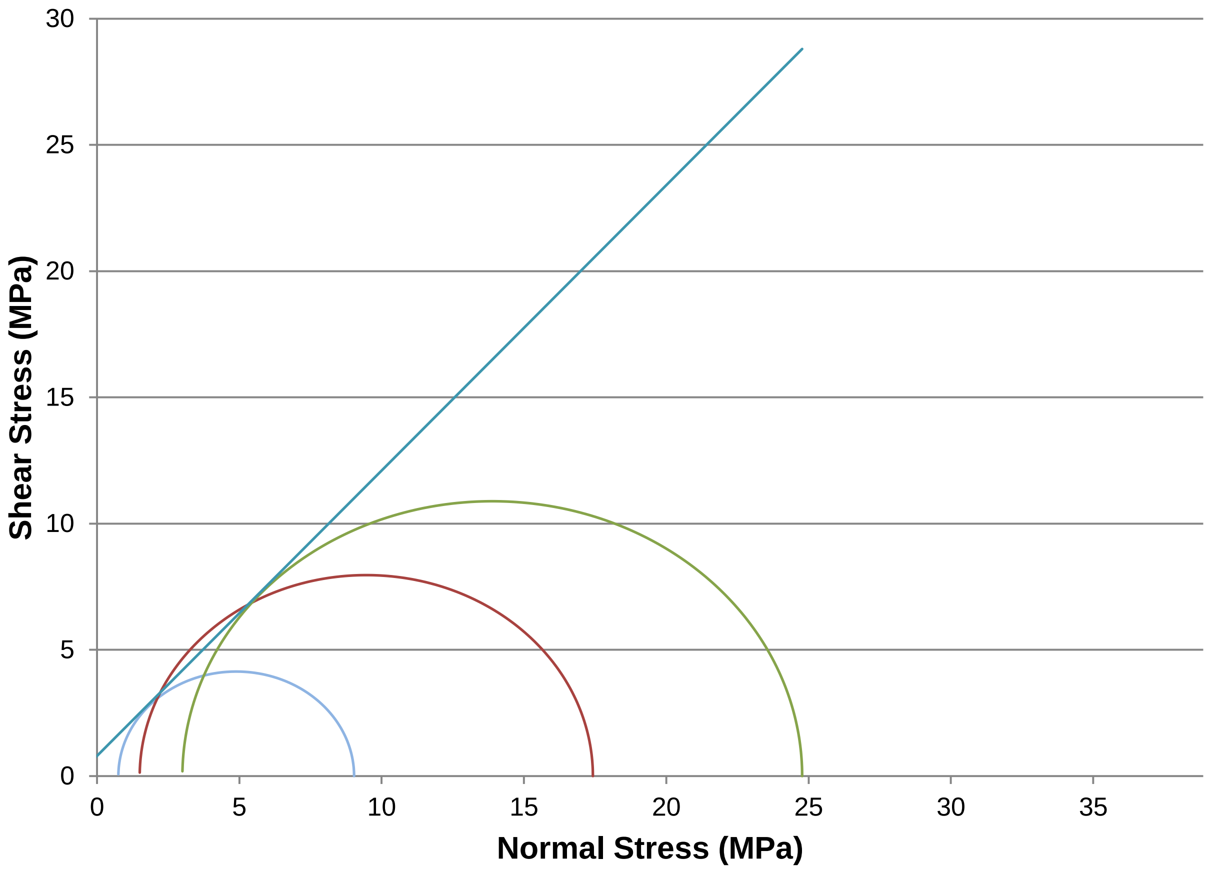
APPROVED SIGNATORY

T Bradbury

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

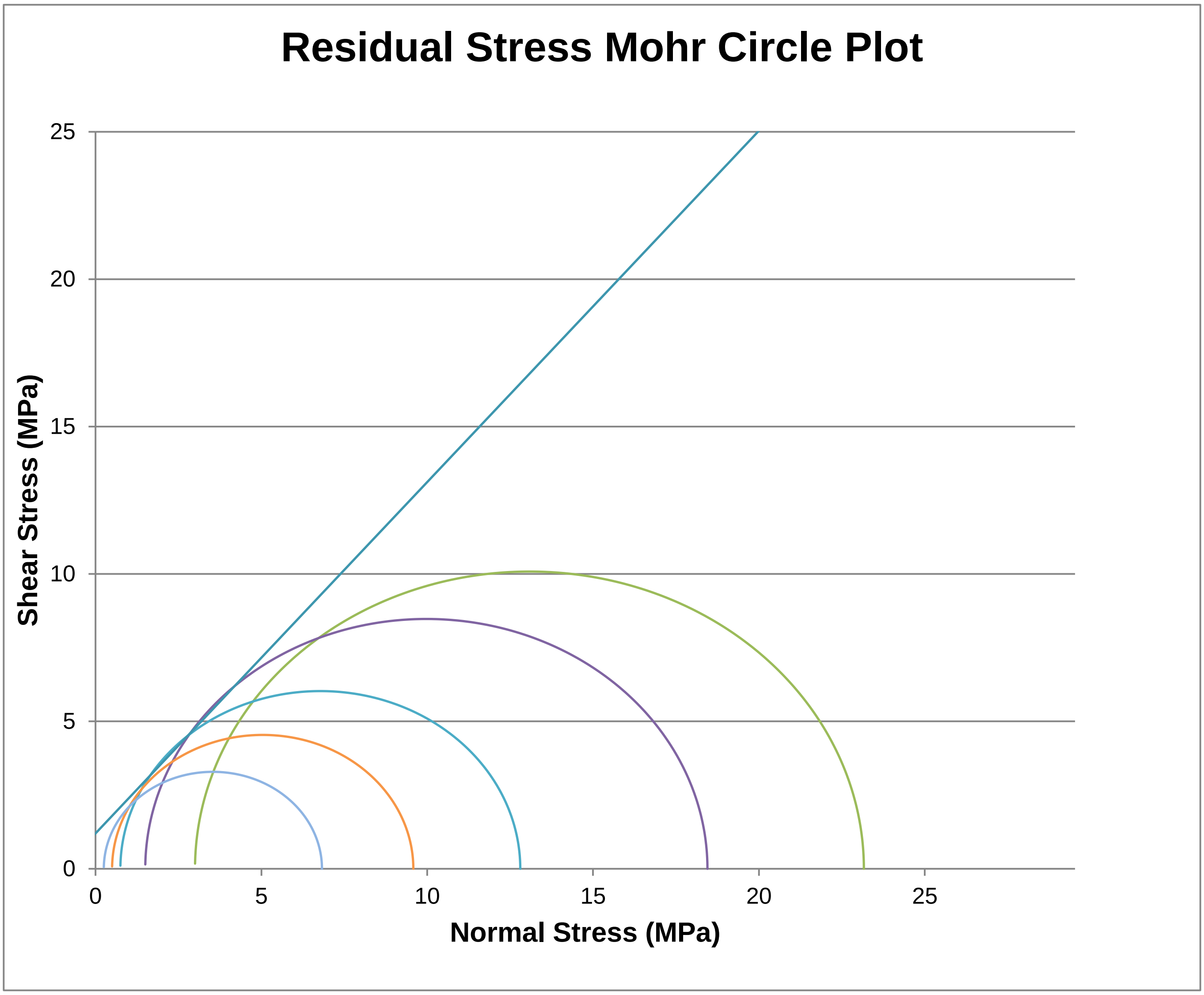
TRIAXIAL PROPERTIES OF A ROCK

Peak Stress Mohr Circle Plot



Estimated Peak Envelope	
Angle	48.5 °
Cohesion	0.8 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5356A

TRIAXIAL PROPERTIES OF A ROCK



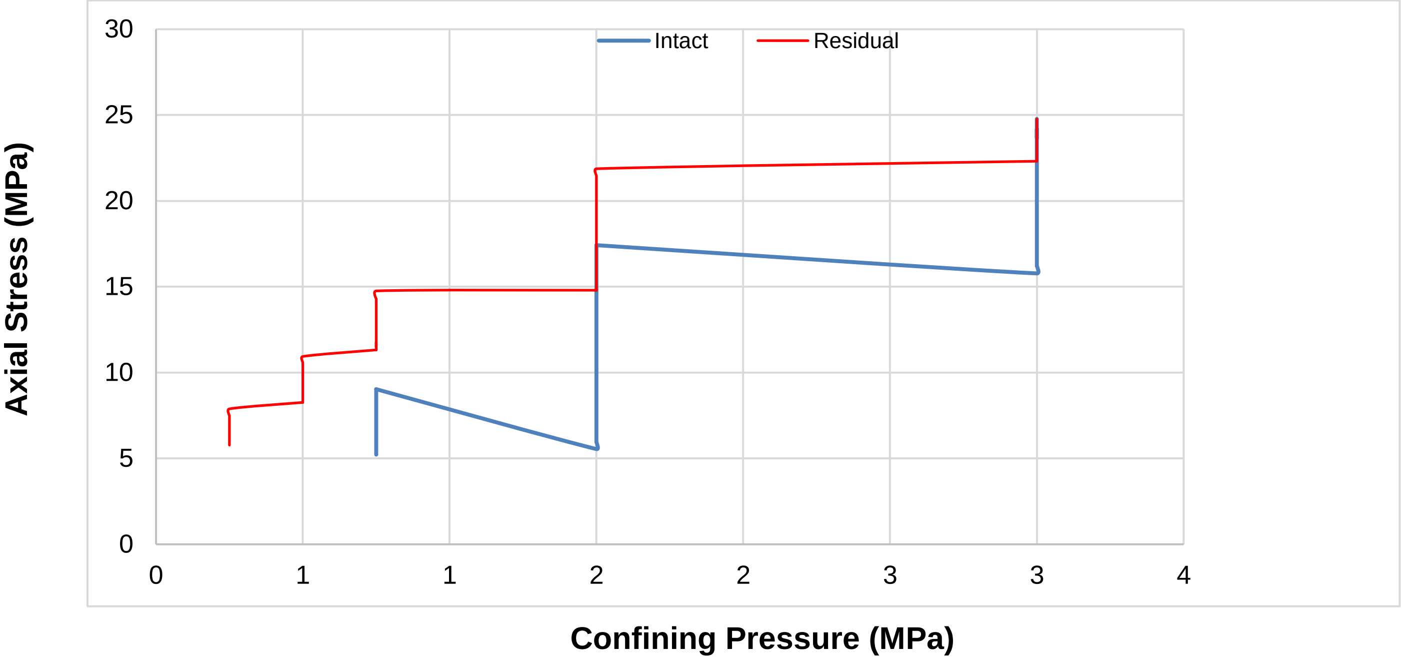
Estimated Residual Envelope	
Angle	50.0 °
Cohesion	1.2 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5356A

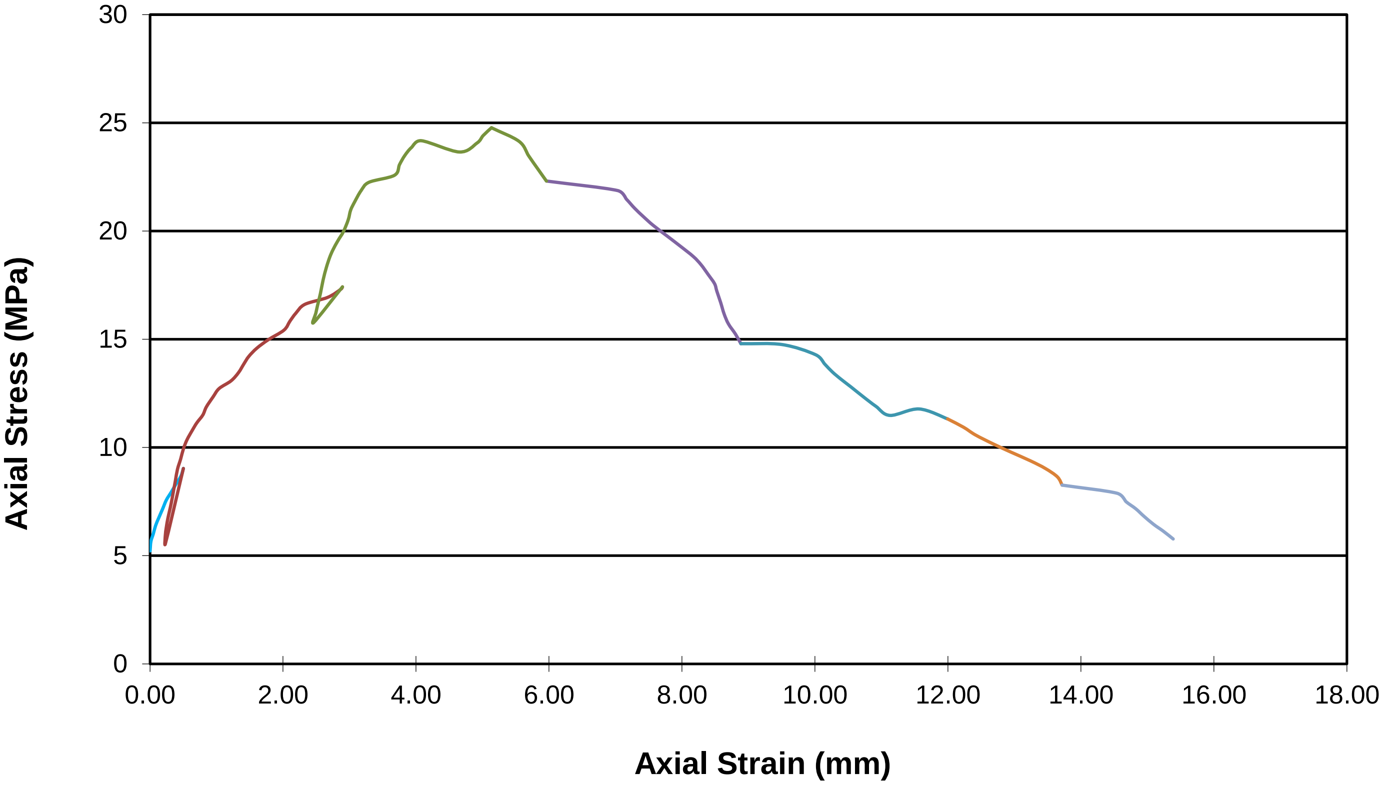
TRIAXIAL PROPERTIES OF A ROCK

Sheet 4 of 7

Mackay Laboratory

LAB REF NO: 19-5356A





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GEO-QF-GR 105 G
(07/17)

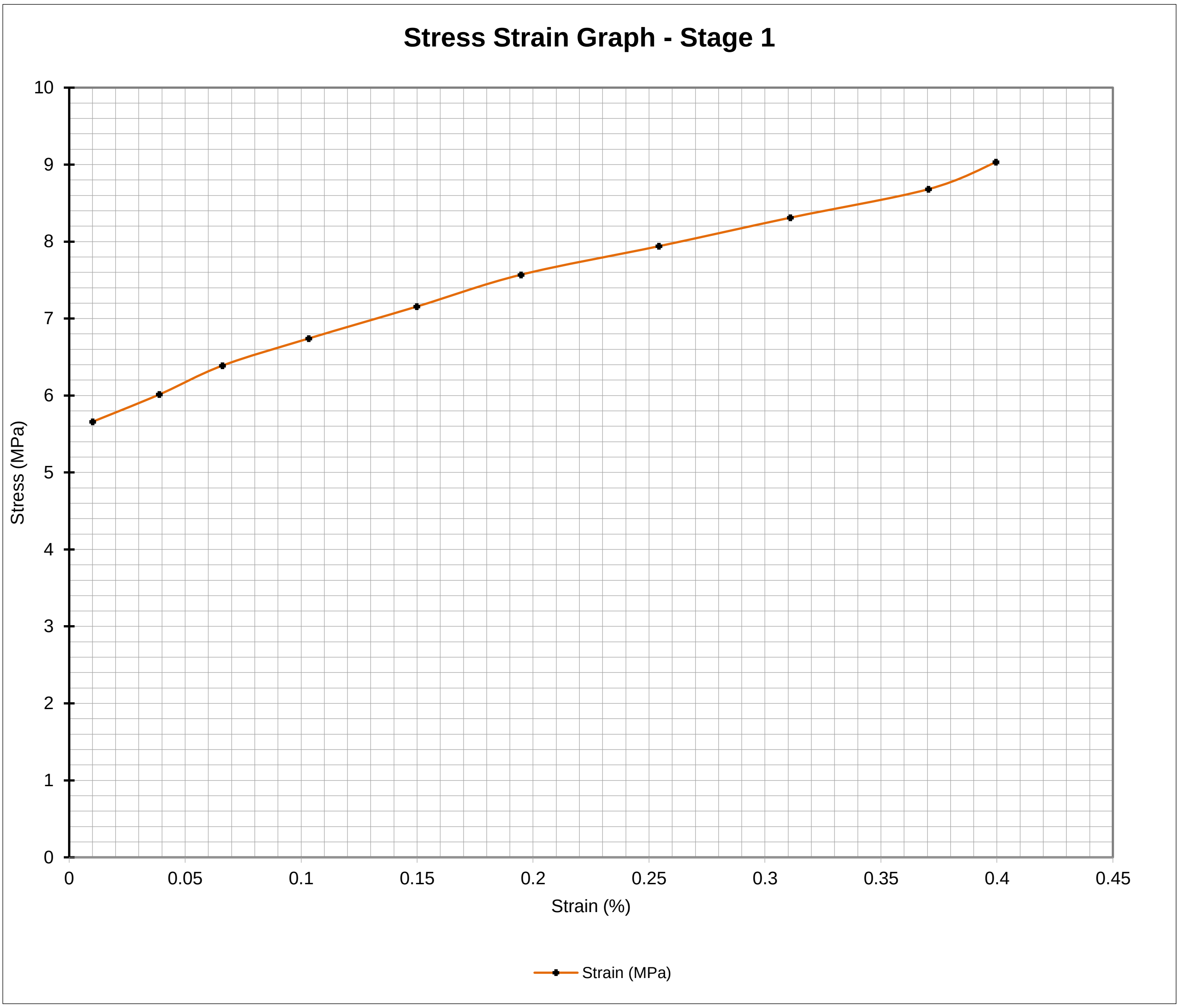
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5356A



TRIAXIAL PROPERTIES OF A ROCK

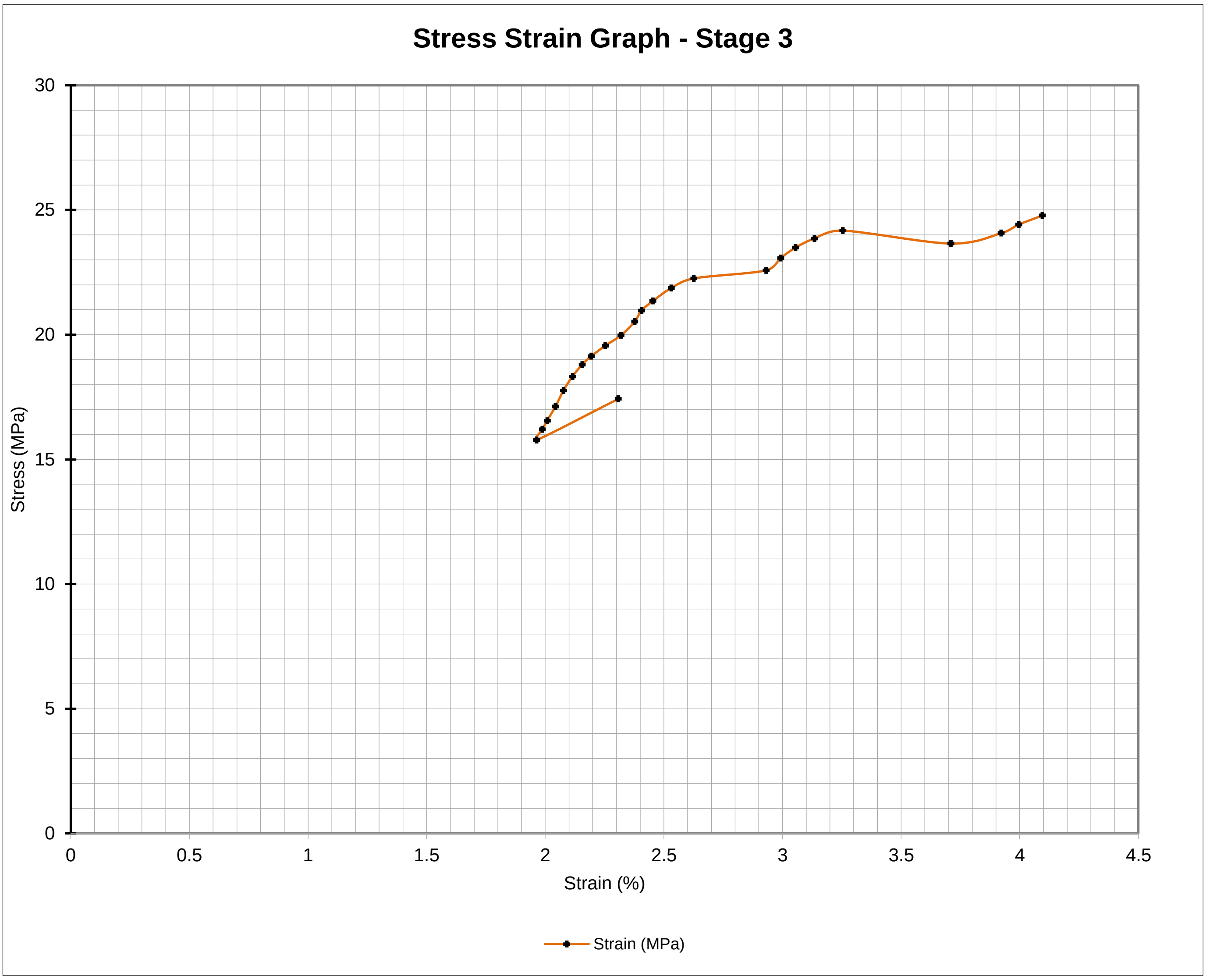
LAB REF NO: 19-5356A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5356A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

GEO-QF-GR 105 G
(07/17)

Sheet 1 of 7

Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5371A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Carbonaceous Siltstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

		Sample Details			
		Borehole:	STX1903G	**Sample number:**	UCS-49
		Depth from (m):	50.67	**Depth to (m):**	50.93
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	125.3		
Measurement:	Displacement Transducer	**Diameter (mm):**	60.9		
		Moisture Content (%):	3.1		
Rate of Loading (MPa/min):	14.30	**Mass of Sample (g):**	867.6		
Time to Failure (min):	4.02	**Dry Density (t/m3):**	2.31		
Test Duration (min):	4.18	**Wet Density (t/m3):**	2.38		

Intact Strength			
	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	18.7	0.48
Stage 2	1.5	24.4	0.75
Stage 3	3	32.4	1.02
Residual Strength			
	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1	3	30.6	
Residual Stress 2	1.5	24.7	
Residual Stress 3	0.75	15.8	
Residual Stress 4	0.5	12.5	
Residual Stress 5	0.25	10.2	

Dominant structural features with respect to core axis

Before Photo	**After Photo**	**Failure Diagram**
		

Comments: Testing was done at Room Temperature.

NATA
WORLD RECOGNISED
ACCREDITATION

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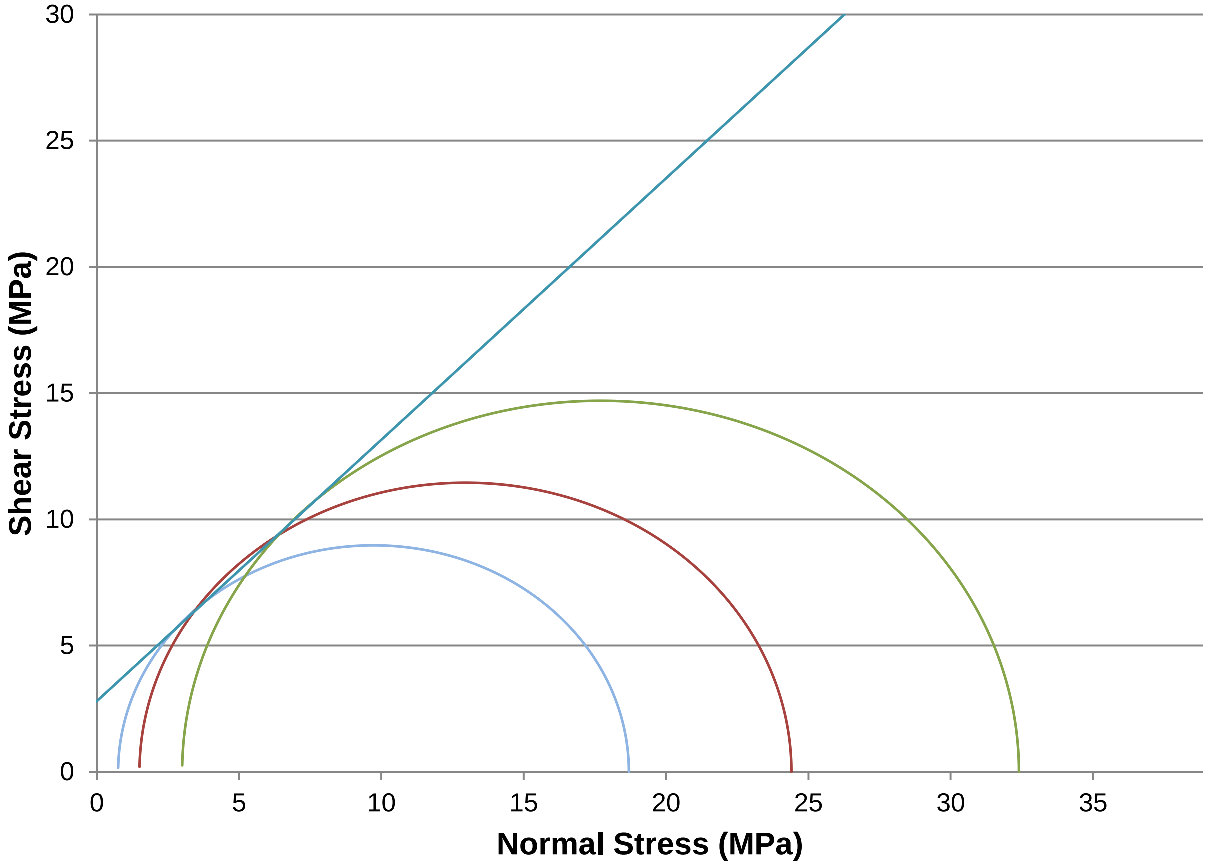
APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

Peak Stress Mohr Circle Plot

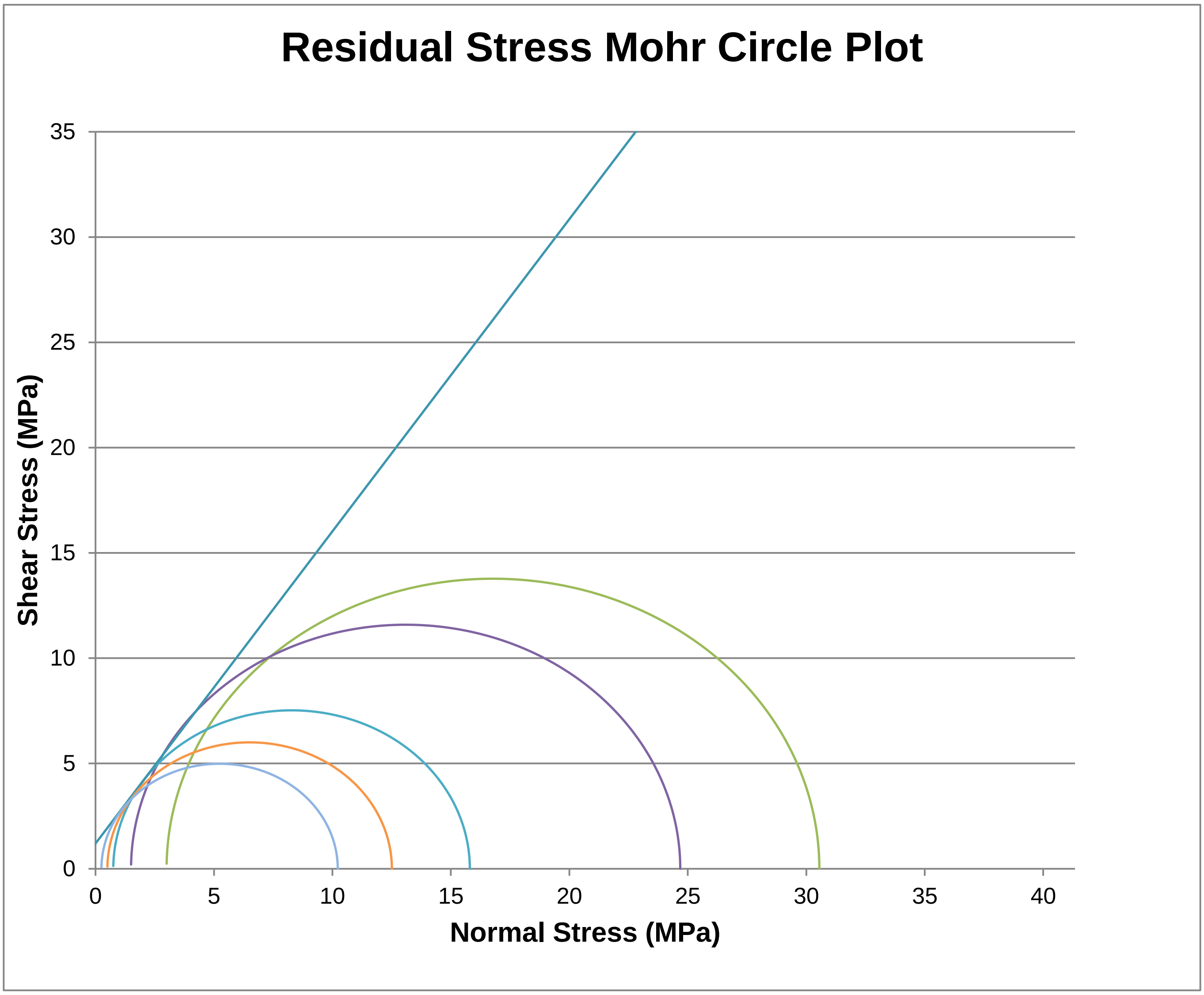


Estimated Peak Envelope	
Angle	46.0 °
Cohesion	2.8 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5371A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK



Estimated Residual Envelope	
Angle	56.0 °
Cohesion	1.2 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5371A

CARDNO (QLD) PTY LTD

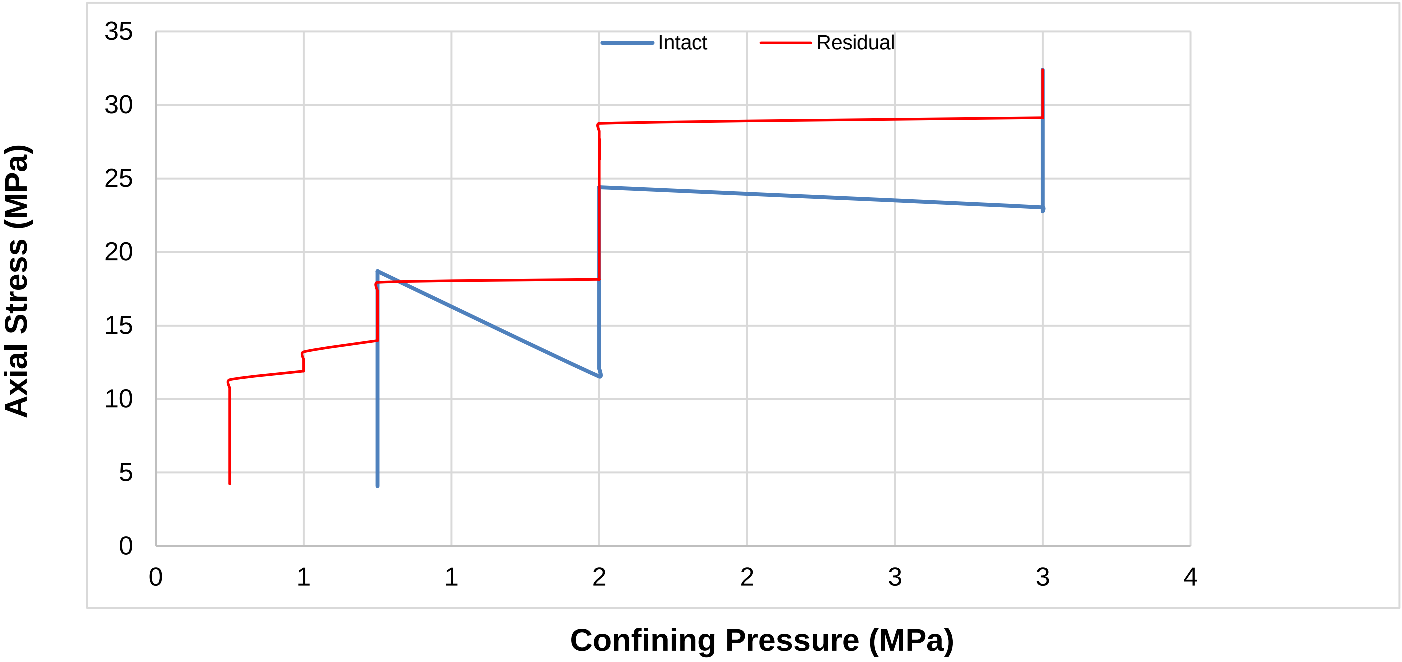
71 MAGGIOLO DRIVE MACKAY QLD

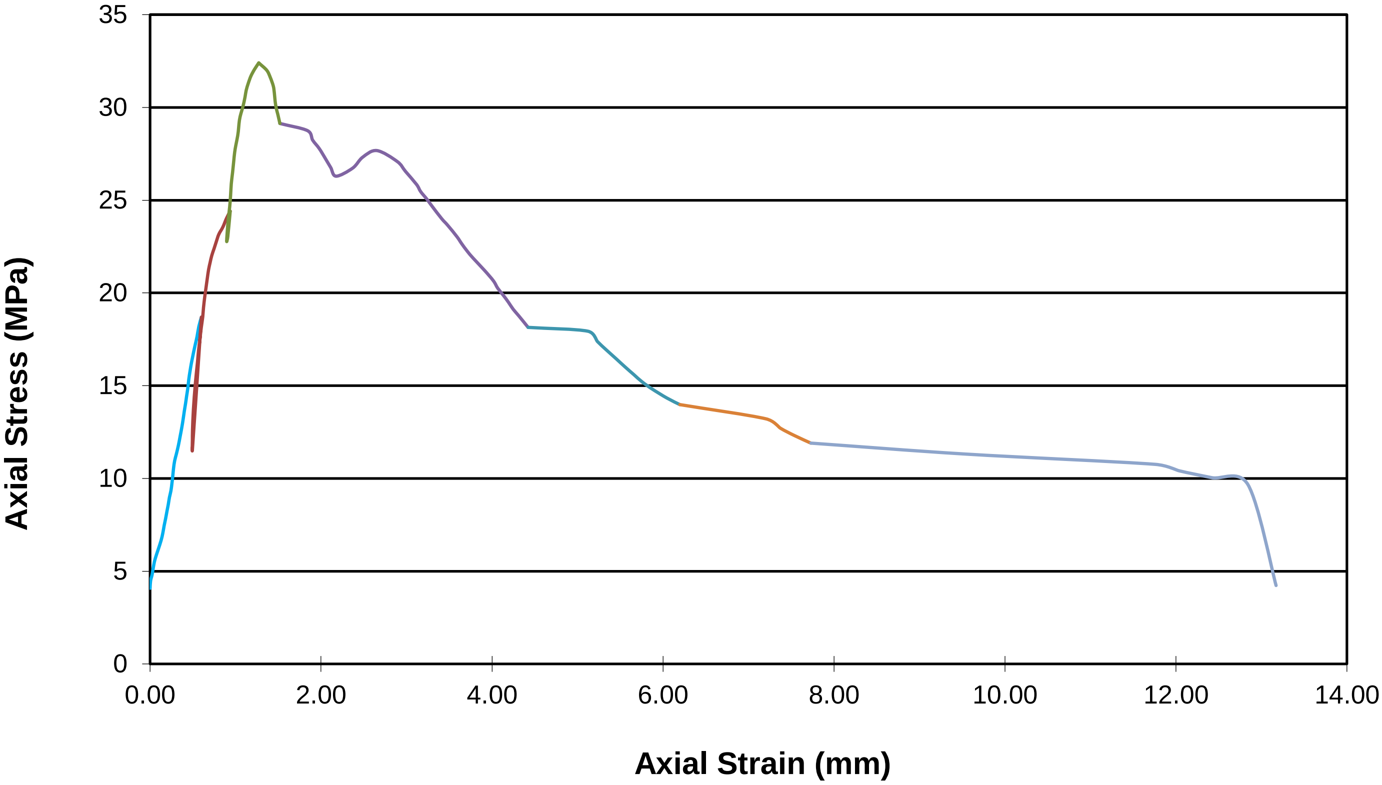
TRIAXIAL PROPERTIES OF A ROCK

Sheet 4 of 7

Mackay Laboratory

LAB REF NO: 19-5371A



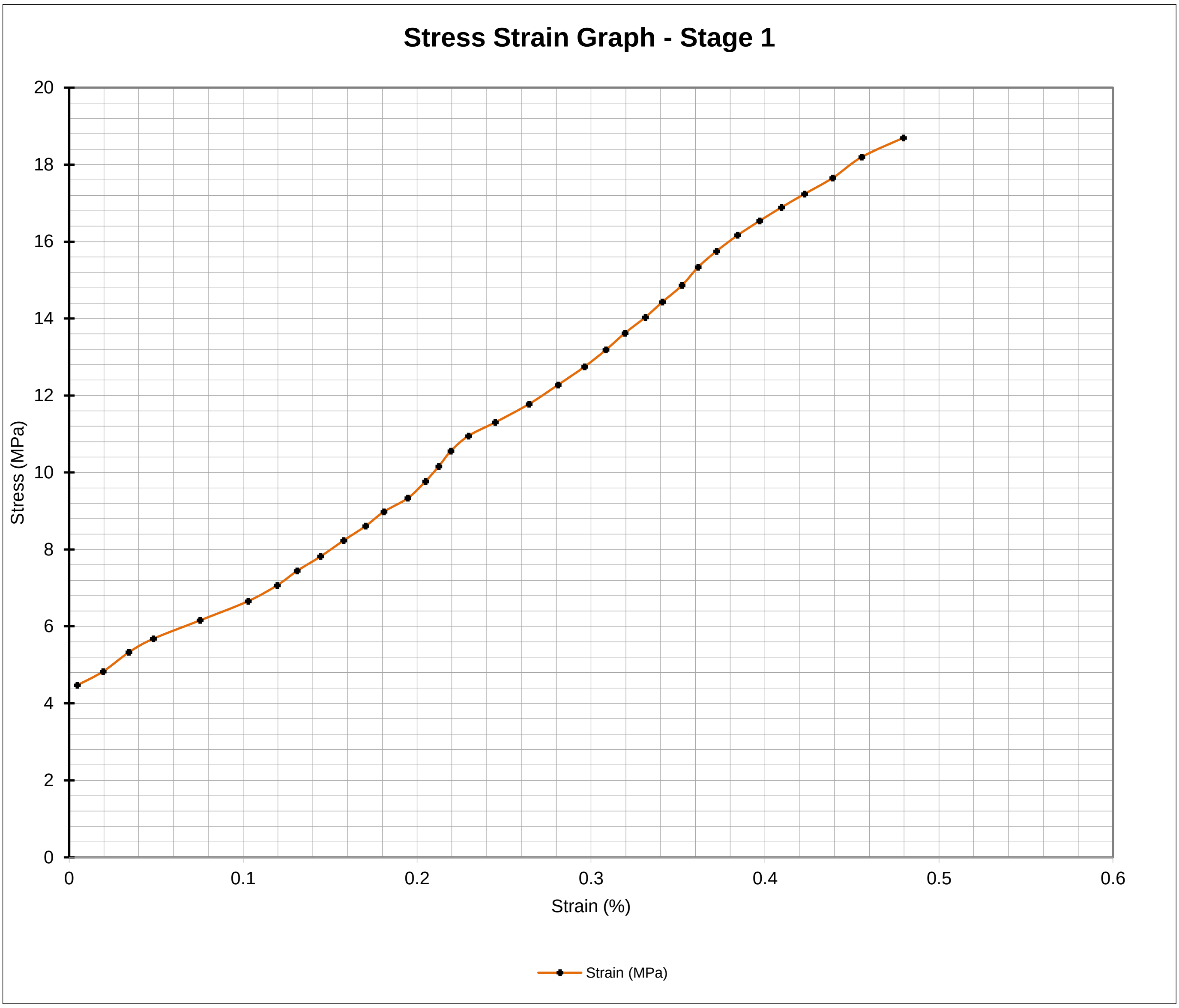


CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

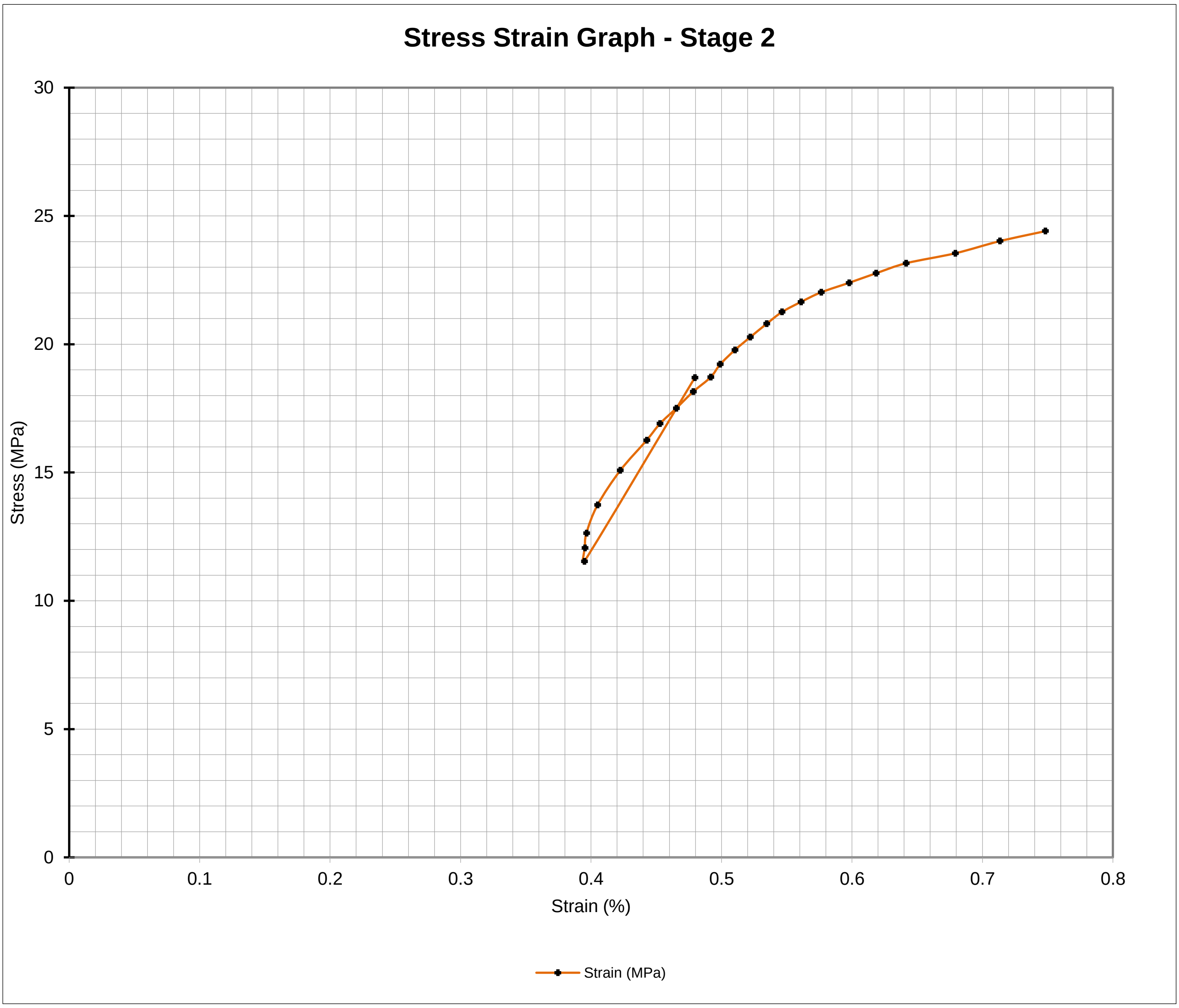
TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5371A



TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5371A



CARDNO (QLD) PTY LTD

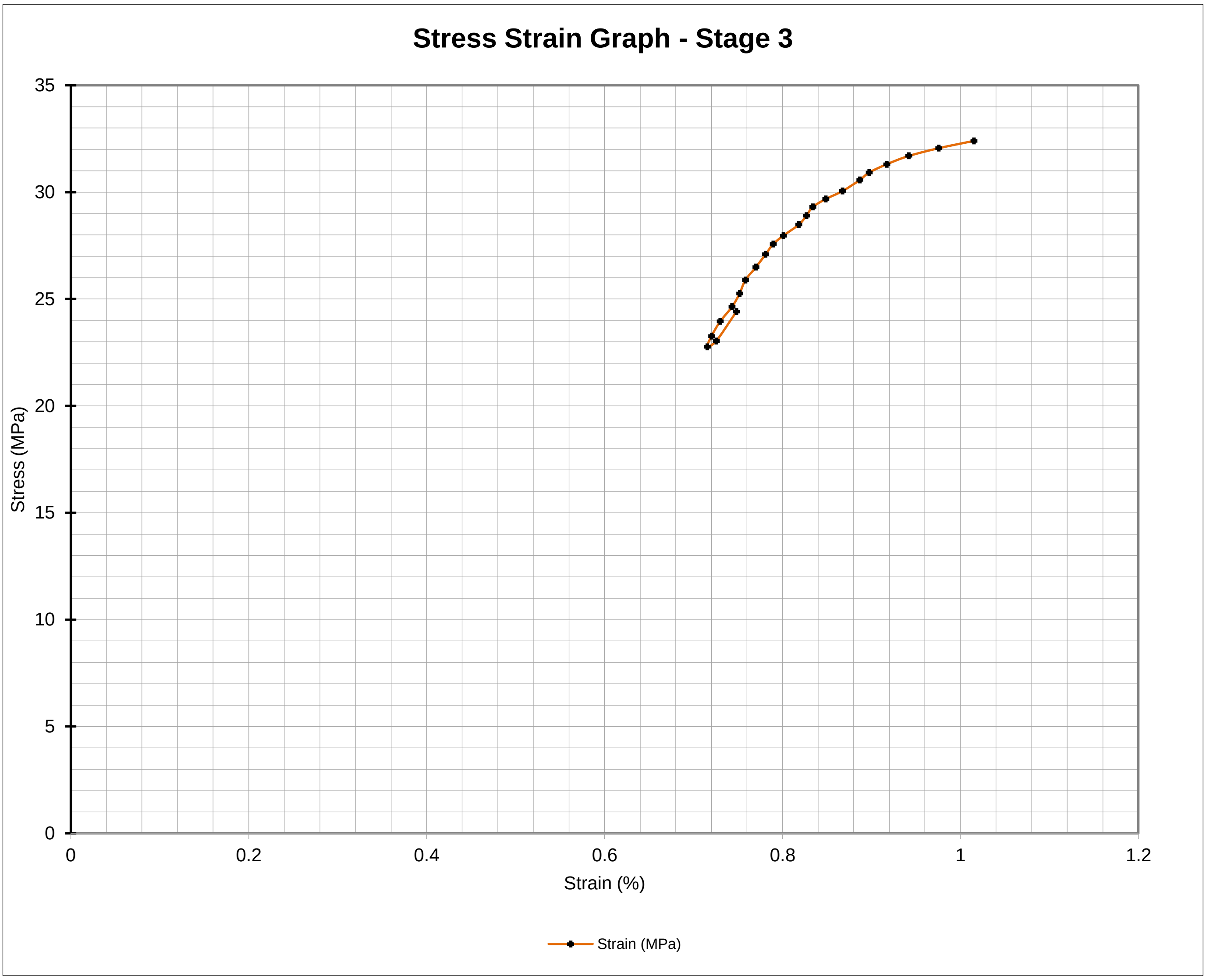
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 7 of 7

Mackay Laboratory

LAB REF NO: 19-5371A



GEO-QF-GR 105 G
(07/17)

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 7 Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5420A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Sandstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

		Sample Details			
		Borehole:	STX1903G	**Sample number:**	UCS-98
		Depth from (m):	89.91	**Depth to (m):**	90.11
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	126.6		
Measurement:	Displacement Transducer	**Diameter (mm):**	61.0		
		Moisture Content (%):	3.0		
Rate of Loading (MPa/min):	20.01	**Mass of Sample (g):**	918.7		
Time to Failure (min):	3.45	**Dry Density (t/m3):**	2.41		
Test Duration (min):	4.07	**Wet Density (t/m3):**	2.48		

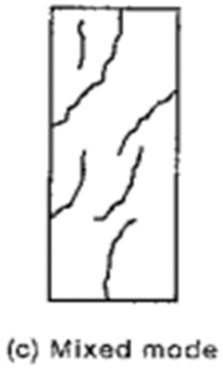
Intact Strength

	Confining Pressure (MPa)	Maximum Principal Stress (MPa):	Axial Strain (%)
Stage 1	0.75	16.8	0.34
Stage 2	1.5	30.6	0.58
Stage 3	3	51.5	1.02

Residual Strength

	Confining Pressure (MPa)	Median Axial Stress (MPa)	
Residual Stress 1	3	39.3	
Residual Stress 2	1.5	25.0	
Residual Stress 3	0.75	17.3	
Residual Stress 4	0.5	12.6	
Residual Stress 5	0.25	8.8	

Dominant structural features with respect to core axis

Before Photo	After Photo	Failure Diagram
		

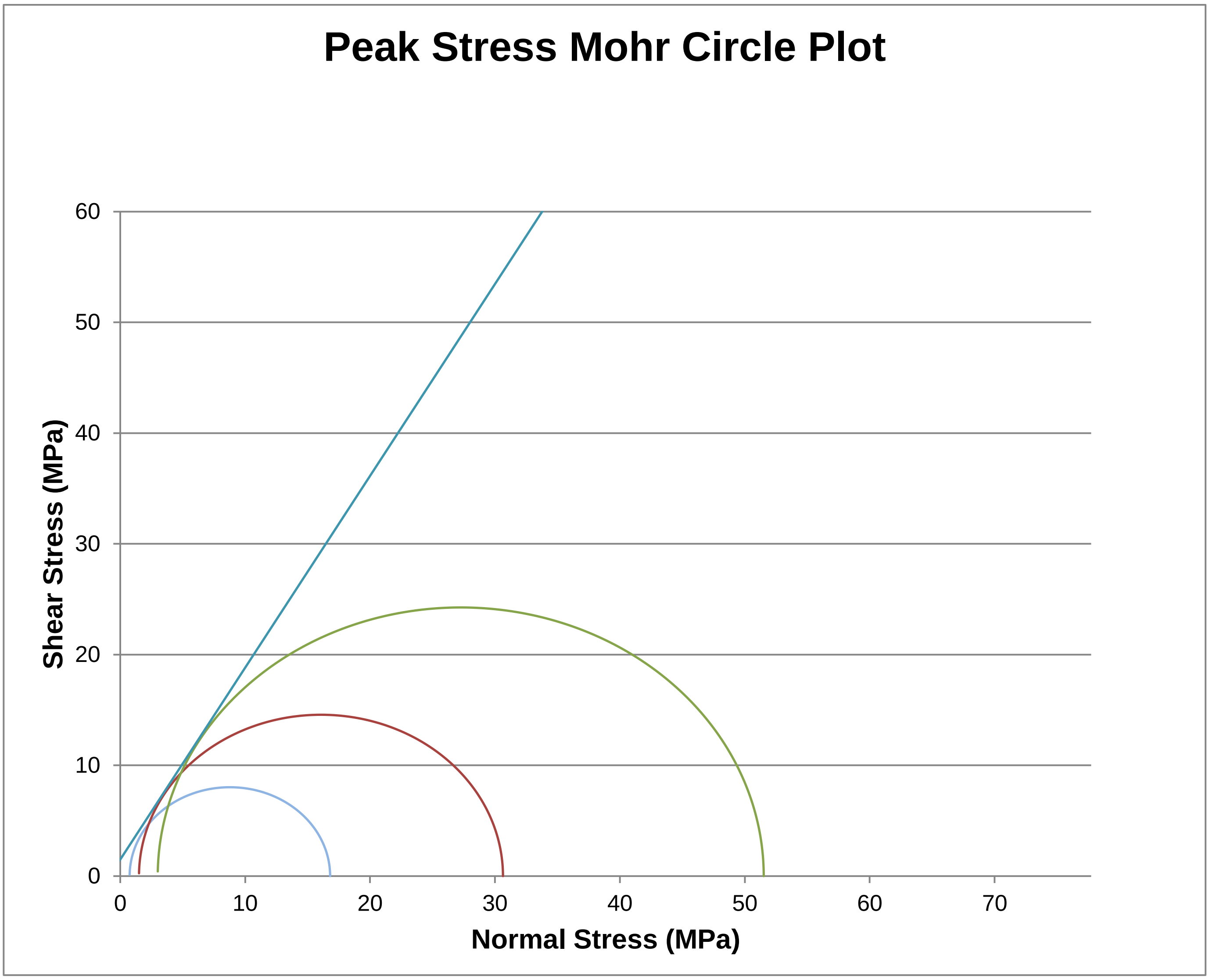
Comments: Testing was done at Room Temperature.

APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

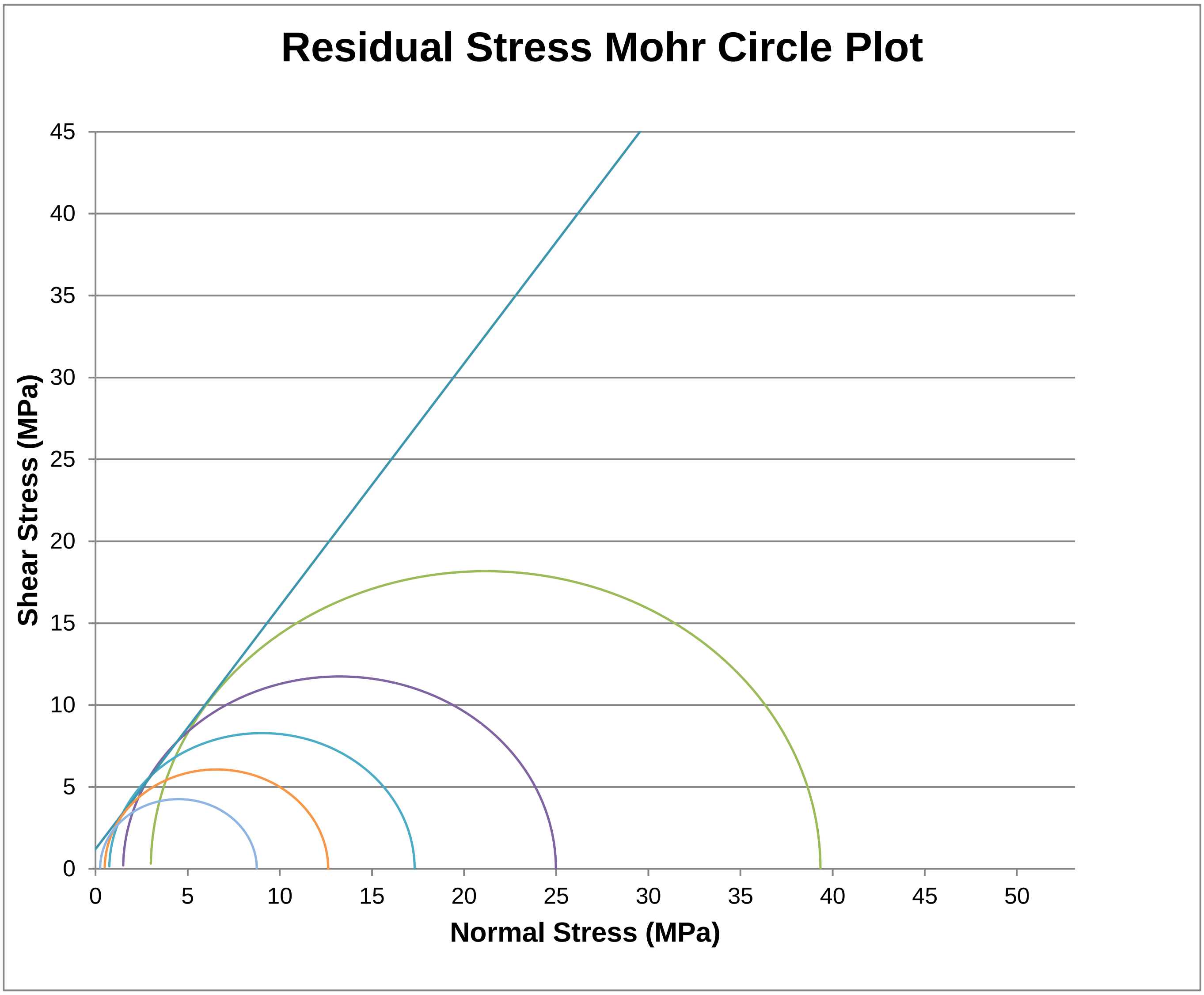
TRIAXIAL PROPERTIES OF A ROCK

Mackay Laboratory



Estimated Peak Envelope	
Angle	60.0 °
Cohesion	1.5 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5420A

TRIAXIAL PROPERTIES OF A ROCK



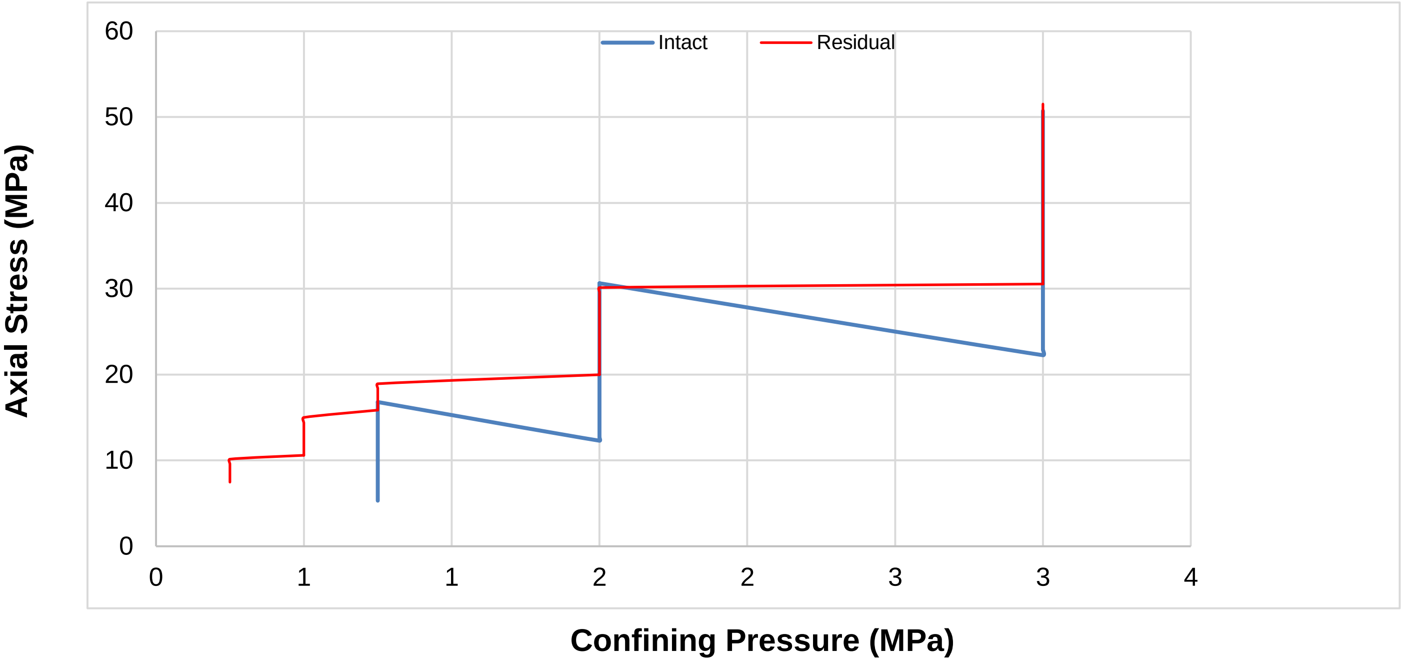
Estimated Residual Envelope	
Angle	56.0 °
Cohesion	1.2 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5420A

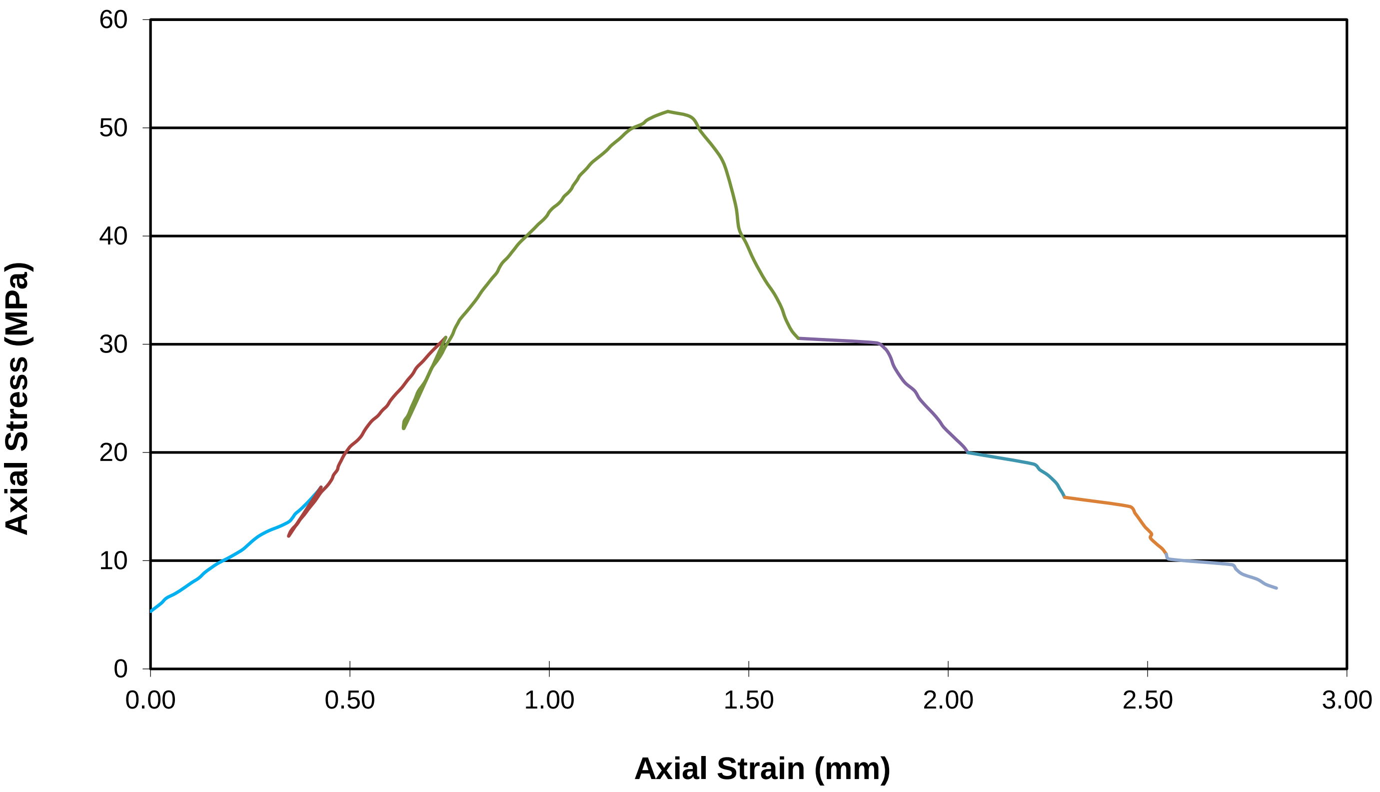
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5420A





CARDNO (QLD) PTY LTD

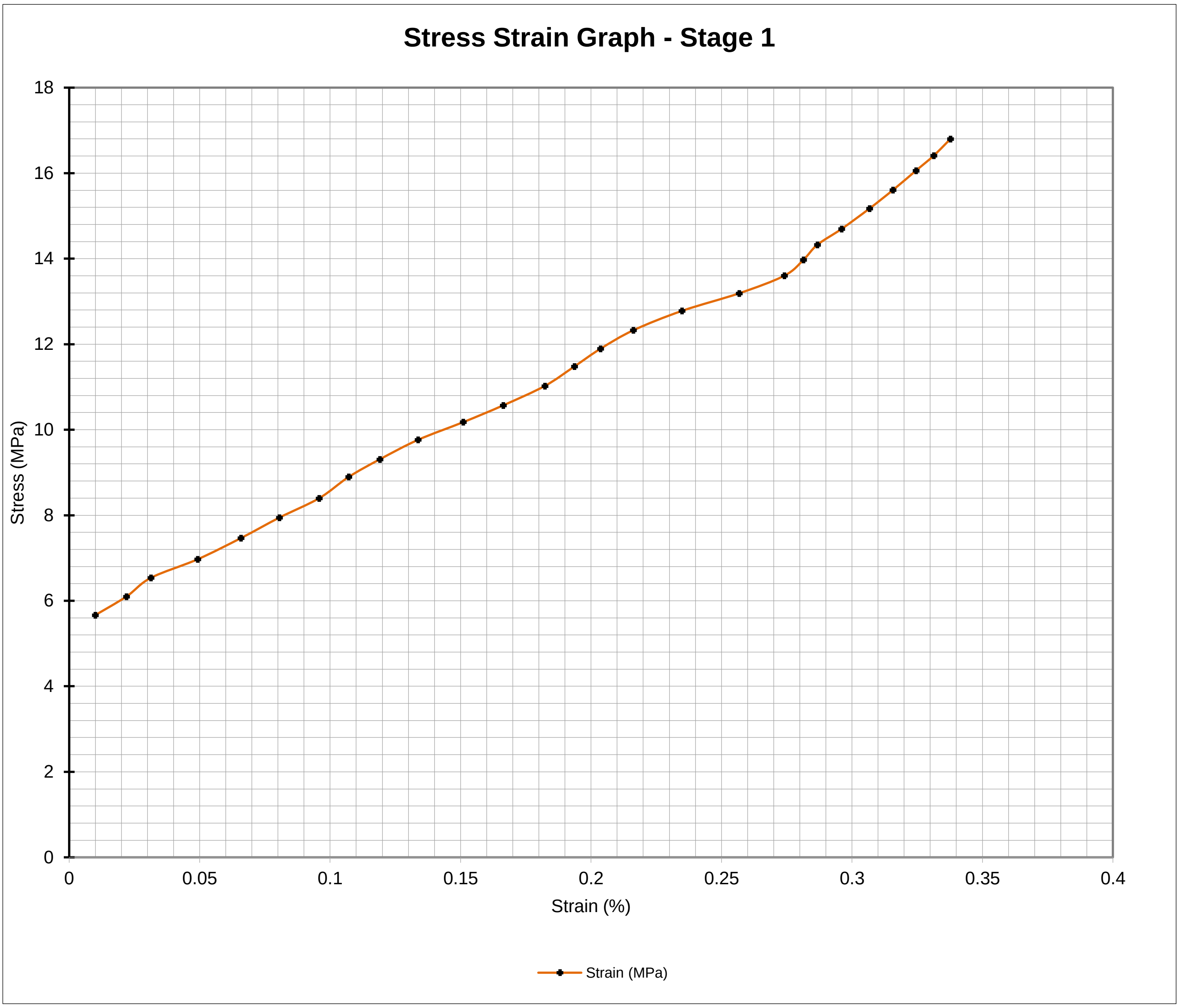
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

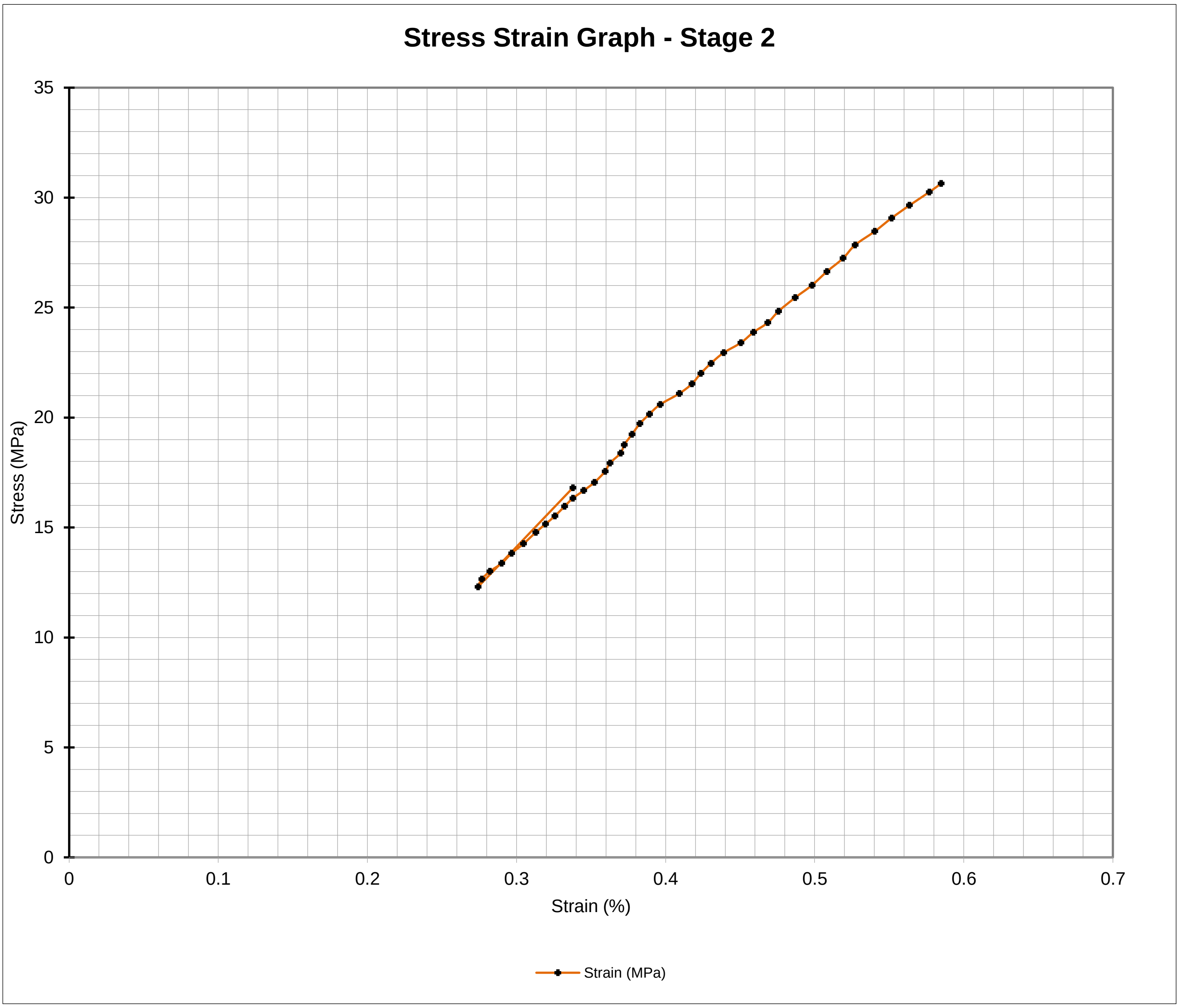
Mackay Laboratory

LAB REF NO: 19-5420A



TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5420A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

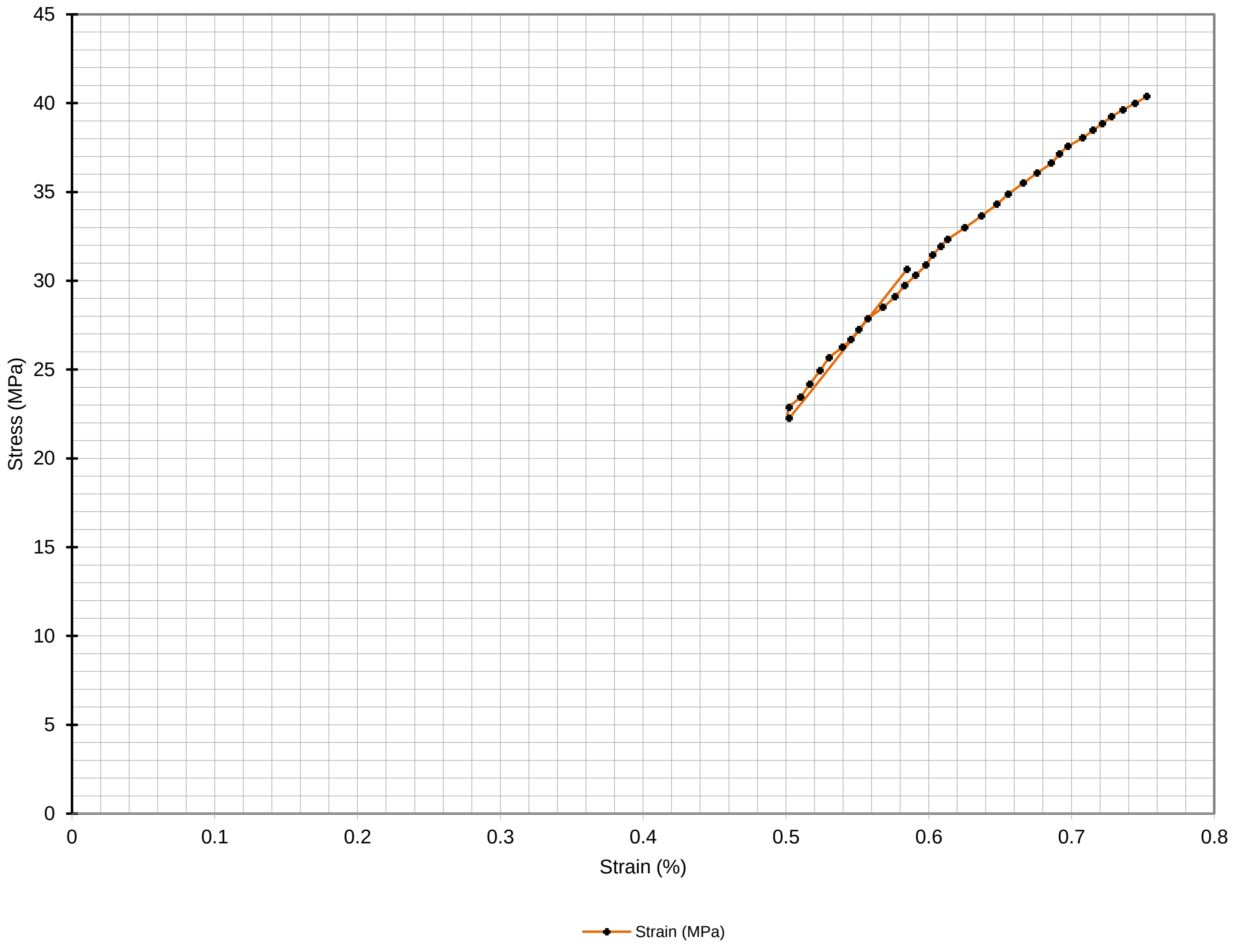
TRIAXIAL PROPERTIES OF A ROCK

Sheet 7 of 7

Mackay Laboratory

LAB REF NO: 19-5420A

Stress Strain Graph - Stage 3



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

GEO-QF-GR 105 G
(07/17)

Sheet 1 of 7

Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5443A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Interlaminated Sandstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

		Sample Details			
		Borehole:	STX1903G	**Sample number:**	UCS-121
		Depth from (m):	131.29	**Depth to (m):**	131.48
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	126.1		
Measurement:	Displacement Transducer	**Diameter (mm):**	60.9		
		Moisture Content (%):	4.5		
Rate of Loading (MPa/min):	36.02	**Mass of Sample (g):**	894.7		
Time to Failure (min):	2.50	**Dry Density (t/m3):**	2.33		
Test Duration (min):	3.09	**Wet Density (t/m3):**	2.44		

Intact Strength

	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	30.4	0.55
Stage 2	1.5	43.3	0.72
Stage 3	3	53.9	2.11

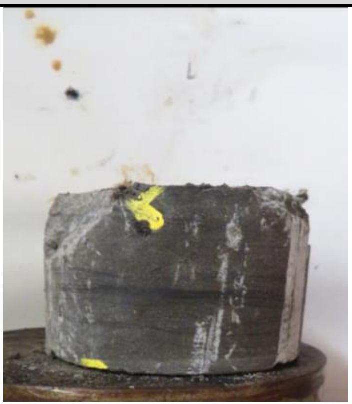
Residual Strength

	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1	3	46.3	
Residual Stress 2	1.5	38.6	
Residual Stress 3	0.75	30.1	
Residual Stress 4	0.5	25.9	
Residual Stress 5	0.25	17.7	

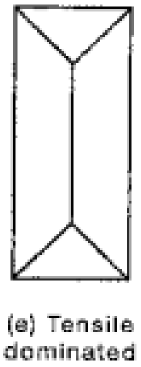
Dominant structural features with respect to core axis

Before Photo

After Photo



Failure Diagram



Comments: Testing was done at Room Temperature.

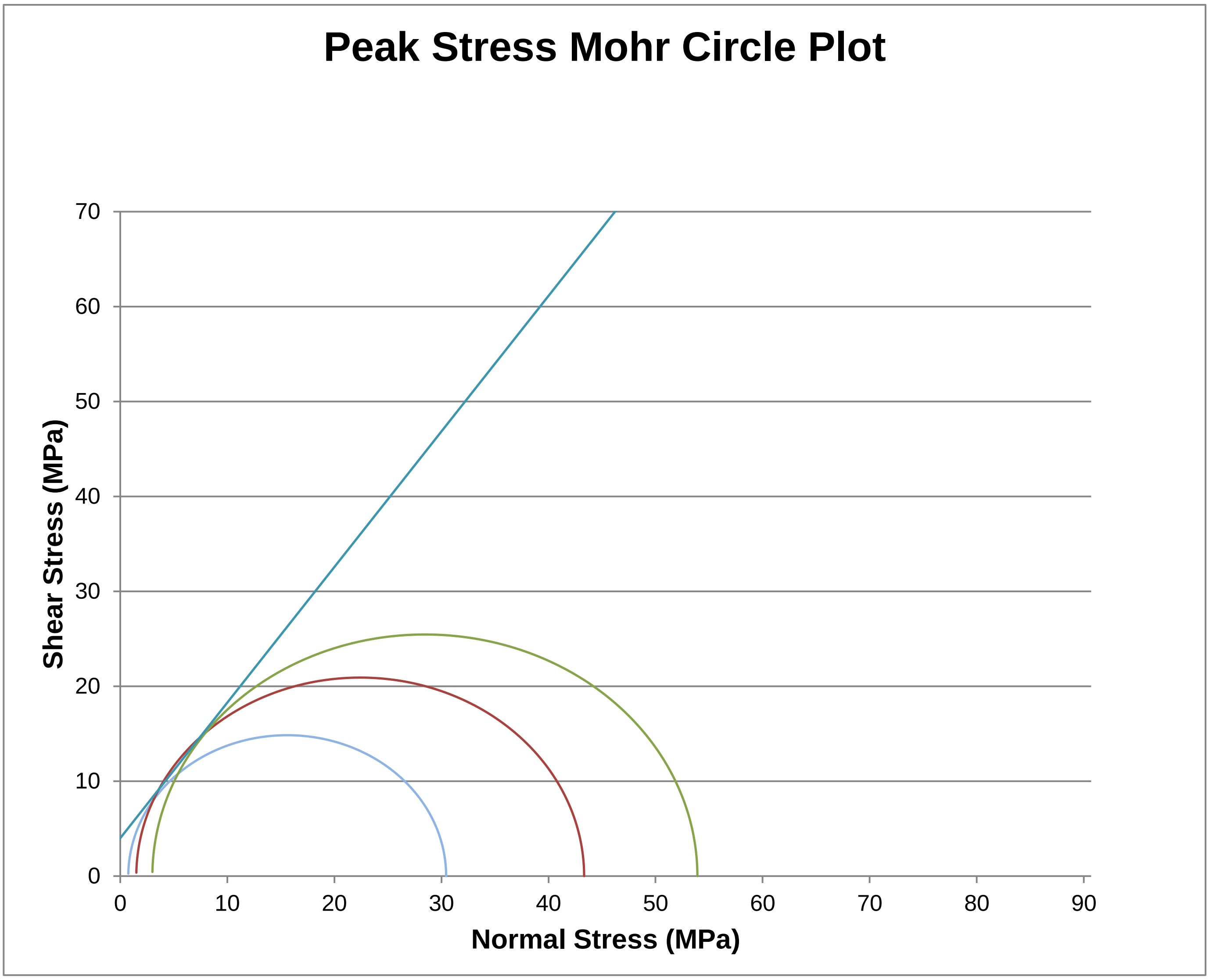
APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

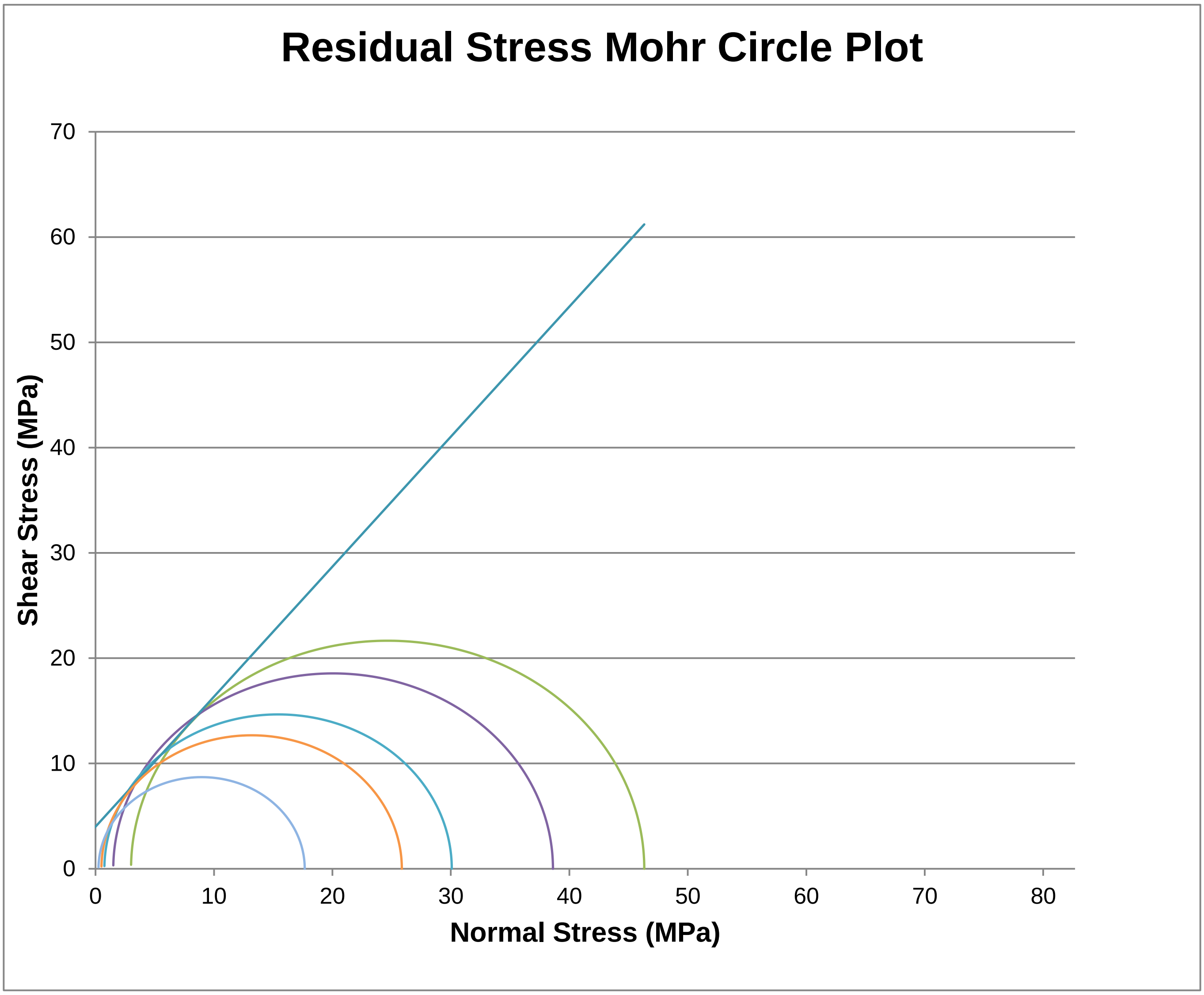


Estimated Peak Envelope	
Angle	55.0 °
Cohesion	4.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5443A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK



Estimated Residual Envelope	
Angle	51.0 °
Cohesion	4.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5443A

CARDNO (QLD) PTY LTD

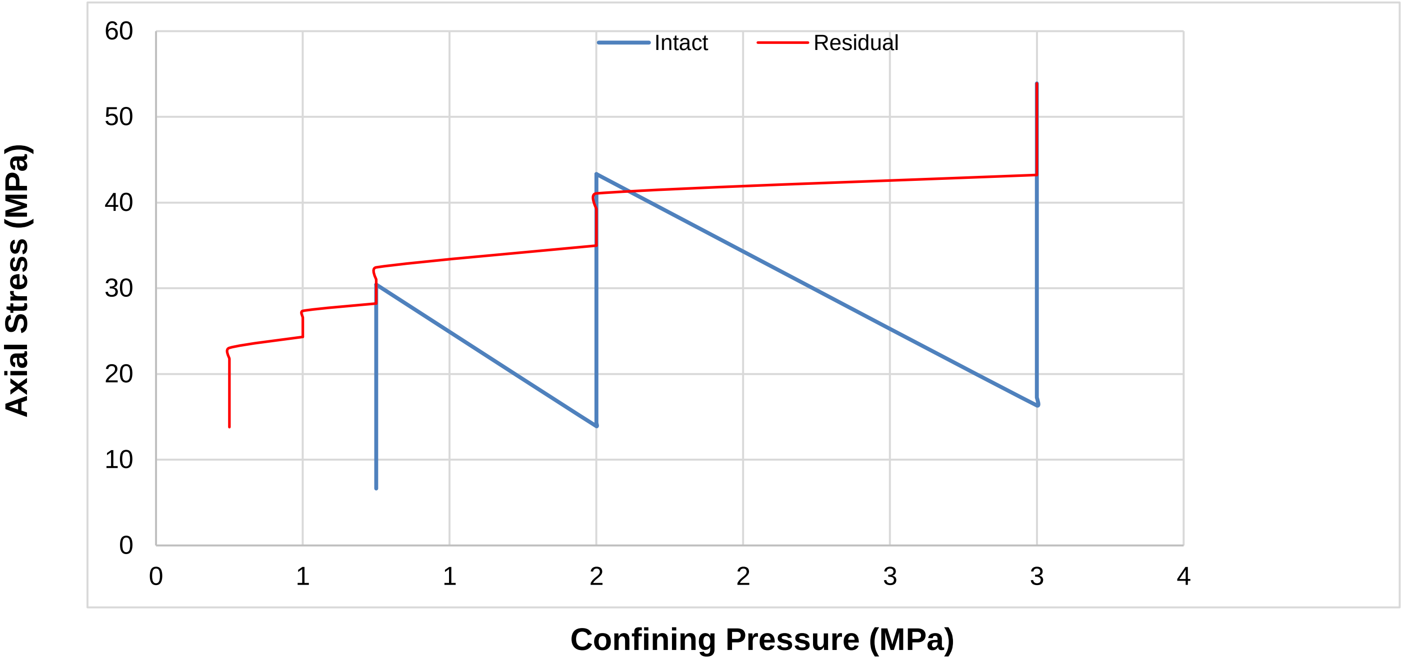
71 MAGGIOLO DRIVE MACKAY QLD

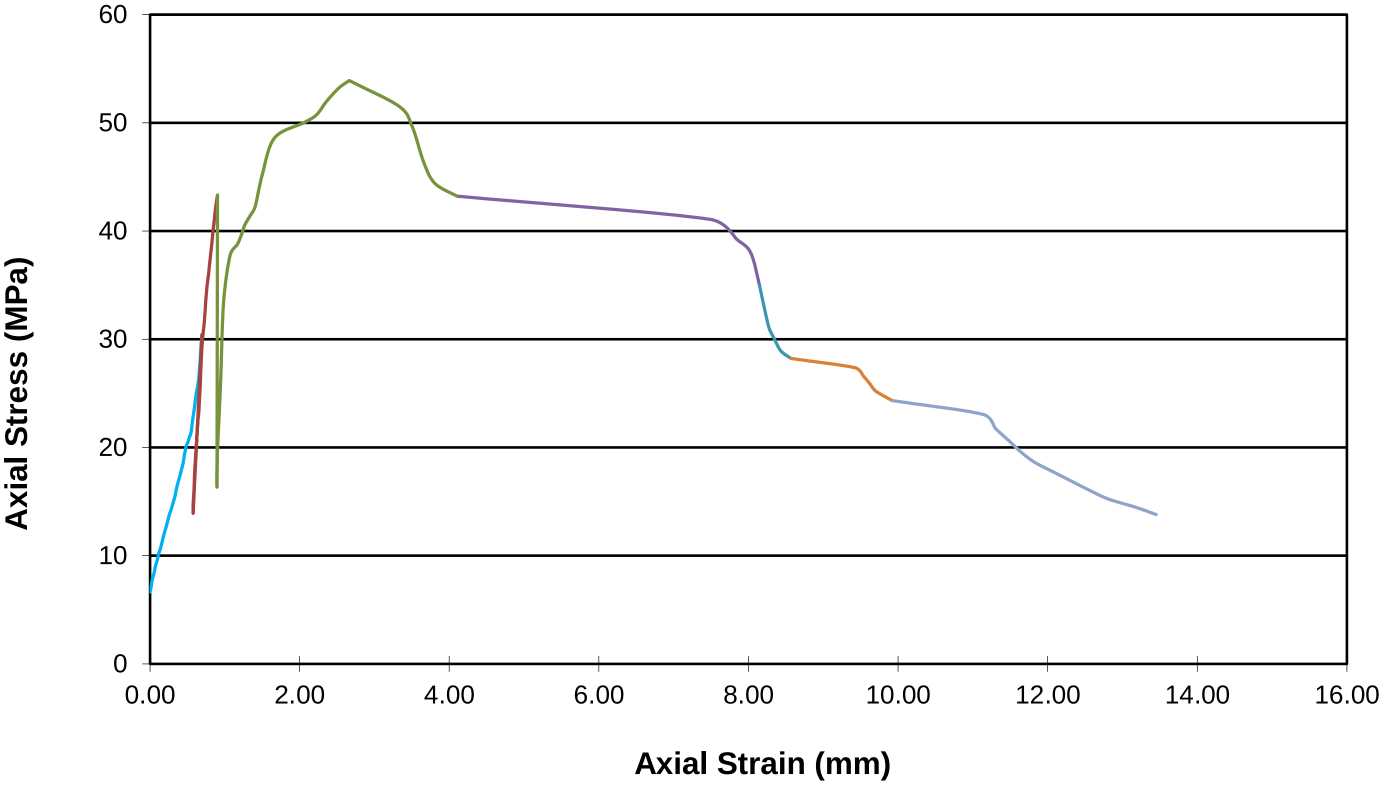
TRIAXIAL PROPERTIES OF A ROCK

Sheet 4 of 7

Mackay Laboratory

LAB REF NO: 19-5443A





CARDNO (QLD) PTY LTD

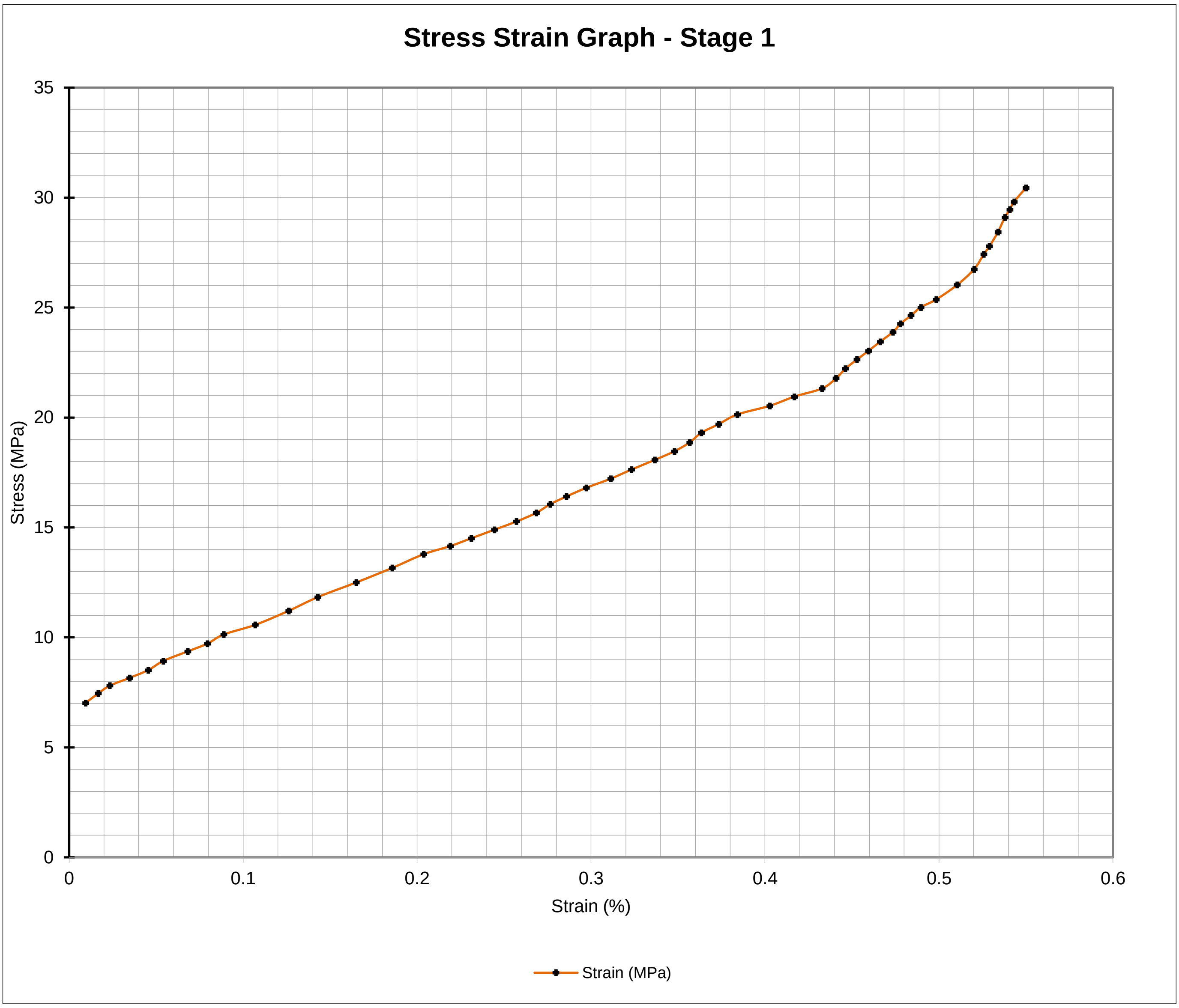
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5443A



CARDNO (QLD) PTY LTD

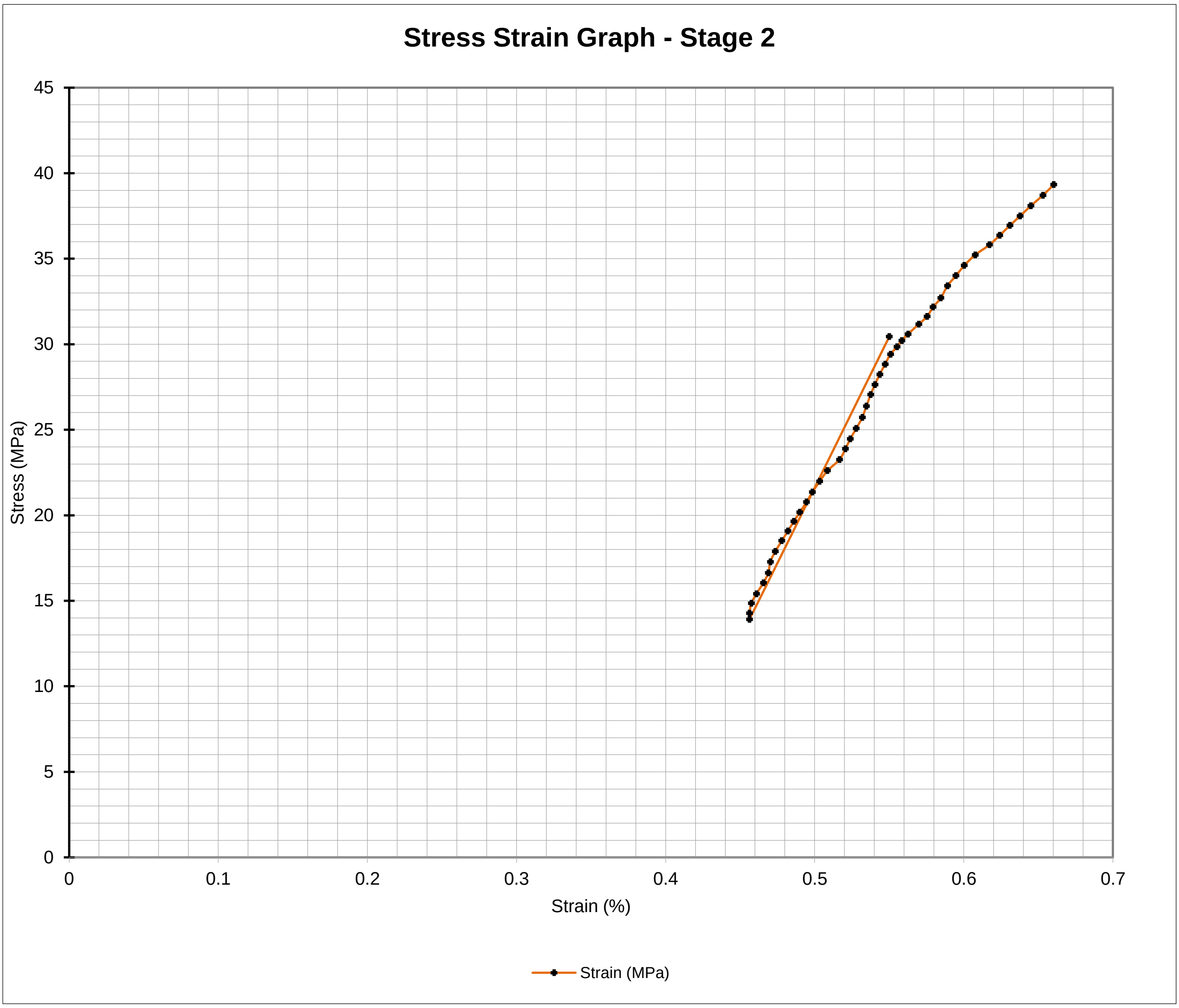
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 6 of 7

Mackay Laboratory

LAB REF NO: 19-5443A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

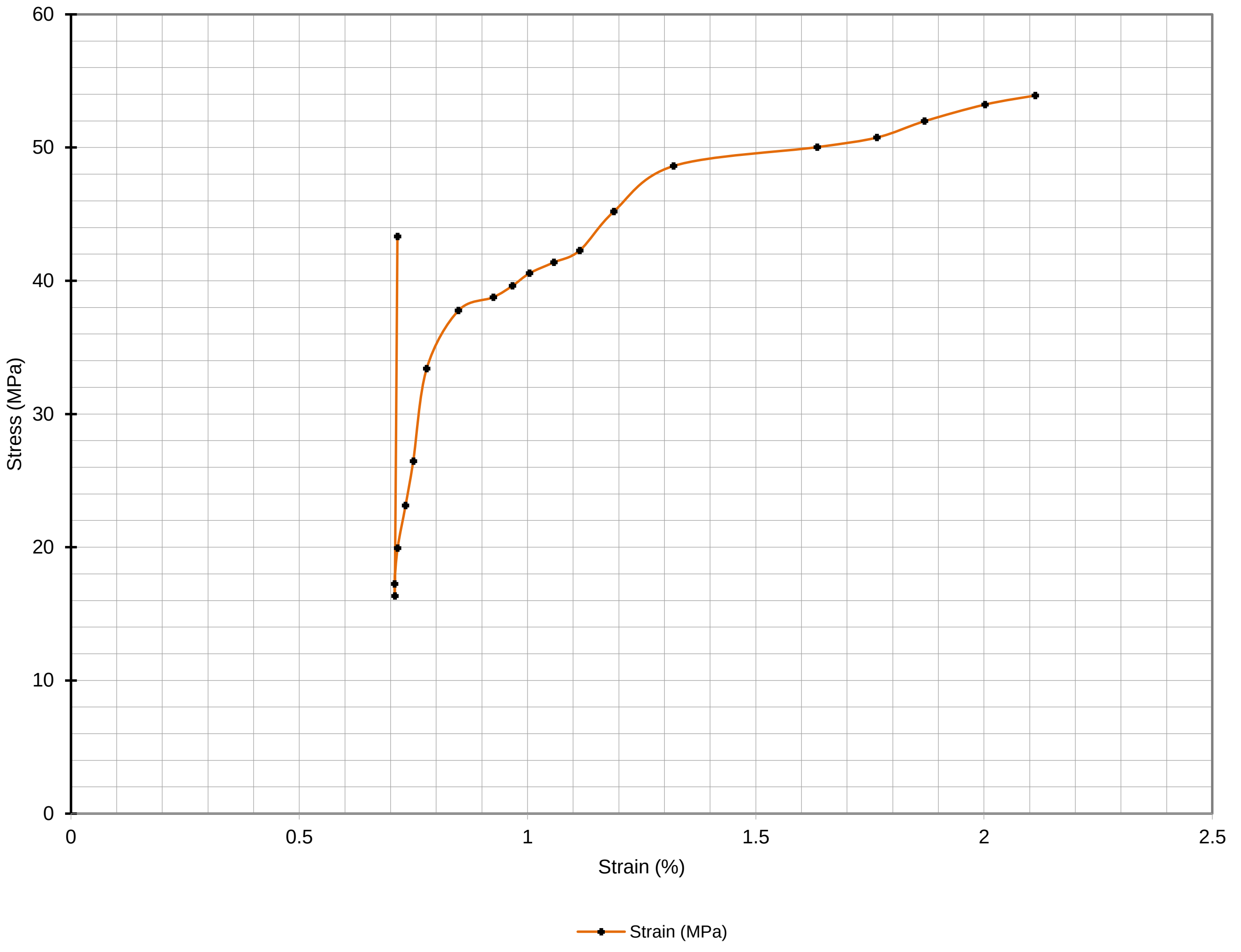
GEO-QF-GR 105 G
(07/17)

Sheet 7 of 7

Mackay Laboratory

LAB REF NO: 19-5443A

Stress Strain Graph - Stage 3



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 7 Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5447A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Interlaminated Sandstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	D7012-14 Method A; D4543			**CLIENT REF:**	-

Seam: -

		Sample Details	
		Borehole: STX1903G	**Sample number:** UCS-125
		Depth from (m): 132.92	**Depth to (m):** 133.10
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	125.8
Measurement:	Displacement Transducer	**Diameter (mm):**	61.0
		Moisture Content (%):	2.2
Rate of Loading (MPa/min):	22.21	**Mass of Sample (g):**	921.3
Time to Failure (min):	3.05	**Dry Density (t/m3):**	2.45
Test Duration (min):	3.29	**Wet Density (t/m3):**	2.51

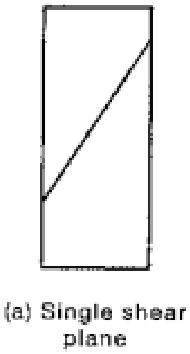
Intact Strength

	Confining Pressure (MPa)	Maximum Principal Stress (MPa):	Axial Strain (%)
Stage 1	0.75	32.5	0.45
Stage 2	1.5	57.6	0.66
Stage 3	3	64.9	3.05

Residual Strength

	Confining Pressure (MPa)	Median Axial Stress (MPa)	
Residual Stress 1	3	19.1	
Residual Stress 2	1.5	14.2	
Residual Stress 3	0.75	11.3	
Residual Stress 4	0.5	9.5	
Residual Stress 5	0.25	7.7	

Dominant structural features with respect to core axis

Before Photo	After Photo	Failure Diagram
		

Comments: Testing was done at Room Temperature.

APPROVED SIGNATORY

T Bradbury

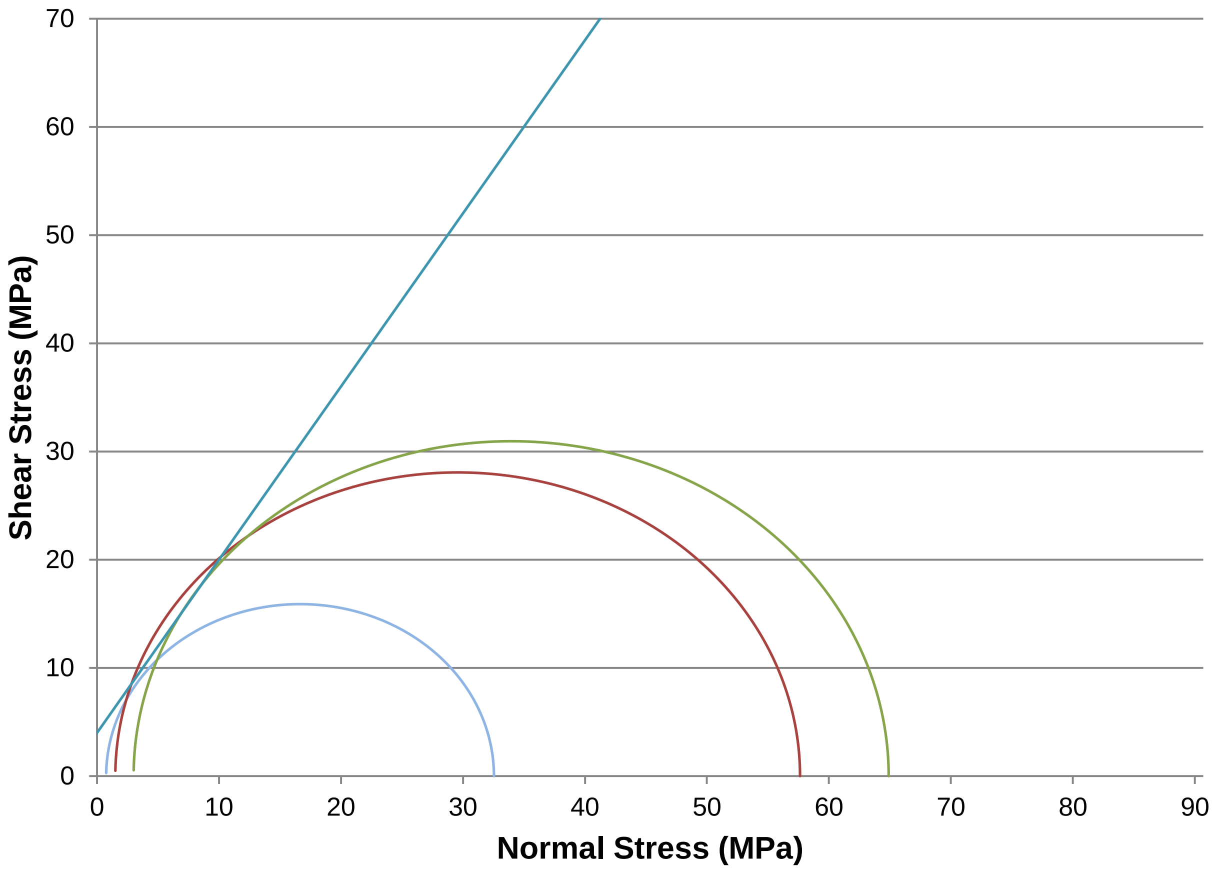
Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Peak Stress Mohr Circle Plot

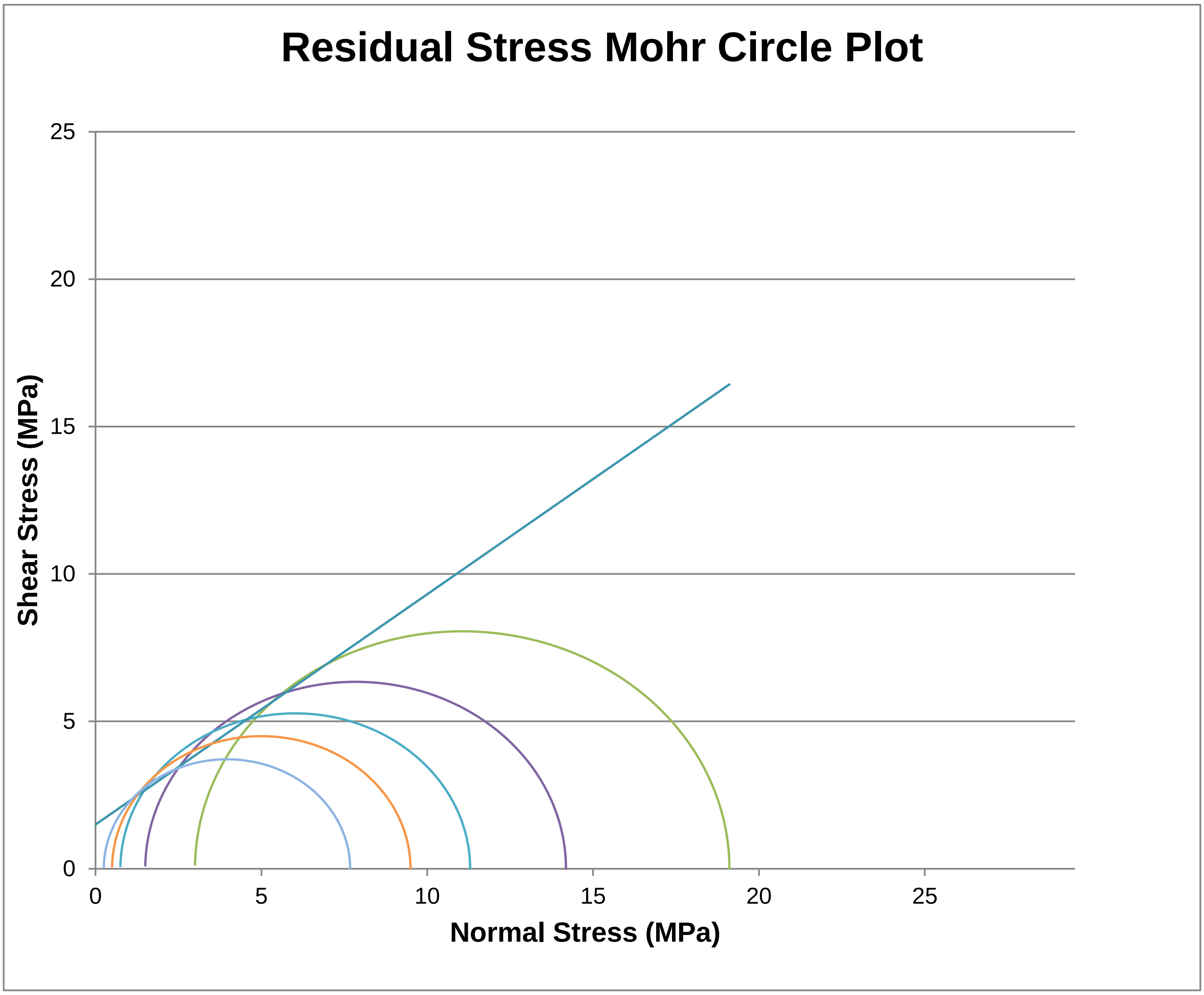


Estimated Peak Envelope	
Angle	58.0 °
Cohesion	4.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5447A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK



Estimated Residual Envelope	
Angle	38.0 °
Cohesion	1.5 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5447A

CARDNO (QLD) PTY LTD

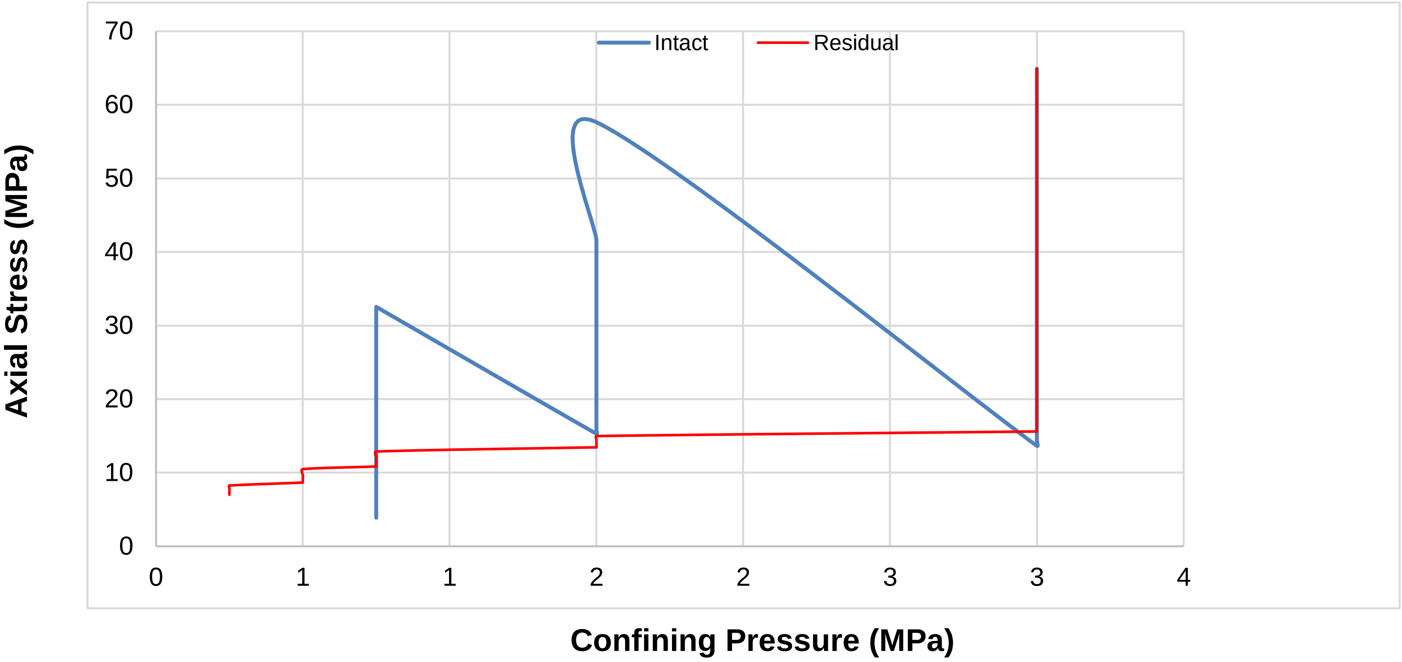
71 MAGGIOLO DRIVE MACKAY QLD

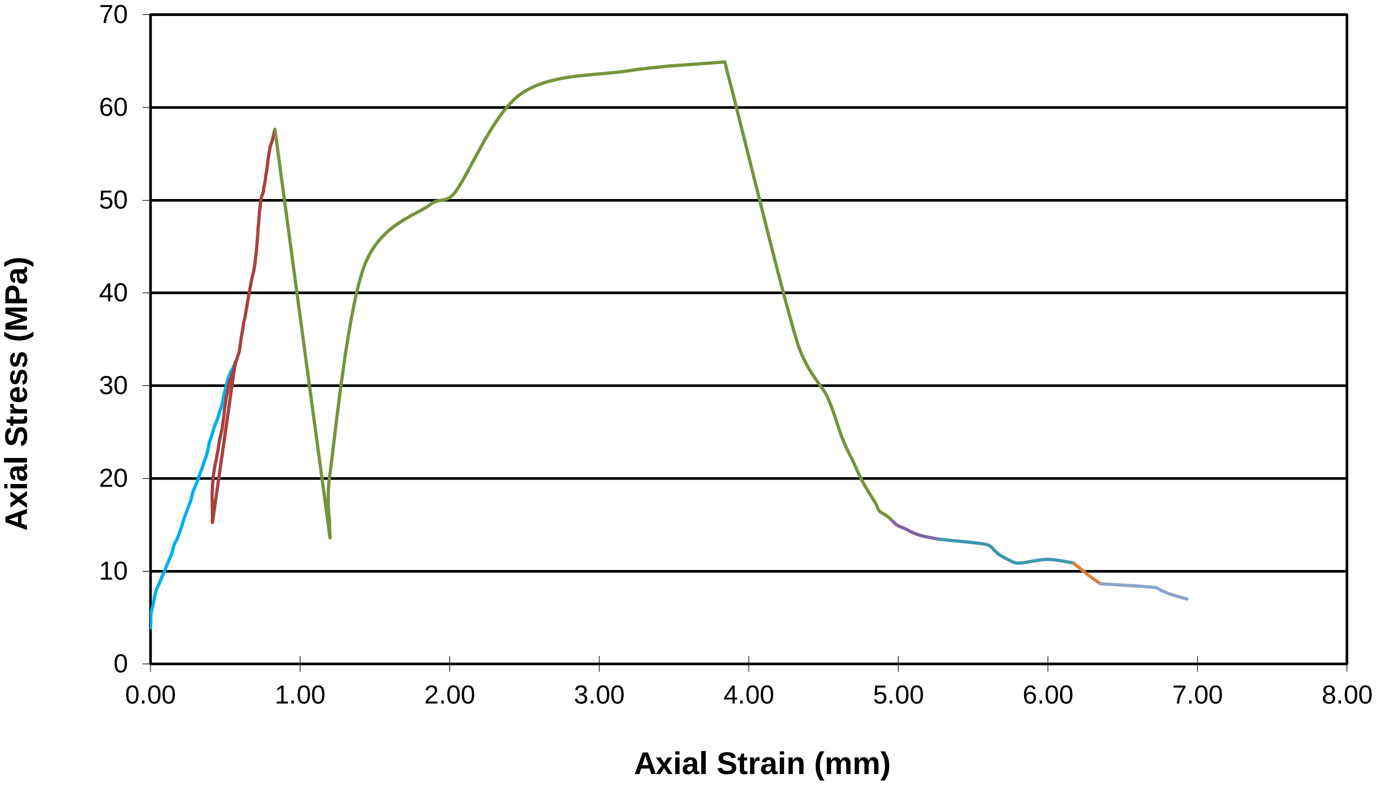
TRIAXIAL PROPERTIES OF A ROCK

Sheet 4 of 7

Mackay Laboratory

LAB REF NO: 19-5447A





CARDNO (QLD) PTY LTD

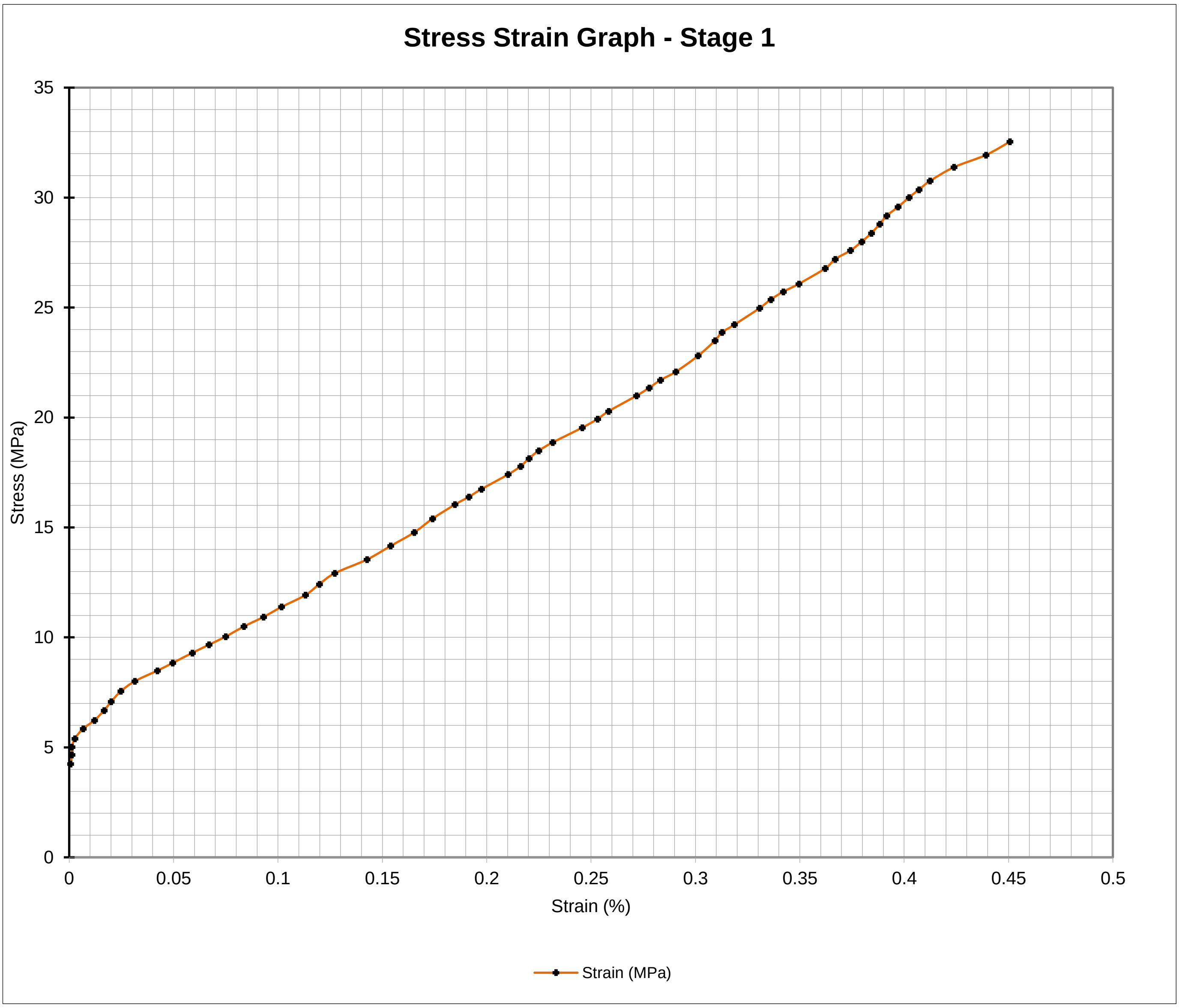
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5447A

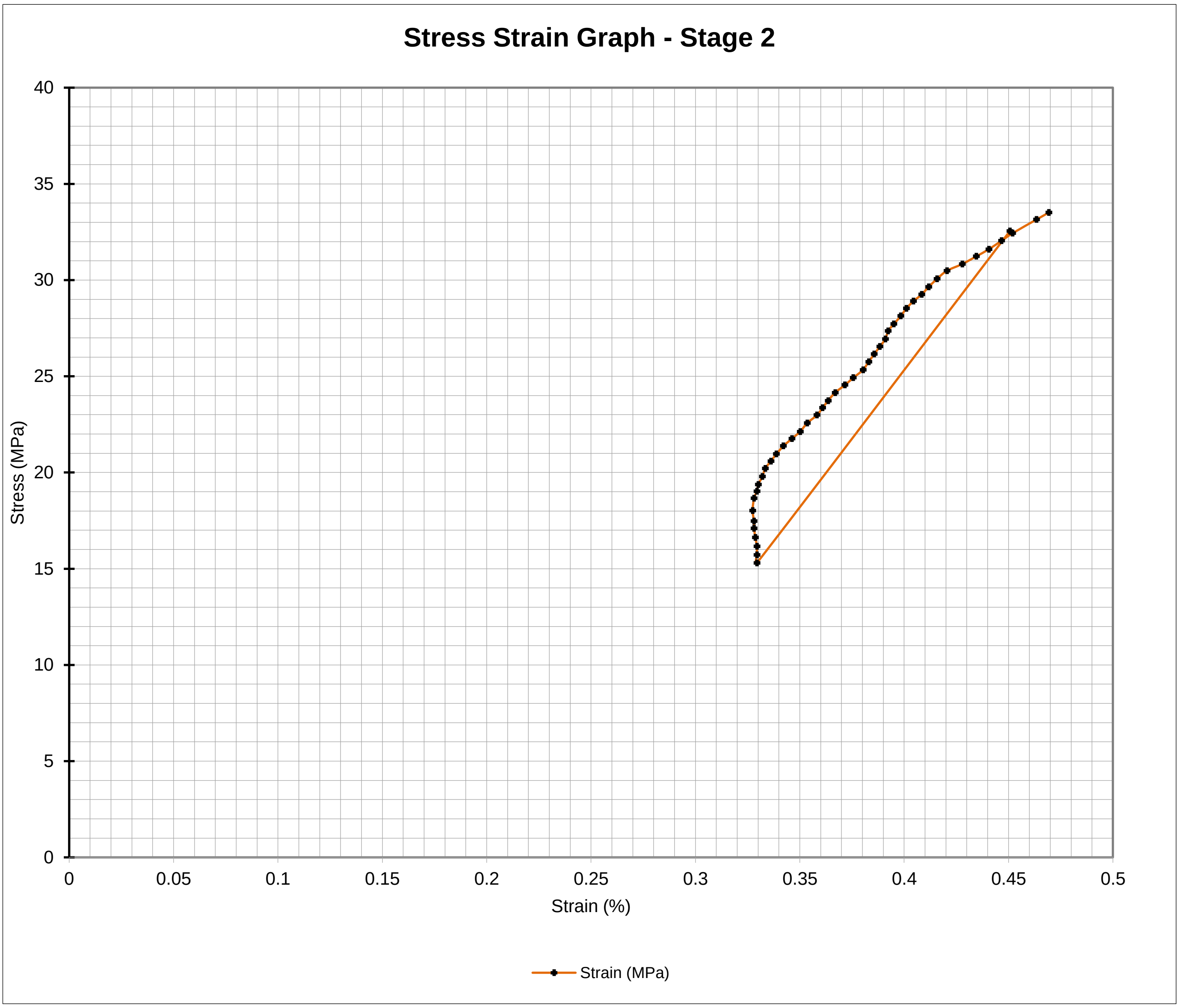


CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5447A



CARDNO (QLD) PTY LTD

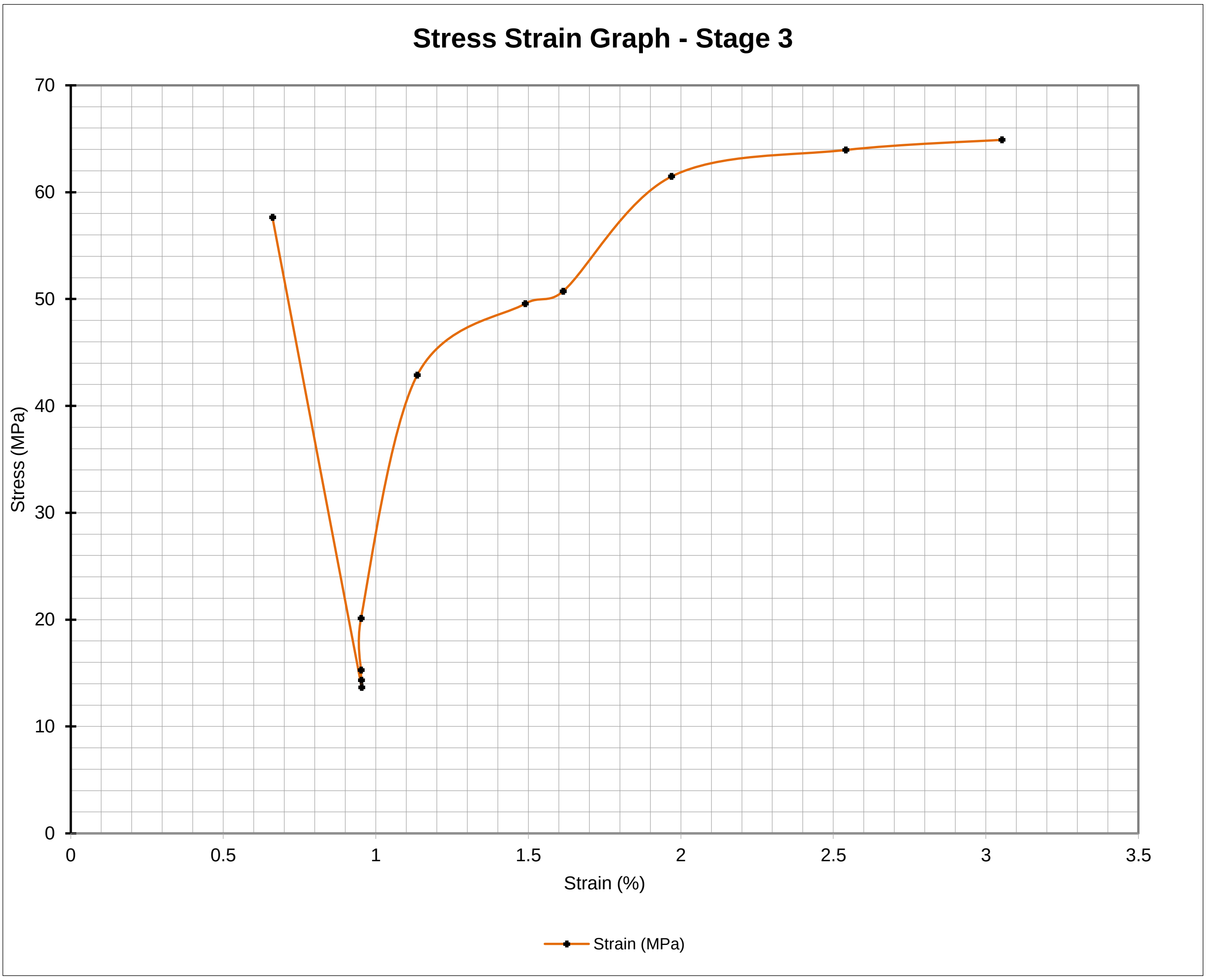
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 7 of 7

Mackay Laboratory

LAB REF NO: 19-5447A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 7 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5451A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Siltstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

Sample Details			
Borehole:	STX1903G	**Sample number:**	UCS-129
Depth from (m):	146.03	**Depth to (m):**	146.20

Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	127.3
Measurement:	Displacement Transducer	**Diameter (mm):**	61.0
		Moisture Content (%):	3.3
Rate of Loading (MPa/min):	21.60	**Mass of Sample (g):**	956.0
Time to Failure (min):	3.40	**Dry Density (t/m3):**	2.49
Test Duration (min):	3.52	**Wet Density (t/m3):**	2.57

Intact Strength			
	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	27.7	0.62
Stage 2	1.5	41.4	0.87
Stage 3	3	42.7	0.98

Residual Strength			
	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1	3	29.0	
Residual Stress 2	1.5	22.5	
Residual Stress 3	0.75	15.9	
Residual Stress 4	0.5	11.5	
Residual Stress 5	0.25	8.6	

Dominant structural features with respect to core axis

Before Photo	After Photo	Failure Diagram
		

Comments: Testing was done at Room Temperature.

APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

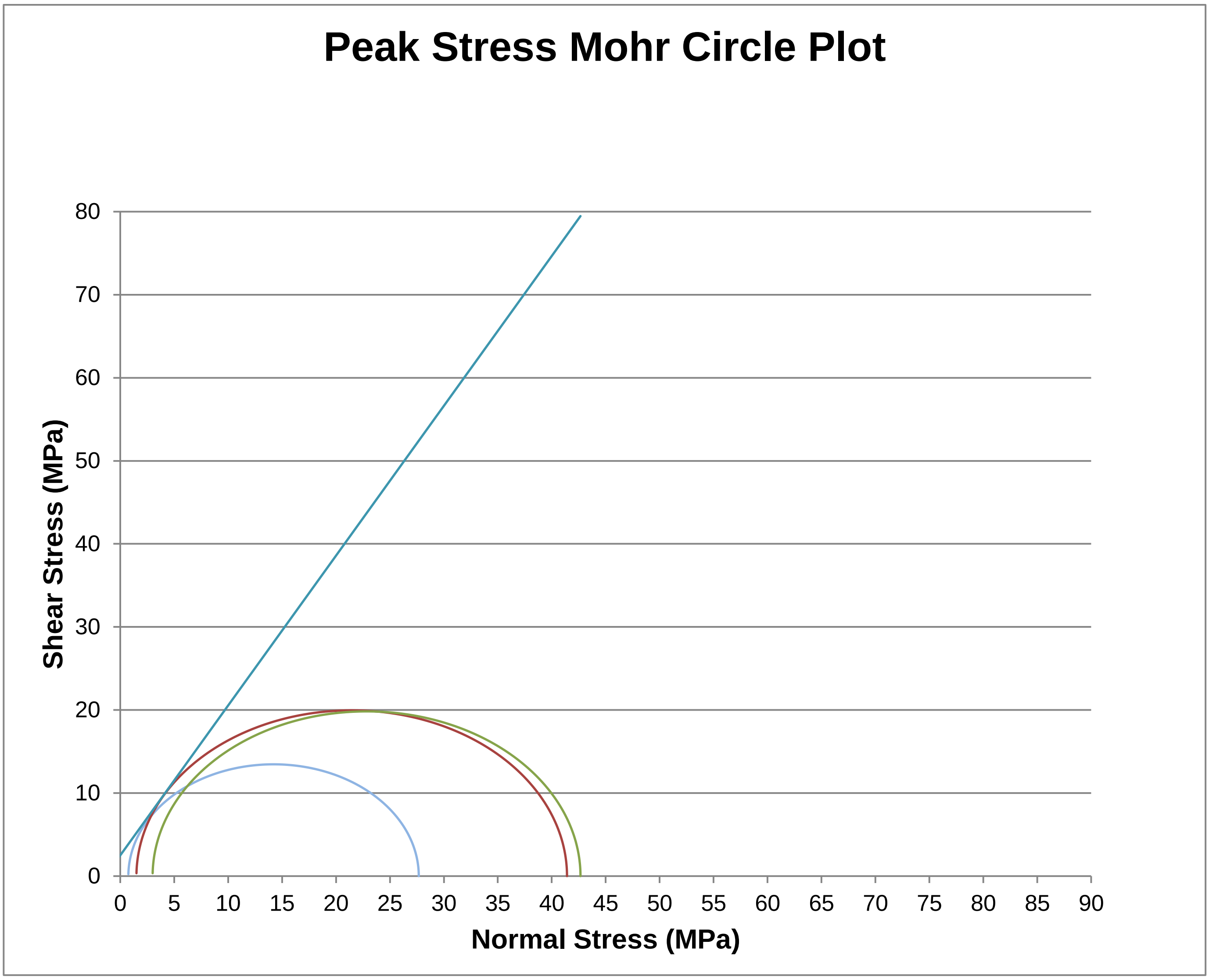
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 2 of 7

Mackay Laboratory



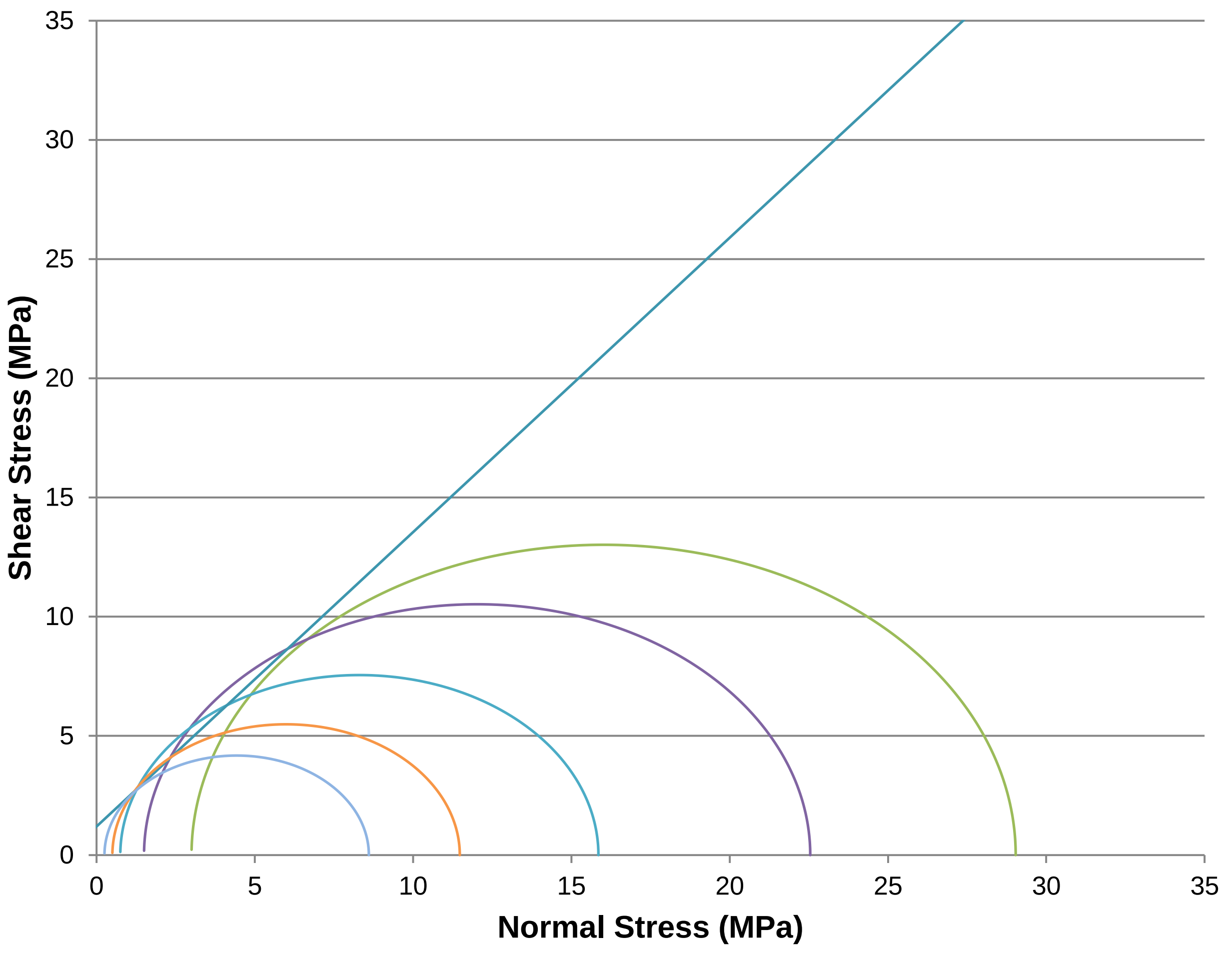
Estimated Peak Envelope	
Angle	61.0 °
Cohesion	2.5 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5451A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Residual Stress Mohr Circle Plot



Estimated Residual Envelope	
Angle	51.0 °
Cohesion	1.2 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5451A

CARDNO (QLD) PTY LTD

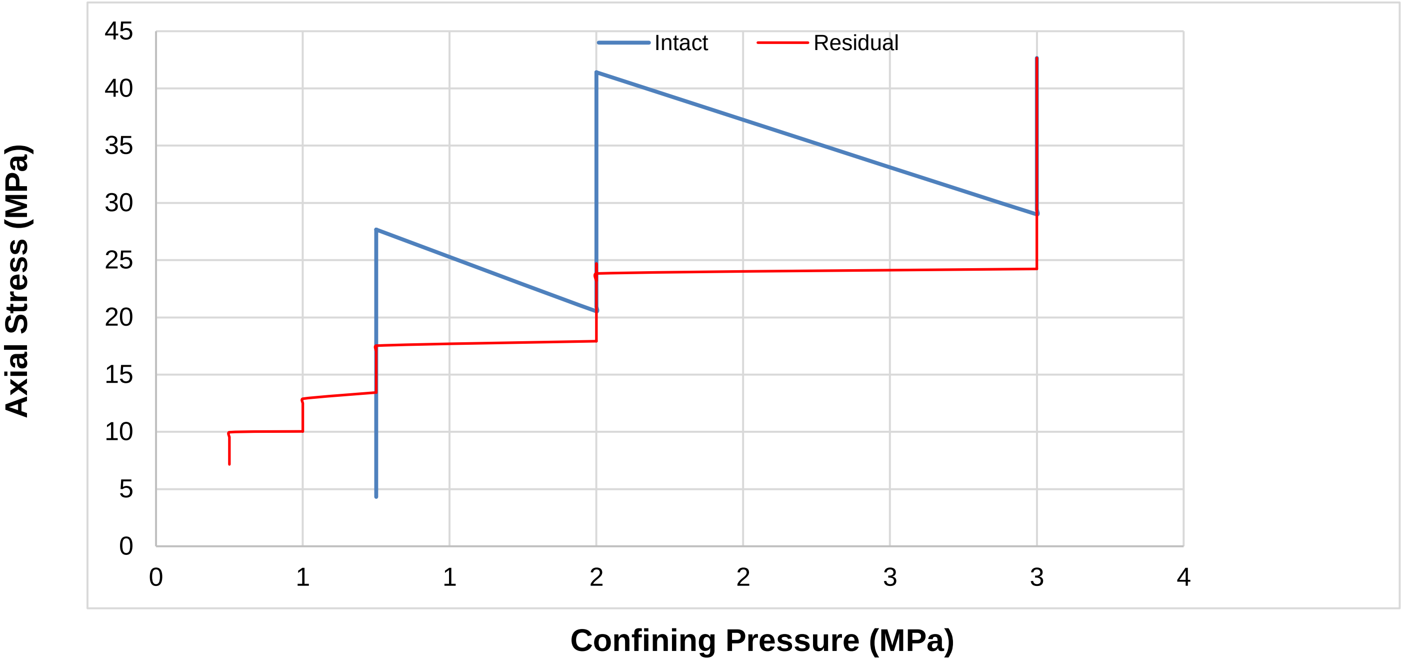
71 MAGGIOLO DRIVE MACKAY QLD

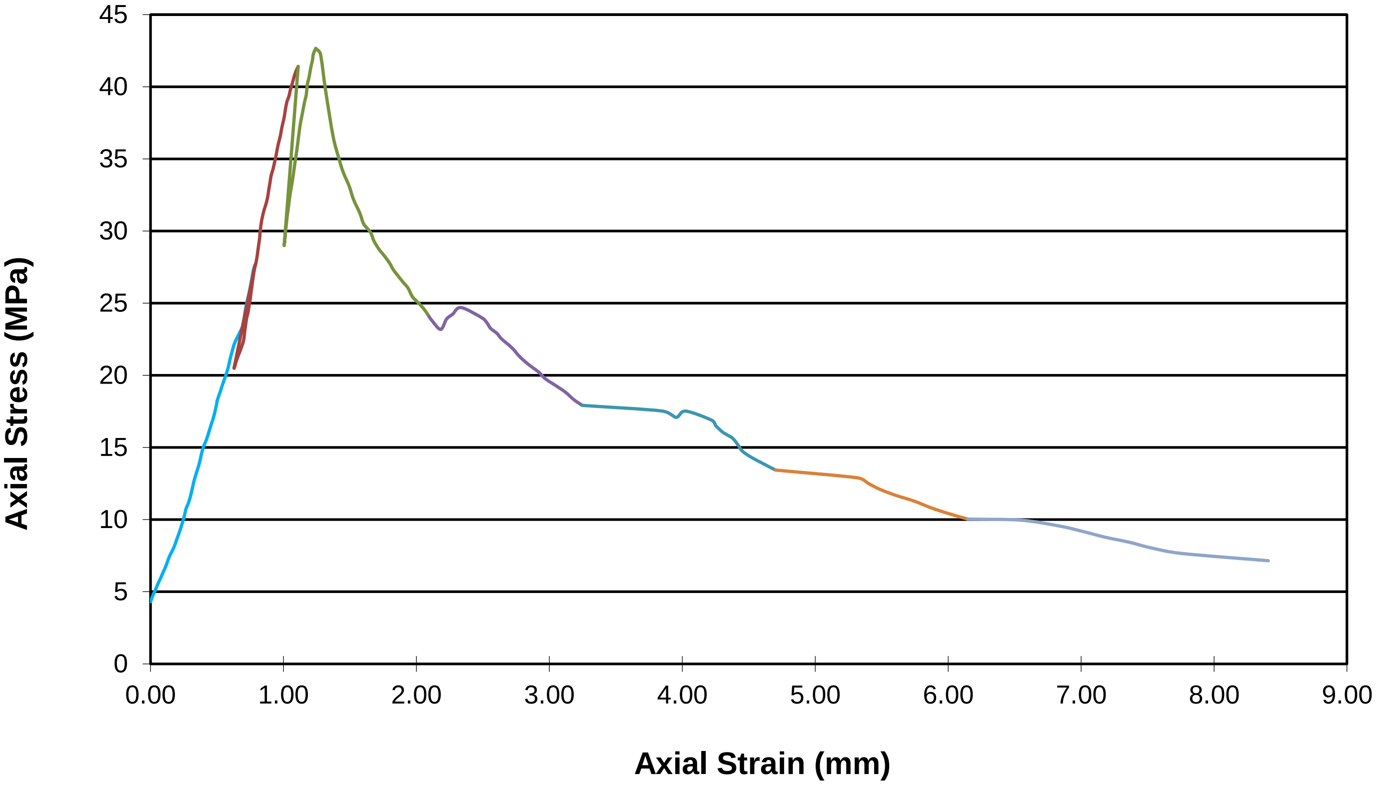
TRIAXIAL PROPERTIES OF A ROCK

Sheet 4 of 7

Mackay Laboratory

LAB REF NO: 19-5451A



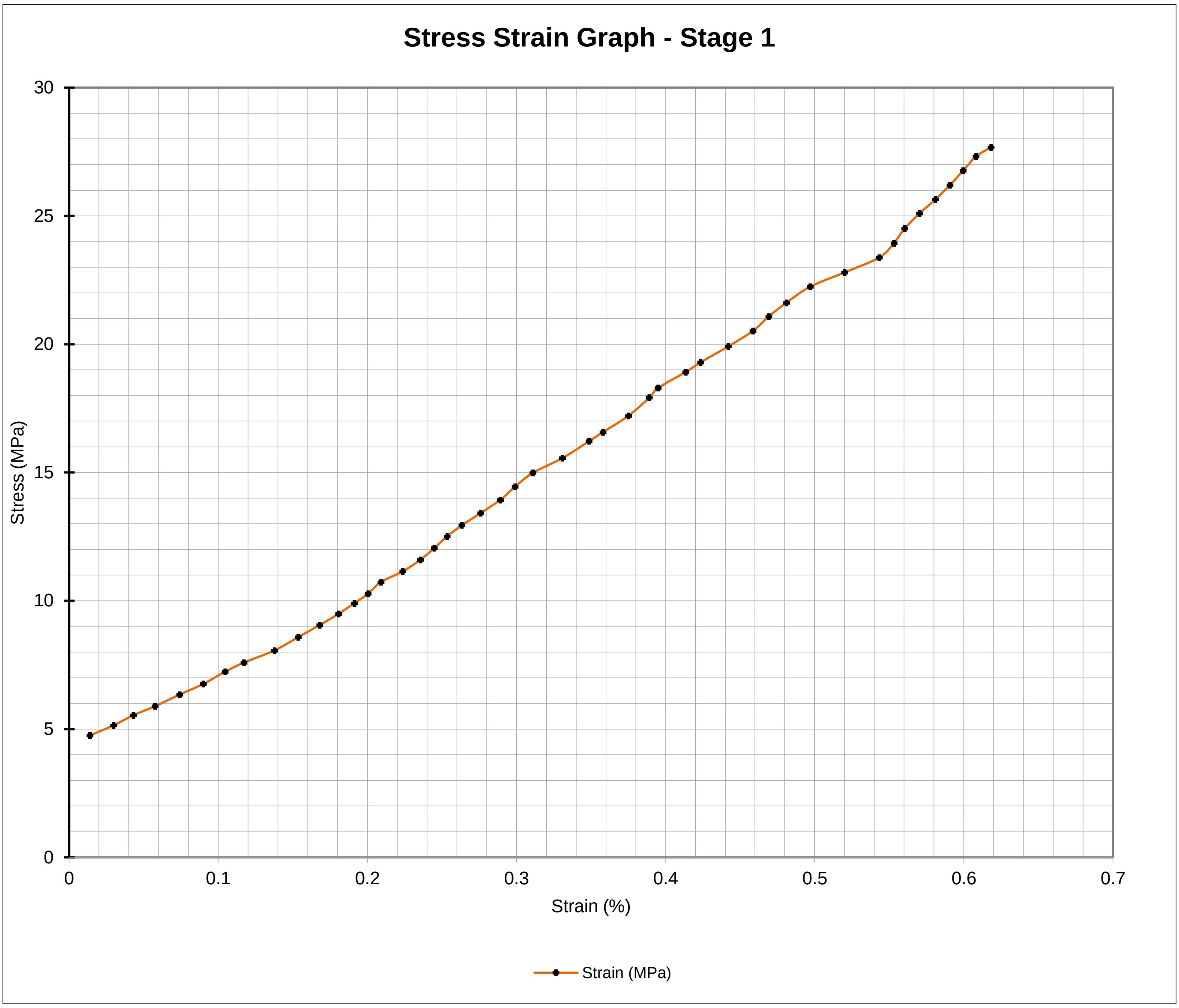


TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5451A

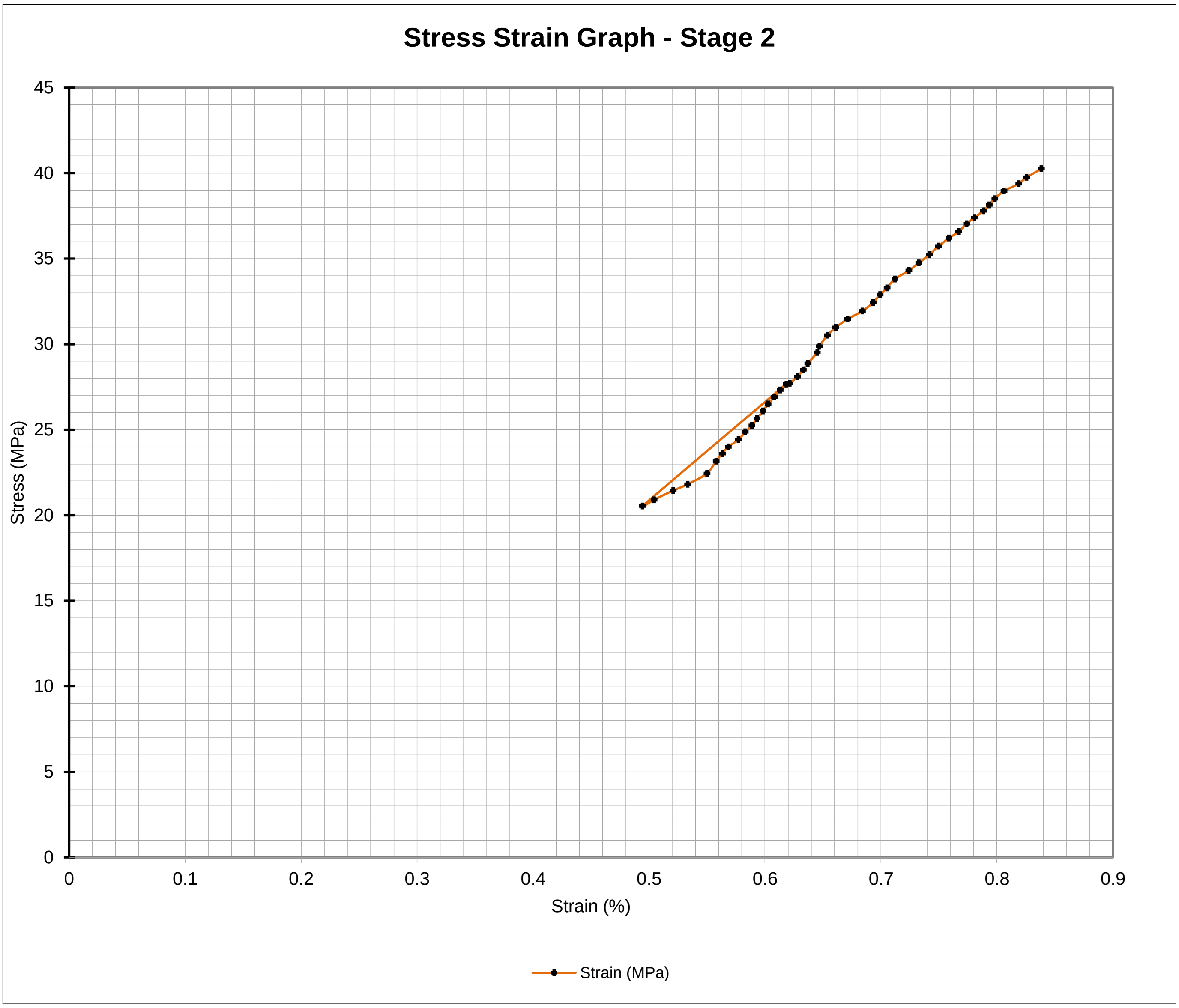


CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5451A



CARDNO (QLD) PTY LTD

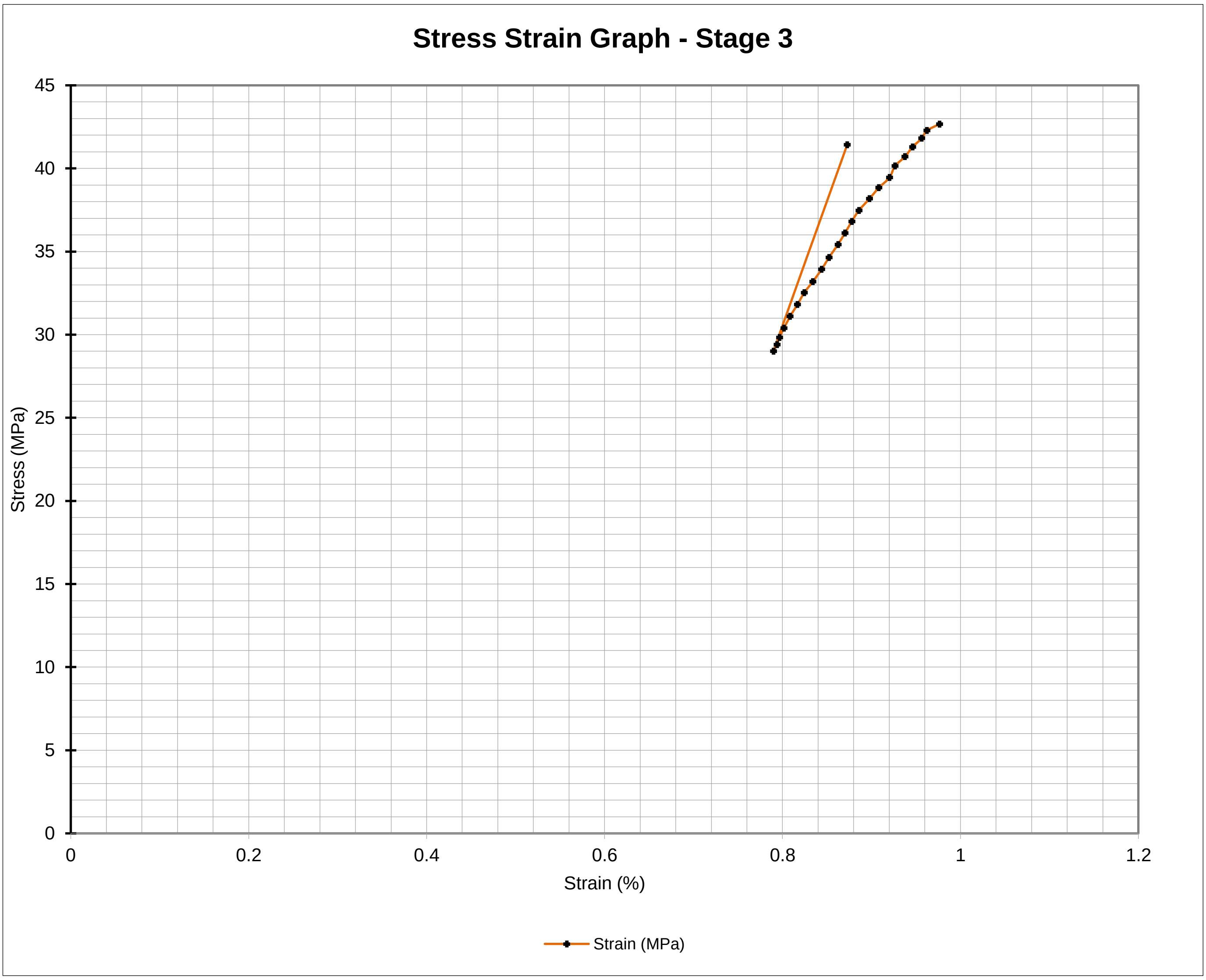
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 7 of 7

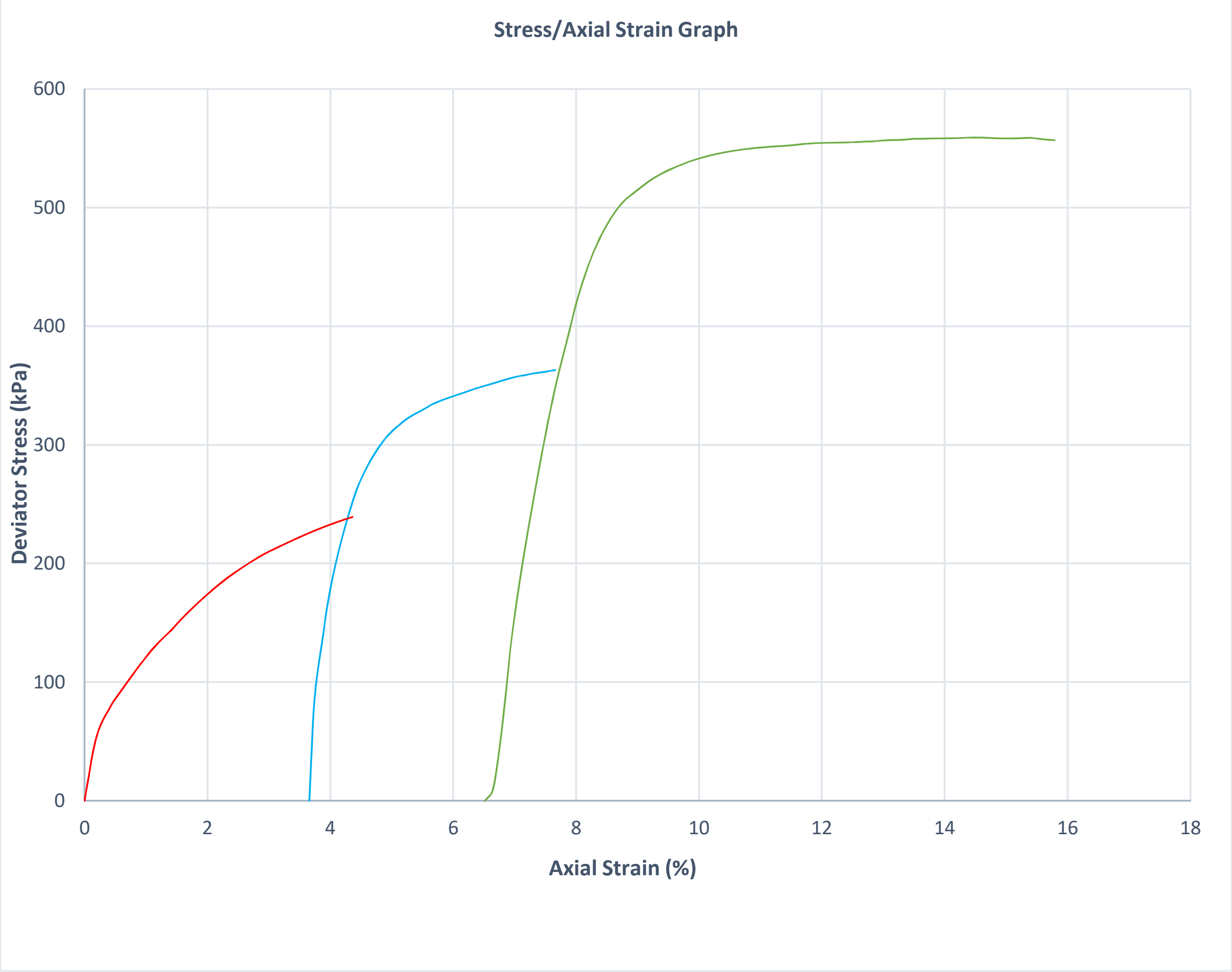
Mackay Laboratory

LAB REF NO: 19-5451A



Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5324A**
Address:	**Level 17, 240 Queen Street, Brisbane, Q**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1903G 1, Depth 11.48-11.63m**		**Page 2**


Stress/Axial Strain Graph

Failure Details

Cell Pressure (kPa)	Back Pressure (kPa)	Effictive Pressure (kPa)	Initial Pore Pressure (kPa)	Failure Pore Pressure (kPa)	Principal Effective Stress			Deviator Stress (kPa)	Strain (%)
					σ'1 (kPa)	σ'3 (kPa)	σ'1/σ'3		
500	400	100	392	422	317	78	4.067	239	4.36
500	300	200	292	335	528	165	3.201	363	7.66
800	400	400	397	496	863	304	2.839	559	14.53

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPROVED SIGNATORY

D.Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

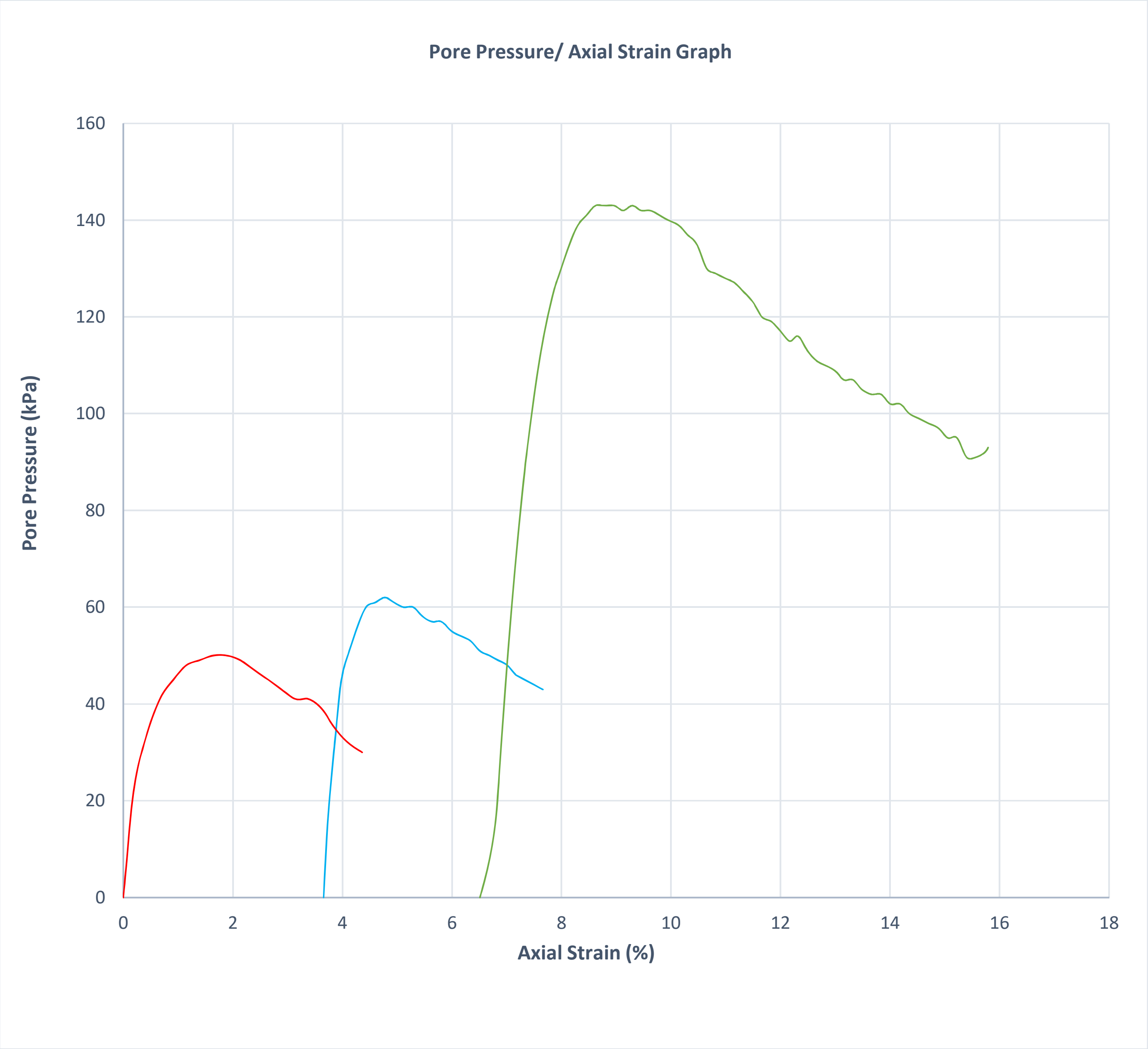
Cardno (Qld) Pty Ltd
ABN 57 051 074 992
Mackay Laboratory

71 Maggiolo Drive
Paget, QLD 4740
P.O.Box 759, Mackay, QLD 4740

Tel: 07 4952 5255
Email: soils@cardno.com.au
Web: www.cardno.com.au

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5324A**
Address:	**Level 17, 240 Queen Street, Brisbane, Q**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1903G 1, Depth 11.48-11.63m**		**Page 3**



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

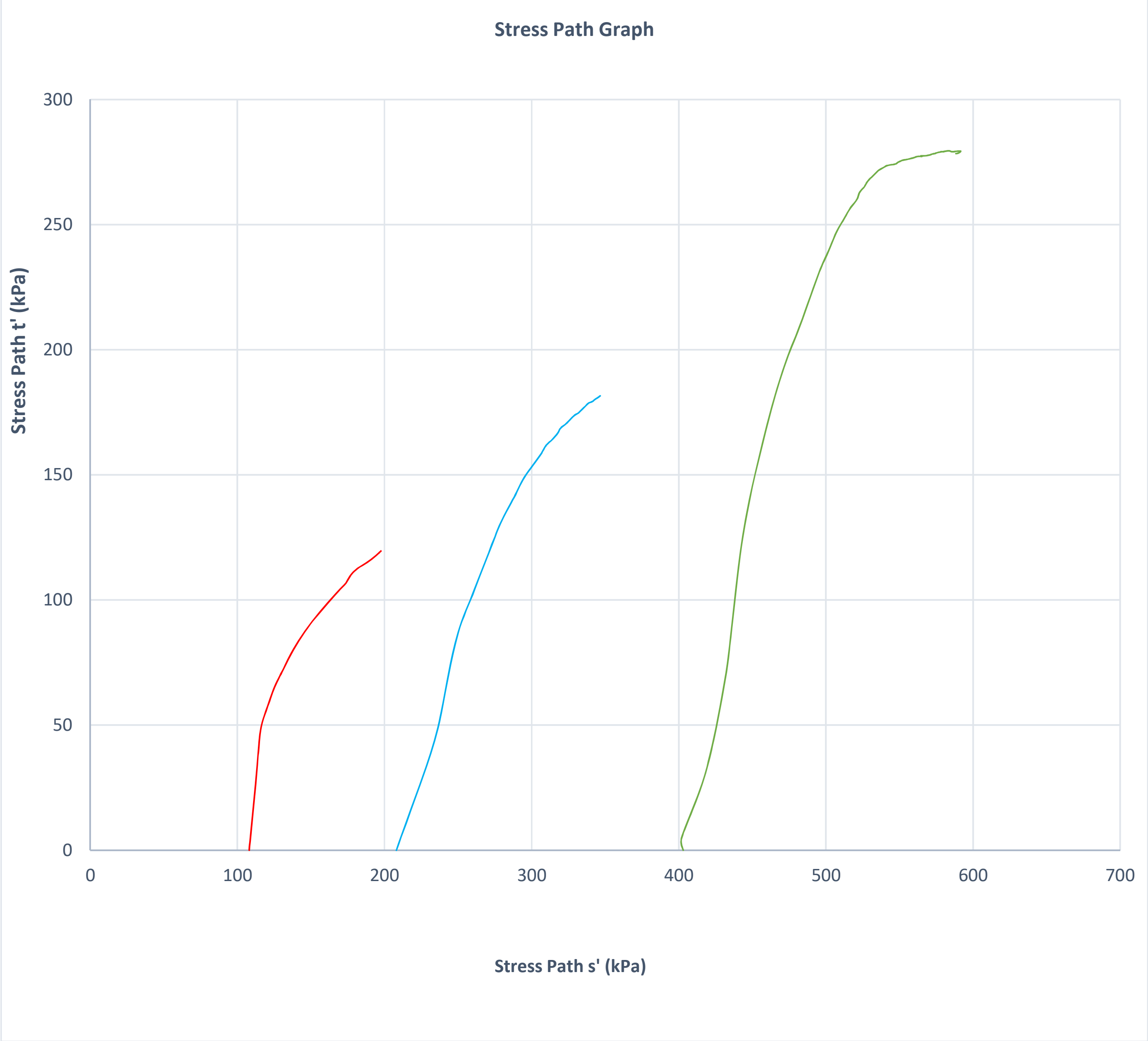
APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5324A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1903G 1, Depth 11.48-11.63m**		**Page 4**



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPROVED SIGNATORY

D.Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

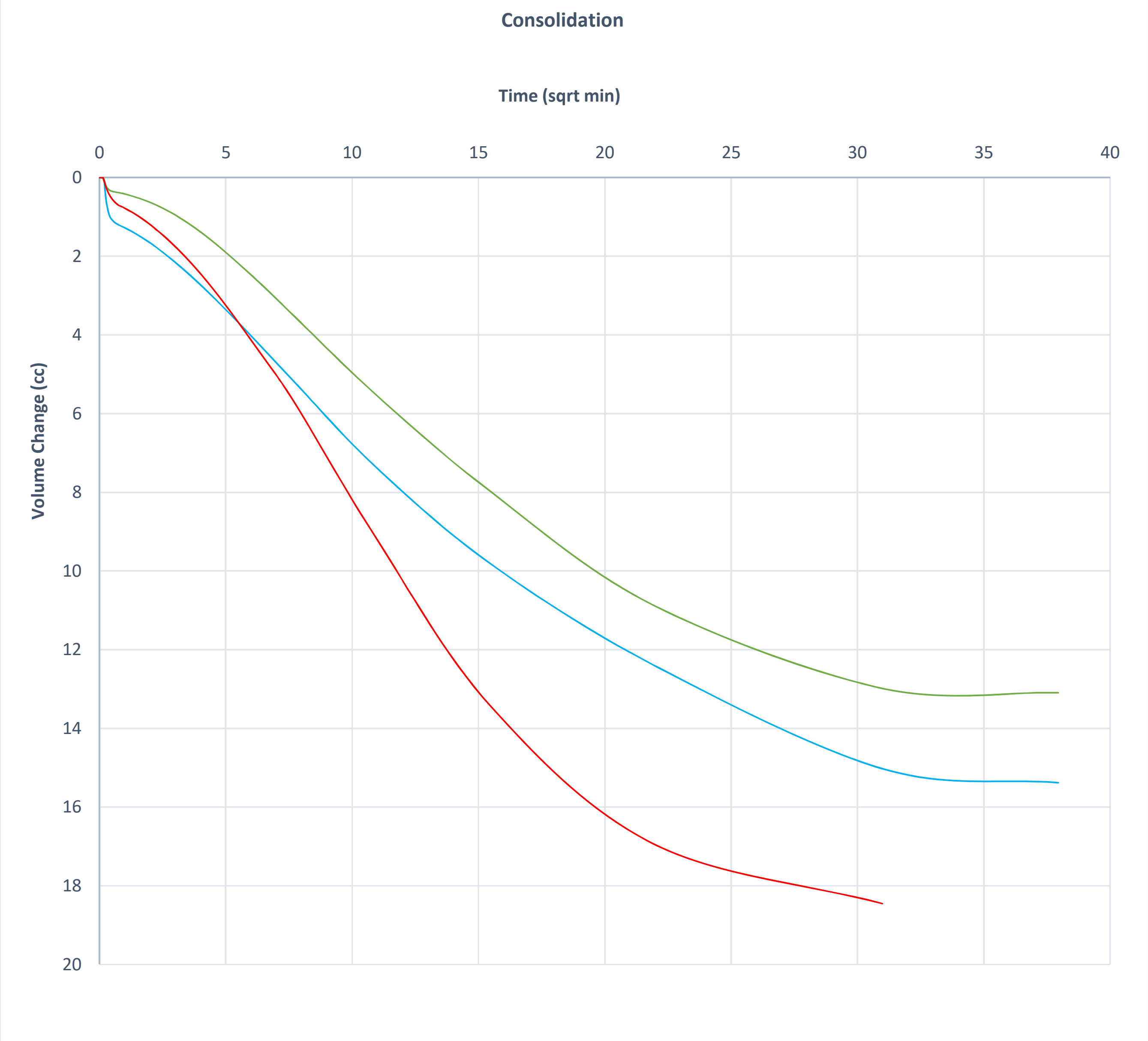
Cardno (Qld) Pty Ltd
ABN 57 051 074 992
Mackay Laboratory

71 Maggiolo Drive
Paget, QLD 4740
P.O.Box 759, Mackay, QLD 4740

Tel: 07 4952 5255
Email: soils@cardno.com.au
Web: www.cardno.com.au

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5324A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1903G 1, Depth 11.48-11.63m**		**Page 5**



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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NATA
WORLD RECOGNISED ACCREDITATION

APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

Cardno (Qld) Pty Ltd
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71 Maggiolo Drive
Paget, QLD 4740
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Tel: 07 4952 5255
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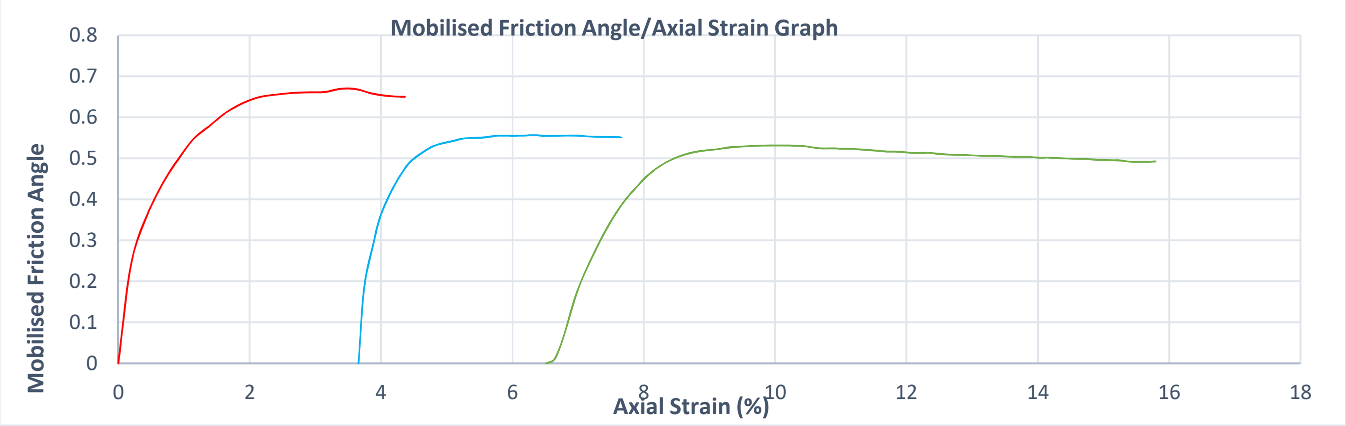
Web: www.cardno.com.au

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5324A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1903G 1, Depth 11.48-11.63m**		**Page 6**



Sample Before Test	Sample After Test
	

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5331A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	25-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	28-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-9
Corrected Depth from (m)	27.3
Corrected Depth to (m)	27.47
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	sandstone
Mass of sample (g)	1059.2
Average sample diameter (mm)	60.6
Diameter variation > 0.3mm?	No
Average height (mm)	156.3
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2884
Uniaxial Comp. Strength (MPa)	**6.4**
Number of specimens in sample	1
Moisture content (%)	4.3
Density at as received moisture content (t/m^3)	2.35
Loading rate (N/min)	2500
Time to failure (min)	7.32
Max. applied load (kN)	18.5
Dominant structural features with respect to core axis  (e) Tensile dominated	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A

Poisson's Ratio method: N/A

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Certificate No.	19-5331A
Date of Issue	28-Oct-19

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A. J. Williams

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5335A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	25-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	28-Oct-19

Borehole No.		STX1903G
Client sample number		ucs-13
Corrected Depth from (m)		29.34
Corrected Depth to (m)		29.55
Stratigraphic horizon		-
Orientation of core axis		Vertical
Lithological description		sandstone
Mass of sample (g)		1093.1
Average sample diameter (mm)		60.8
Diameter variation > 0.3mm?		No
Average height (mm)		159.1
Length / Diameter ratio (ratio 2.5 to 3)		2.6
Cross sectional area (mm^2)		2903
Uniaxial Comp. Strength (MPa)		**3.8**
Number of specimens in sample		1
Moisture content (%)		4.5
Density at as received moisture content (t/m^3)		2.37
Loading rate (N/min)		1250
Time to failure (min)		7.53
Max. applied load (kN)		11.0
Dominant structural features with respect to core axis  (e) Tensile dominated	Before 	After 
Secant Young's Modulus (GPa)		**N/A**
Corrected Poisson's Ratio		**N/A**
Remarks		

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5335A
Date of Issue	28-Oct-19

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REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 | Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5346A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-24
Corrected Depth from (m)	35.63
Corrected Depth to (m)	35.81
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	sandstone
Mass of sample (g)	1107.7
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	157.9
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2913
Uniaxial Comp. Strength (MPa)	**7.2**
Number of specimens in sample	1
Moisture content (%)	4.4
Density at as received moisture content (t/m^3)	2.41
Loading rate (N/min)	2500
Time to failure (min)	8.30
Max. applied load (kN)	21.0
Dominant structural features with respect to core axis  (e) Tensile dominated	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Certificate No.	19-5346A
Date of Issue	24-Oct-19

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Issue: 1 Rev: 0
(8/17)

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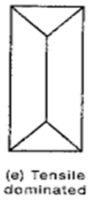
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5348A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-26</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>36.4</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>36.59</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>sandstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1087.8</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>60.8</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>157</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2903</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>**5.2**</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>4.6</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.39</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>2500</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>6.01</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>15.0</td></tr>
<tr><td>Dominant structural features with respect to core axis  </td><td>Before </td><td>After </td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>**N/A**</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>**N/A**</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 | Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5352A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-30</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>38.56</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>38.73</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>sandstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1181.6</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>60.9</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>159.6</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2913</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>**6.4**</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>3.3</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.54</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>2500</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>7.29</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>18.5</td></tr>
<tr><td>Dominant structural features with respect to core axis  </td><td>Before </td><td>After </td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>**N/A**</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>**N/A**</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Had a natural crack along a lamination that was glued prior to test.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
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Date of Issue	24-Oct-19

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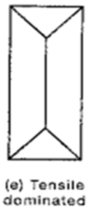
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** 19-5359A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 22-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013) **CHECKED BY:** AW **CHECK DATE:** 24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-37
Corrected Depth from (m)	43.01
Corrected Depth to (m)	43.16
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	siltstone / tuff
Mass of sample (g)	1416.7
Average sample diameter (mm)	61
Diameter variation > 0.3mm?	No
Average height (mm)	153.7
Length / Diameter ratio (ratio 2.5 to 3)	2.5
Cross sectional area (mm^2)	2919
Uniaxial Comp. Strength (MPa)	**25.7**
Number of specimens in sample	1
Moisture content (%)	0.2
Density at as received moisture content (t/m^3)	3.16
Loading rate (N/min)	12500
Time to failure (min)	5.58
Max. applied load (kN)	75.0
Dominant structural features with respect to core axis  Before 	After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Accredited No.	910
Certificate No.	19-5359A
Date of Issue	24-Oct-19

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Authorised Signatory

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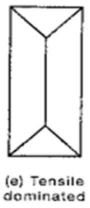
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5364A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td>Borehole No.</td><td colspan="2">STX1903G</td></tr>
<tr><td>Client sample number</td><td colspan="2">ucs-42</td></tr>
<tr><td>Corrected Depth from (m)</td><td colspan="2">47.8</td></tr>
<tr><td>Corrected Depth to (m)</td><td colspan="2">48.01</td></tr>
<tr><td>Stratigraphic horizon</td><td colspan="2">-</td></tr>
<tr><td>Orientation of core axis</td><td colspan="2">Vertical</td></tr>
<tr><td>Lithological description</td><td colspan="2">sandstone</td></tr>
<tr><td>Mass of sample (g)</td><td colspan="2">1172.4</td></tr>
<tr><td>Average sample diameter (mm)</td><td colspan="2">61</td></tr>
<tr><td>Diameter variation > 0.3mm?</td><td colspan="2">No</td></tr>
<tr><td>Average height (mm)</td><td colspan="2">161.9</td></tr>
<tr><td>Length / Diameter ratio (ratio 2.5 to 3)</td><td colspan="2">2.7</td></tr>
<tr><td>Cross sectional area (mm^2)</td><td colspan="2">2922</td></tr>
<tr><td>Uniaxial Comp. Strength (MPa)</td><td colspan="2">13.2</td></tr>
<tr><td>Number of specimens in sample</td><td colspan="2">1</td></tr>
<tr><td>Moisture content (%)</td><td colspan="2">2.6</td></tr>
<tr><td>Density at as received moisture content (t/m^3)</td><td colspan="2">2.48</td></tr>
<tr><td>Loading rate (N/min)</td><td colspan="2">5000</td></tr>
<tr><td>Time to failure (min)</td><td colspan="2">7.46</td></tr>
<tr><td>Max. applied load (kN)</td><td colspan="2">38.5</td></tr>
<tr><td>Dominant structural features with respect to core axis
 </td><td>Before
</td><td>After
</td></tr>
<tr><td>Secant Young's Modulus (GPa)</td><td colspan="2">N/A</td></tr>
<tr><td>Corrected Poisson's Ratio</td><td colspan="2">N/A</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens:	Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.
Compression machine:	Shimadzu U.E.H. -50 S/N 79097
Variations from standard:	Time to failure less than standard 10 to 15 minutes. Had a natural crack along a lamination that was glued prior to test.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5364A
Date of Issue	24-Oct-19

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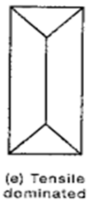
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5366A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-44
Corrected Depth from (m)	48.8
Corrected Depth to (m)	48.96
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	sandstone
Mass of sample (g)	1098.5
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	156
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2913
Uniaxial Comp. Strength (MPa)	**8.6**
Number of specimens in sample	1
Moisture content (%)	3.2
Density at as received moisture content (t/m^3)	2.42
Loading rate (N/min)	5000
Time to failure (min)	5.03
Max. applied load (kN)	25.0
Dominant structural features with respect to core axis  (e) Tensile dominated	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5366A
Date of Issue	24-Oct-19

Accredited for compliance with ISO/IEC 17025-testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australia/national standards.

Authorised Signatory

A. J. Williams

GEO-QF-GR71 Ga
Issue: 1 Rev: 0
(8/17)

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5374A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-52
Corrected Depth from (m)	51.6
Corrected Depth to (m)	51.86
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	coal
Mass of sample (g)	625.1
Average sample diameter (mm)	61
Diameter variation > 0.3mm?	No
Average height (mm)	157.5
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2922
Uniaxial Comp. Strength (MPa)	**5.6**
Number of specimens in sample	1
Moisture content (%)	3
Density at as received moisture content (t/m^3)	1.36
Loading rate (N/min)	2500
Time to failure (min)	6.41
Max. applied load (kN)	16.5
Dominant structural features with respect to core axis  (d) Tensile dominated	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5374A
Date of Issue	24-Oct-19

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5379A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-57</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>57.04</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>57.27</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>sandstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1167.1</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>61</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>159.2</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2922</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>8.7</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>1.9</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.51</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>5000</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>5.02</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>25.5</td></tr>
<tr><td>Dominant structural features with respect to core axis

(d) Tensile dominated</td><td>Before
</td><td>After
</td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>N/A</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>N/A</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5379A
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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5380A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-58</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>58.22</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>58.4</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>interbeddefd carbonaceous siltstone/ coal</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1051.6</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>60.9</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>156.9</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2913</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>**5.8**</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>3.4</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.30</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>2500</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>6.53</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>17.0</td></tr>
<tr><td>Dominant structural features with respect to core axis

(e) Tensile dominated</td><td>Before
</td><td>After
</td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>**N/A**</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>**N/A**</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5380A
Date of Issue	24-Oct-19

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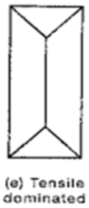
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5396A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-74
Corrected Depth from (m)	69.88
Corrected Depth to (m)	70.05
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	carbonaceous siltstone
Mass of sample (g)	1092.2
Average sample diameter (mm)	61
Diameter variation > 0.3mm?	No
Average height (mm)	159.9
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2922
Uniaxial Comp. Strength (MPa)	**2.2**
Number of specimens in sample	1
Moisture content (%)	3.1
Density at as received moisture content (t/m^3)	2.34
Loading rate (N/min)	1250
Time to failure (min)	5.20
Max. applied load (kN)	6.5
Dominant structural features with respect to core axis 	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

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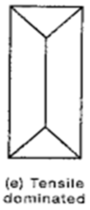
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation
LOCATION: Styx Basin
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013)

JOB NO.: M30863
LAB REF NO: 19-5405A
SAMPLED BY: Cardno
SAMPLE DATE: 02-Sep-19
TESTED BY: MS
TEST DATE: 22-Oct-19
CHECKED BY: AW
CHECK DATE: 24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-83
Corrected Depth from (m)	78.07
Corrected Depth to (m)	78.27
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	carbonaceous siltstone
Mass of sample (g)	1113.7
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	160.3
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2913
Uniaxial Comp. Strength (MPa)	**13.7**
Number of specimens in sample	1
Moisture content (%)	2.9
Density at as received moisture content (t/m^3)	2.39
Loading rate (N/min)	5000
Time to failure (min)	8.03
Max. applied load (kN)	40.0
Dominant structural features with respect to core axis 	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5405A
Date of Issue	24-Oct-19

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5410A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-88
Corrected Depth from (m)	80.22
Corrected Depth to (m)	80.37
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	interbeddefd carbonaceous siltstone/ coal
Mass of sample (g)	628.2
Average sample diameter (mm)	61.1
Diameter variation > 0.3mm?	No
Average height (mm)	149.2
Length / Diameter ratio (ratio 2.5 to 3)	2.4
Cross sectional area (mm^2)	2929
Uniaxial Comp. Strength (MPa)	**6.5**
Number of specimens in sample	1
Moisture content (%)	4.1
Density at as received moisture content (t/m^3)	1.44
Loading rate (N/min)	2500
Time to failure (min)	7.41
Max. applied load (kN)	19.0
Dominant structural features with respect to core axis  	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.
Height to diameter ratio less than 2.5 due to core structural features.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5410A
Date of Issue	24-Oct-19

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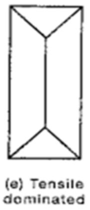
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5412A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-90</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>81.9</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>82.08</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>carbonaceous siltstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>905.5</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>60.9</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>133.8</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.2</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2913</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>6.9</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>3.5</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.32</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>2500</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>7.59</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>20.0</td></tr>
<tr><td>Dominant structural features with respect to core axis
 </td><td>Before
</td><td>After
</td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>N/A</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>N/A</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.
Height to diameter ratio less than 2.5 due to core structural features.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5412A
Date of Issue	24-Oct-19

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 | Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5422A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-100</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>91.2</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>91.38</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>sandstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1389.6</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>61</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>157.7</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2922</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>**14.2**</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>0.5</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>3.02</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>5000</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>8.28</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>41.5</td></tr>
<tr><td>Dominant structural features with respect to core axis

 </td><td>Before
</td><td>After

 </td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>**N/A**</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>**N/A**</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5422A
Date of Issue	24-Oct-19

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Authorised Signatory

A. J. Williams

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5425A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.		STX1903G
Client sample number		ucs-103
Corrected Depth from (m)		95.4
Corrected Depth to (m)		95.57
Stratigraphic horizon		-
Orientation of core axis		Vertical
Lithological description		carbonaceous siltstone
Mass of sample (g)		905.8
Average sample diameter (mm)		60.9
Diameter variation > 0.3mm?		No
Average height (mm)		134.9
Length / Diameter ratio (ratio 2.5 to 3)		2.2
Cross sectional area (mm^2)		2913
Uniaxial Comp. Strength (MPa)		**4.6**
Number of specimens in sample		1
Moisture content (%)		3.5
Density at as received moisture content (t/m^3)		2.31
Loading rate (N/min)		2500
Time to failure (min)		5.32
Max. applied load (kN)		13.5
Dominant structural features with respect to core axis  (e) Tensile dominated	Before 	After 
Secant Young's Modulus (GPa)		**N/A**
Corrected Poisson's Ratio		**N/A**
Remarks		

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.
Height to diameter ratio less than 2.5 due to core structural features.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5425A
Date of Issue	24-Oct-19

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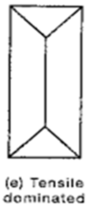
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5428A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	22-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-107</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>99.82</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>100.04</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>siltstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1199.1</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>60.9</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>158.6</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2910</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>**28.8**</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>1.2</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.60</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>12500</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>6.45</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>83.7</td></tr>
<tr><td>Dominant structural features with respect to core axis
 </td><td>Before
</td><td>After
</td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>**N/A**</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>**N/A**</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Date of Issue	24-Oct-19

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CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT: Central Queensland Coal
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation
LOCATION: Styx Basin
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013)

JOB NO.: M30863
SAMPLED BY: Cardno
TESTED BY: MS
CHECKED BY: AW

LAB REF NO: 19-5433A
SAMPLE DATE: 02-Sep-19
TEST DATE: 22-Oct-19
CHECK DATE: 24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-111
Corrected Depth from (m)	112.62
Corrected Depth to (m)	112.78
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	coal
Mass of sample (g)	555.3
Average sample diameter (mm)	61.1
Diameter variation > 0.3mm?	No
Average height (mm)	148.7
Length / Diameter ratio (ratio 2.5 to 3)	2.4
Cross sectional area (mm^2)	2932
Uniaxial Comp. Strength (MPa)	**6.0**
Number of specimens in sample	1
Moisture content (%)	3.4
Density at as received moisture content (t/m^3)	1.27
Loading rate (N/min)	2500
Time to failure (min)	7.01
Max. applied load (kN)	17.5
Dominant structural features with respect to core axis  (d) Tensile dominated	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Height to diameter ratio less than 2.5 due to core structural features.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Certificate No.	19-5433A
Date of Issue	24-Oct-19

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Issue: 1 Rev: 0
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CARDNO (QLD) PTY LTD
71 MAGGIOLO DRIVE MACKAY QLD
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 | Mackay Laboratory

CLIENT: Central Queensland Coal
JOB NO.: M30863
LAB REF NO: 19-5438A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation
SAMPLED BY: Cardno
SAMPLE DATE: 02-Sep-19
LOCATION: Styx Basin
TESTED BY: MS
TEST DATE: 22-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013)
CHECKED BY: AW
CHECK DATE: 24-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1903G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-116</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>119.68</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>119.91</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>sandstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1186.1</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>61</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>156.4</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2919</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>6.9</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>1.6</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.60</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>2500</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>8.04</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>20.2</td></tr>
<tr><td>Dominant structural features with respect to core axis

(e) Tensile dominated</td><td>Before
</td><td>After
</td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>N/A</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>N/A</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Certificate No.	19-5438A
Date of Issue	24-Oct-19

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Issue: 1 Rev: 0
(8/17)

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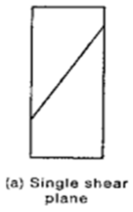
REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5440A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	23-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	24-Oct-19

Borehole No.	STX1903G
Client sample number	ucs-118
Corrected Depth from (m)	120.54
Corrected Depth to (m)	120.8
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	carbonaceous mudstone
Mass of sample (g)	1136.4
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	161.7
Length / Diameter ratio (ratio 2.5 to 3)	2.7
Cross sectional area (mm^2)	2916
Uniaxial Comp. Strength (MPa)	**8.7**
Number of specimens in sample	1
Moisture content (%)	2.4
Density at as received moisture content (t/m^3)	2.41
Loading rate (N/min)	5000
Time to failure (min)	5.10
Max. applied load (kN)	25.5
Dominant structural features with respect to core axis  (a) Single shear plane	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

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Certificate No.	19-5440A
Date of Issue	24-Oct-19

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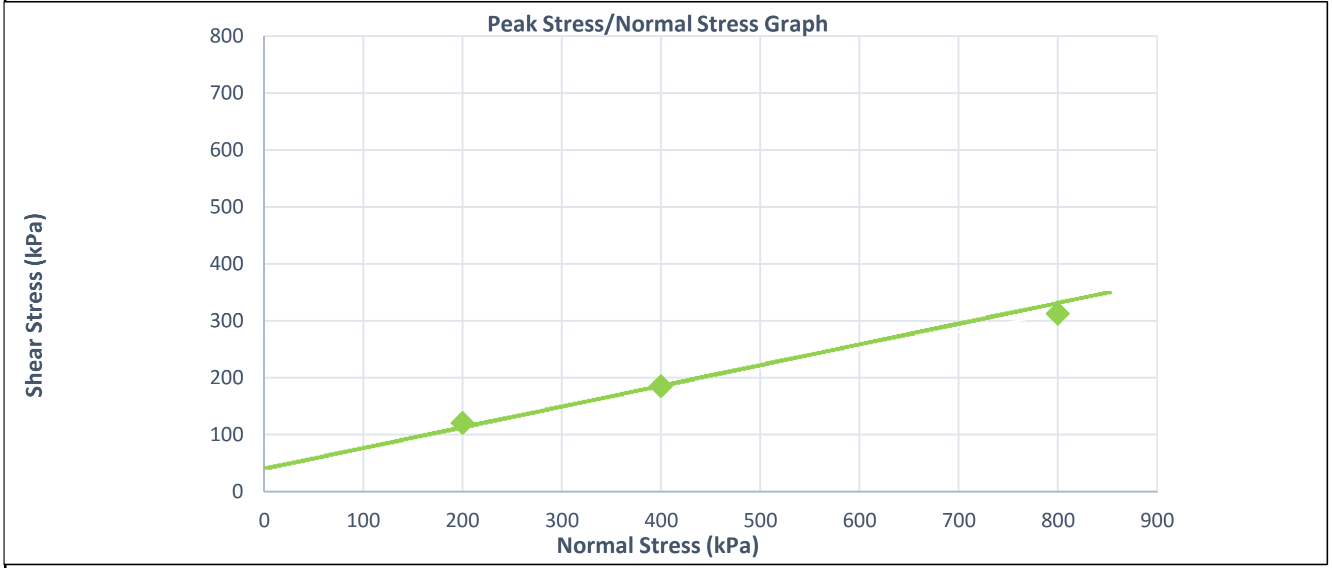
Tel: 07 4952 5255
Email: soils@cardno.com.au
Web: www.cardno.com.au

Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5339A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**6/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-16**		**Page 1**

Borehole: STX1903G Sample ID: Shear-16 Depth From: 31.64 Depth To: 31.8

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	5/11/2019	Wet Density	2.27	2.27	2.27
Sampled By:	Cardno	Dry Density	2.15	2.15	2.15
Sampling Method:	AS 1289 1.2.1	Moisture (%)	5.5	5.5	5.5
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Siltstone	Peak Shear Stress (kPa)	120	185	313
Sample Type:	Core	Primary Consolidation (mm)	0.3	0.4	0.2
Lab Ref Number:	19-5339A	Strain Rate (mm/min)	0.124	0.115	0.107



Effective Cohesion C' (kPa):	40.0
Effective Angle of Friction ϕ' (Degrees):	20.0
Failure Criteria:	Peak Shear Stress

Sample/s supplied by Cardn(Note: Graph not to scale

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APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager

NATA Accreditation Number

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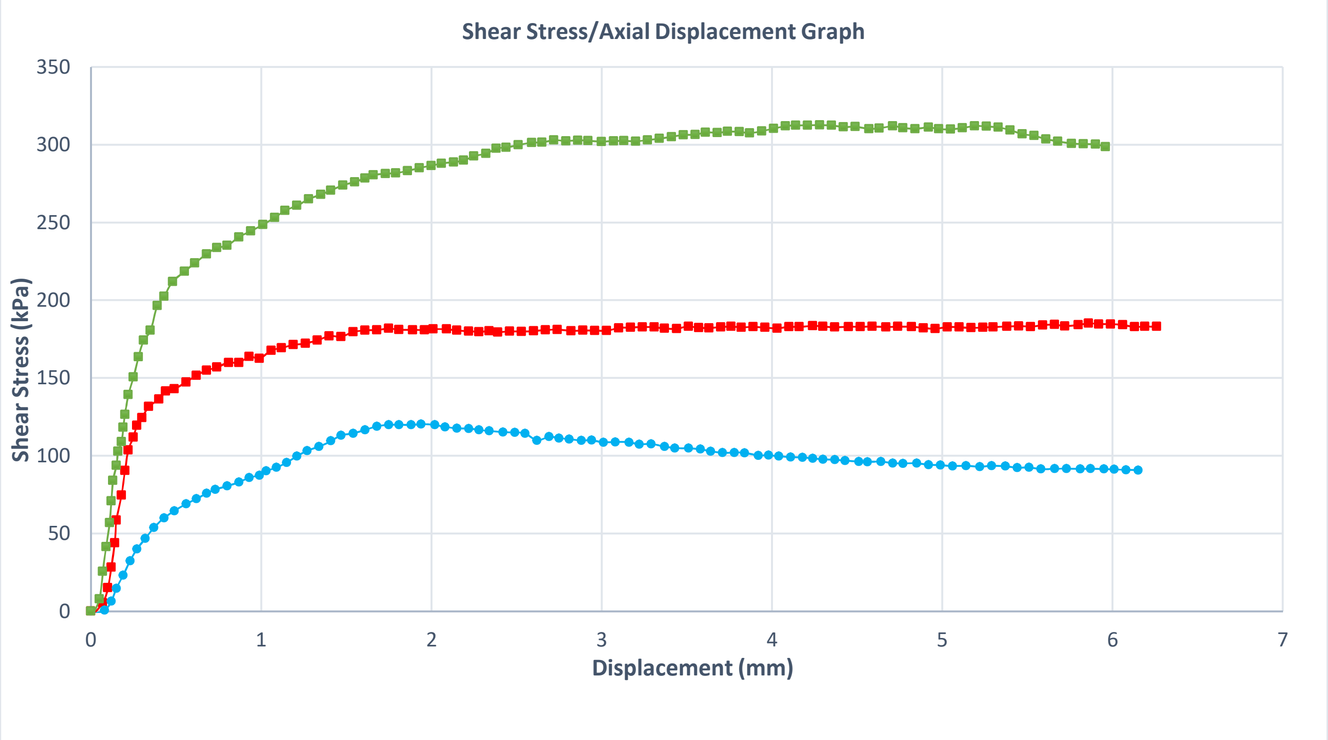
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5339A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**6/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**	**Page 2**	



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	120	1.94	50
2	400	185	5.86	52
3	800	313	4.28	54

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D. Hoskins

Derren Hoskins - Lab Manager

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Direct Shear on Rock Report

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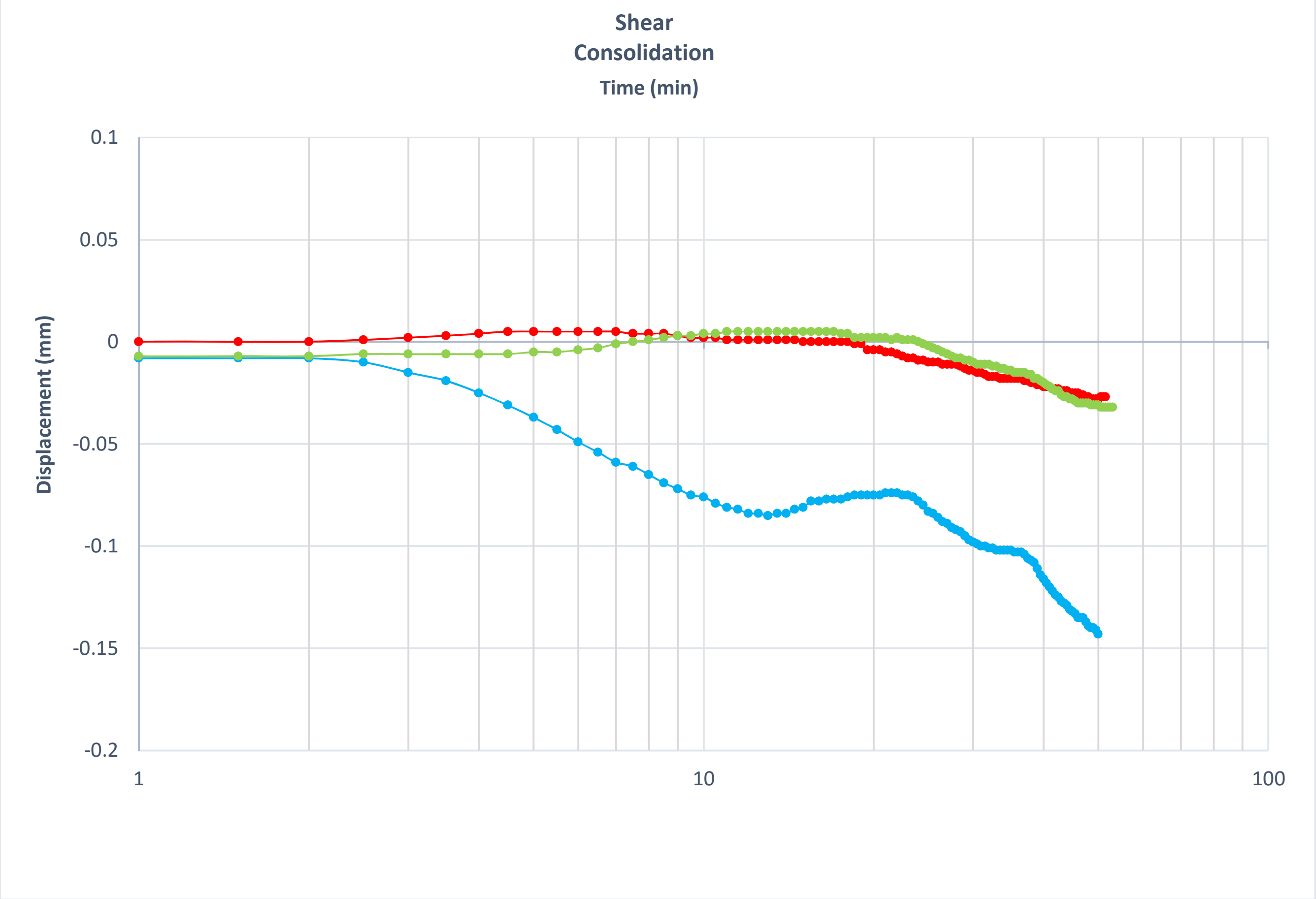
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**6/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



Sample/s supplied by Cardn(Note: Graph not to scale

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NATA Accreditation Number

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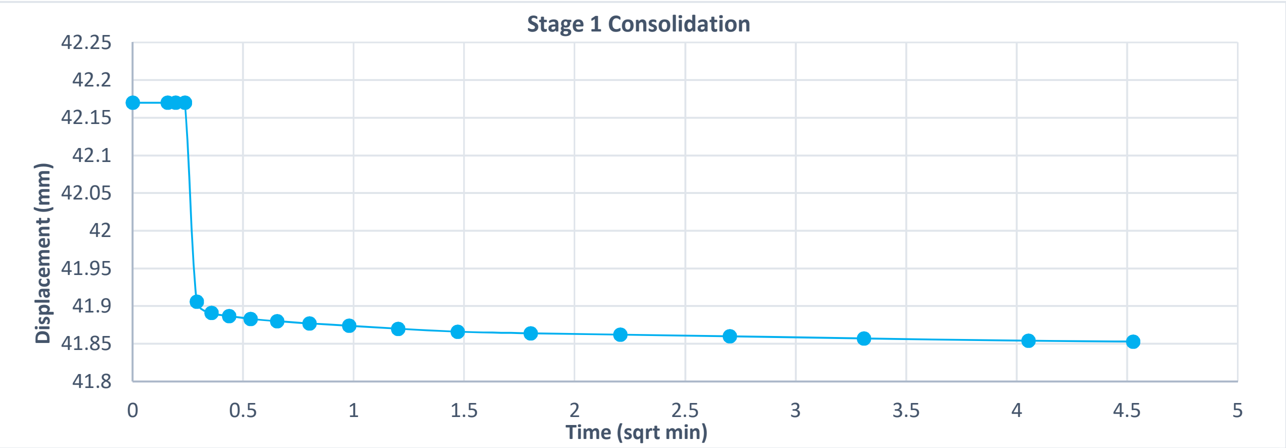
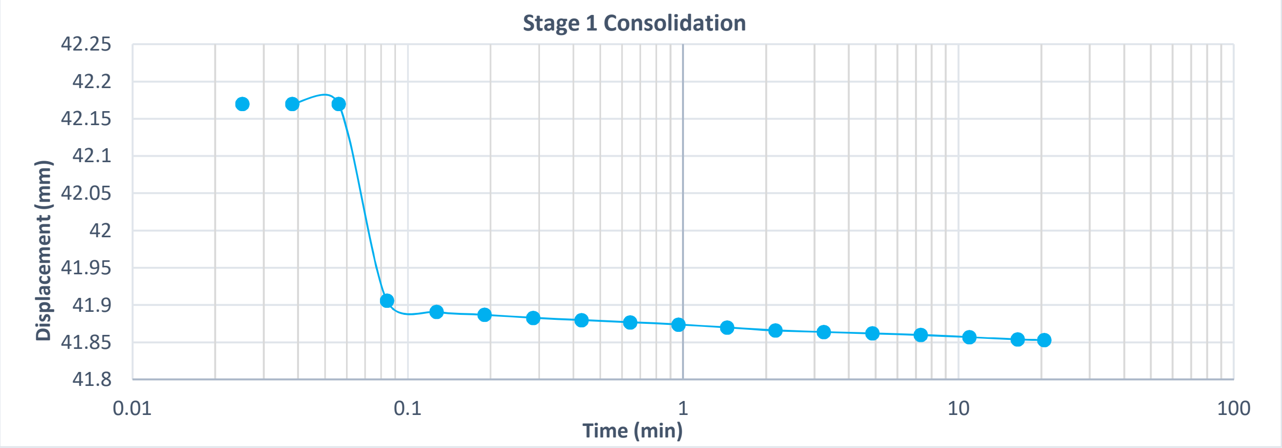
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5339A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**6/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





Sample/s supplied by Cardno Note: Graph not to scale

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Direct Shear on Rock Report

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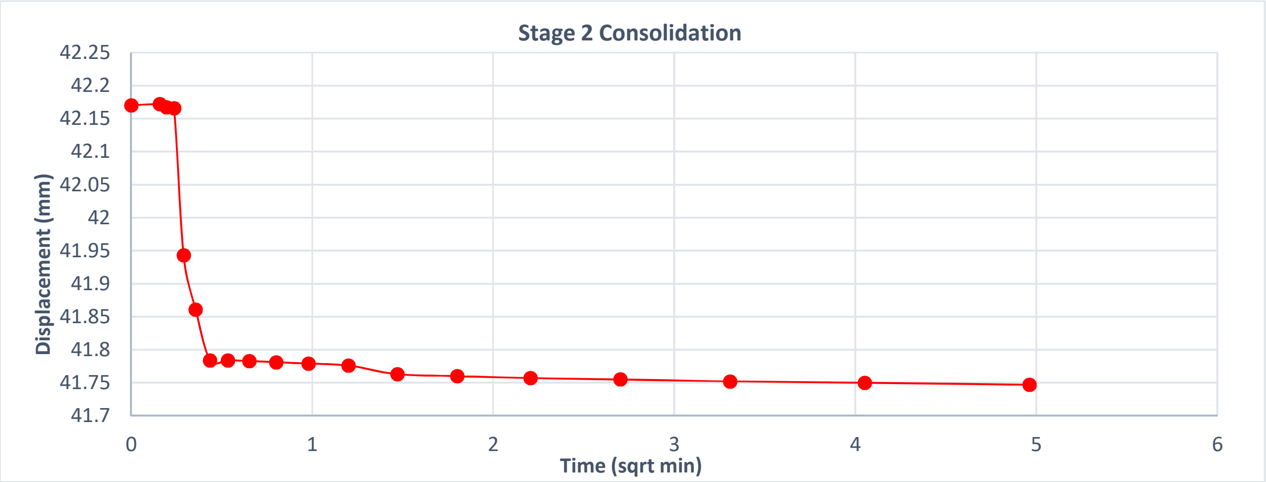
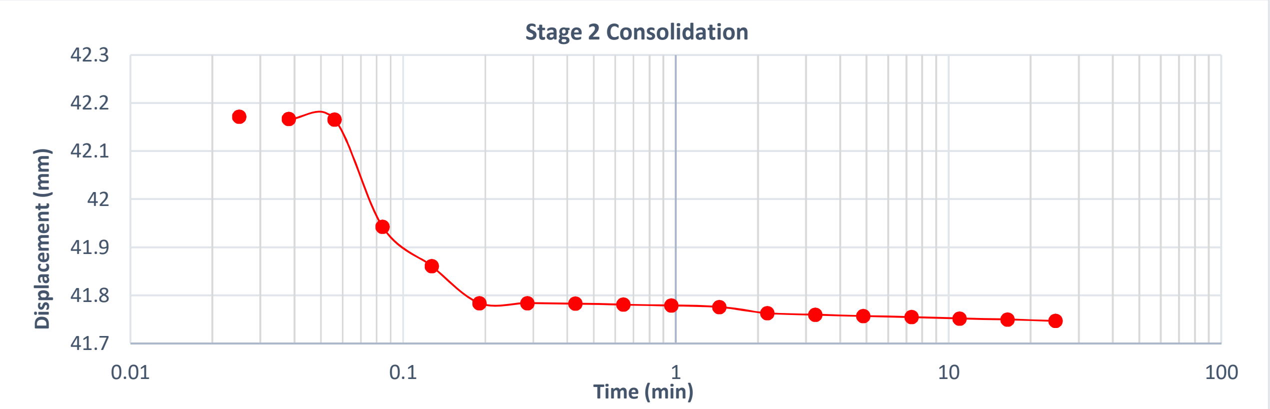
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**6/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





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Derren Hoskins - Lab Manager

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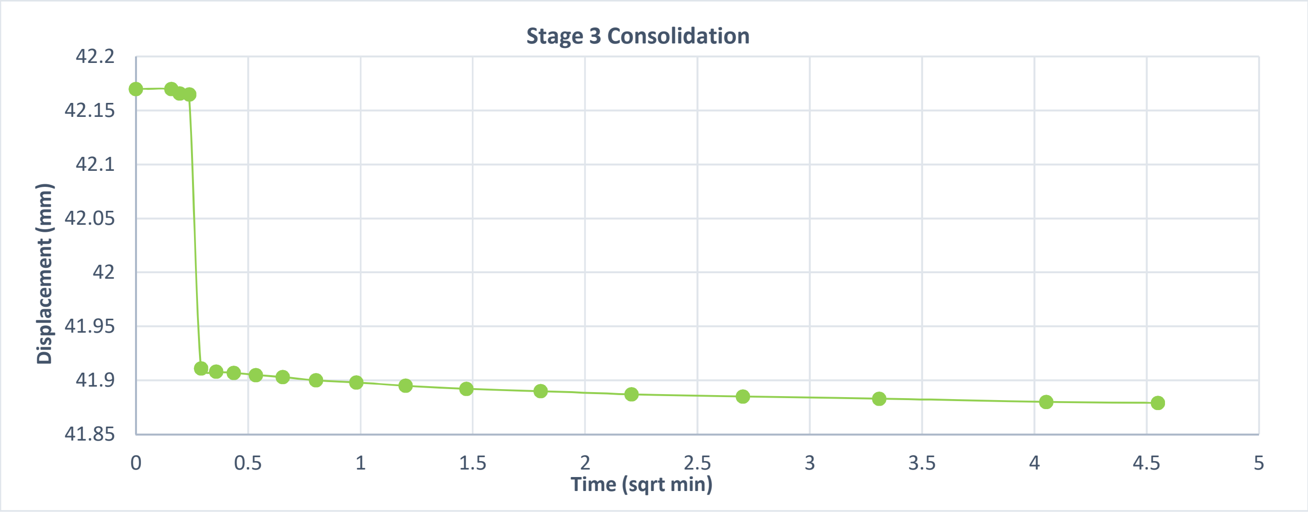
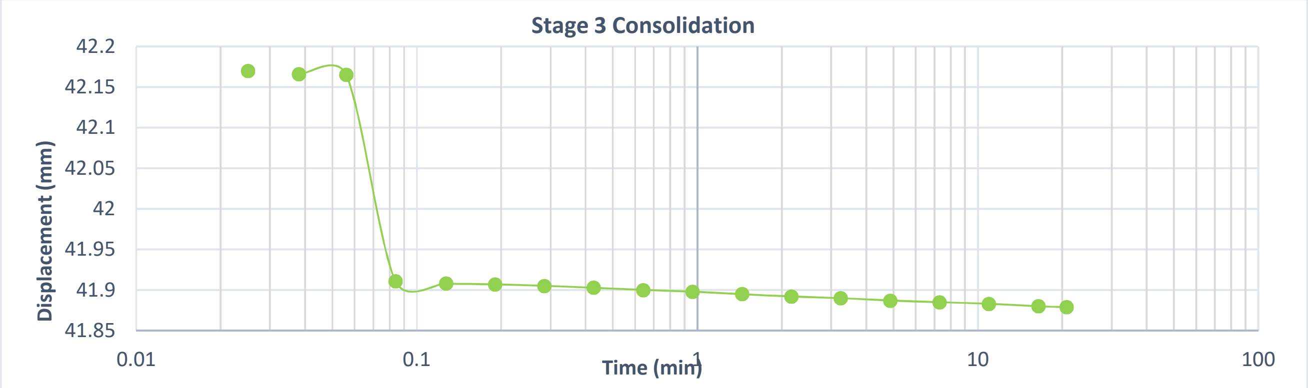
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5339A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**6/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





Sample/s supplied by Cardno Note: Graph not to scale

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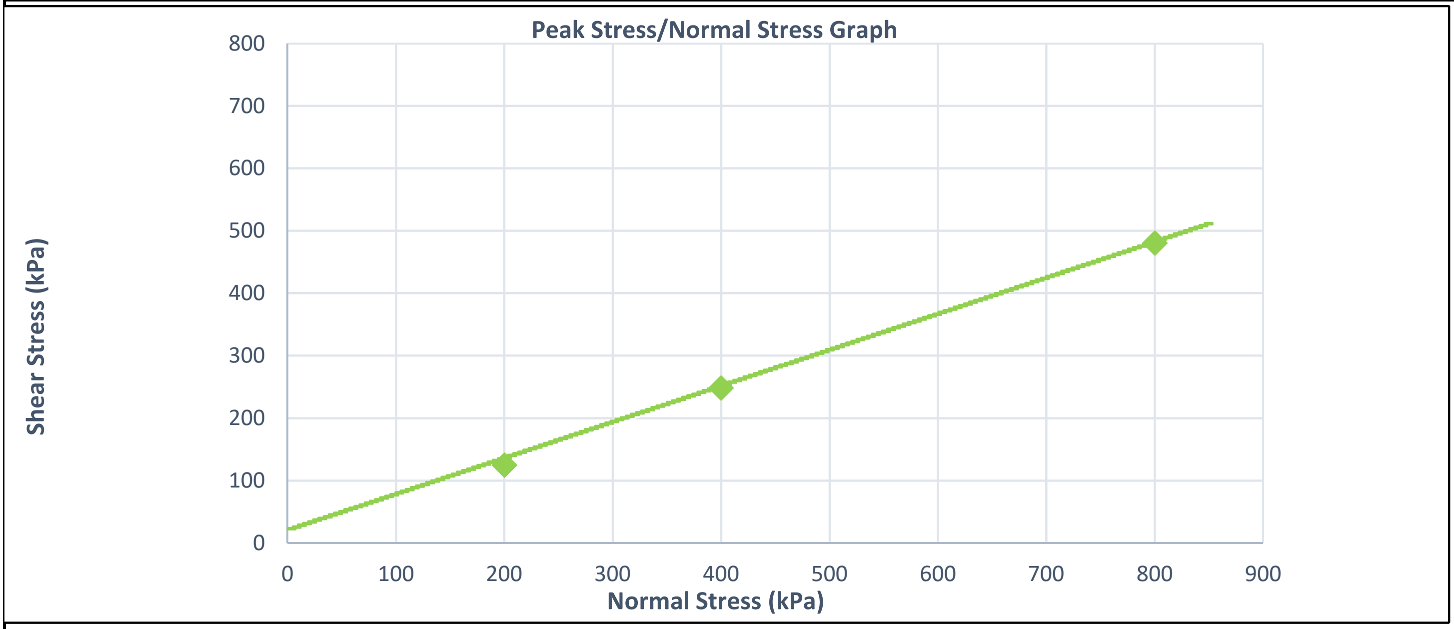
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5345A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**7/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-23**		**Page 1**

Borehole: STX1903G Sample ID: Shear-23 Depth From: 24.68 Depth To: 24.87

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	5/11/2019	Wet Density	2.39	2.39	2.39
Sampled By:	Cardno	Dry Density	2.26	2.26	2.26
Sampling Method:	AS 1289 1.2.1	Moisture (%)	5.5	5.5	5.5
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Sandstone	Peak Shear Stress (kPa)	125	248	480
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.1	0.2
Lab Ref Number:	19-5345A	Strain Rate (mm/min)	0.122	0.108	0.099



Effective Cohesion C' (kPa): 20.0
Effective Angle of Friction ϕ' (Degrees): 30.0
Failure Criteria: Peak Shear Stress

Sample/s supplied by Cardn Note: Graph not to scale

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Derren Hoskins - Lab Manager

NATA Accreditation Number
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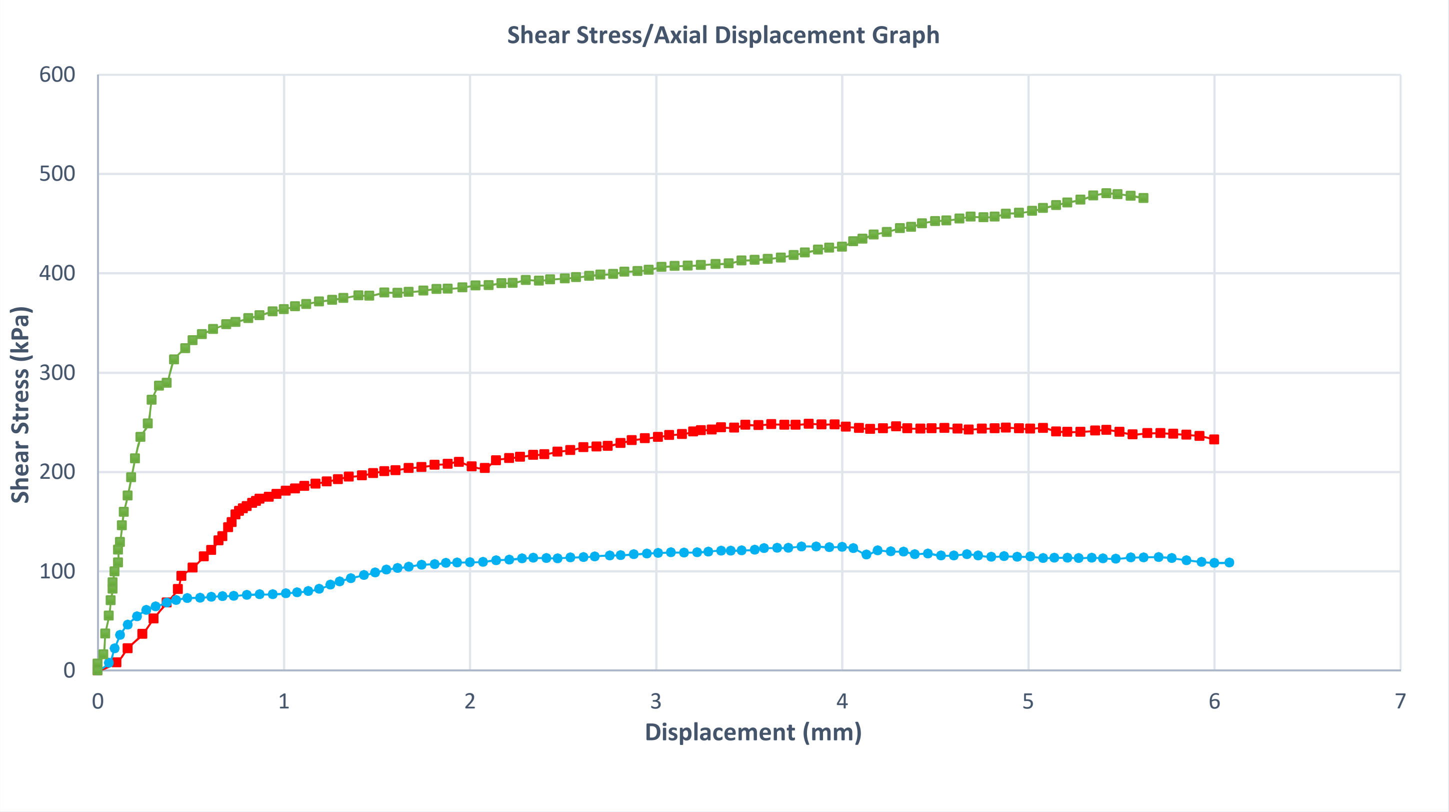
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	125	3.78	55
2	400	248	3.82	56
3	800	480	5.42	61

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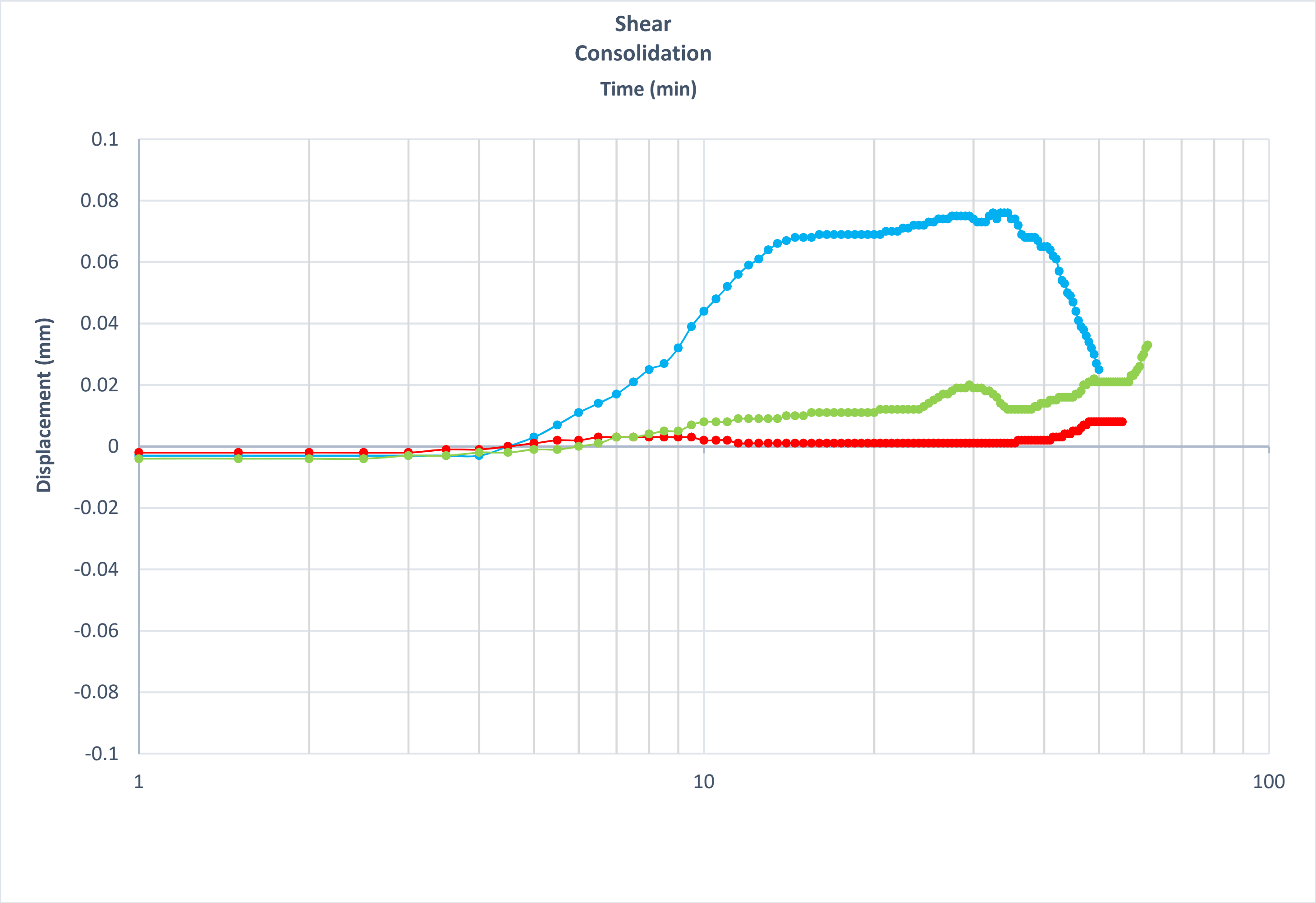
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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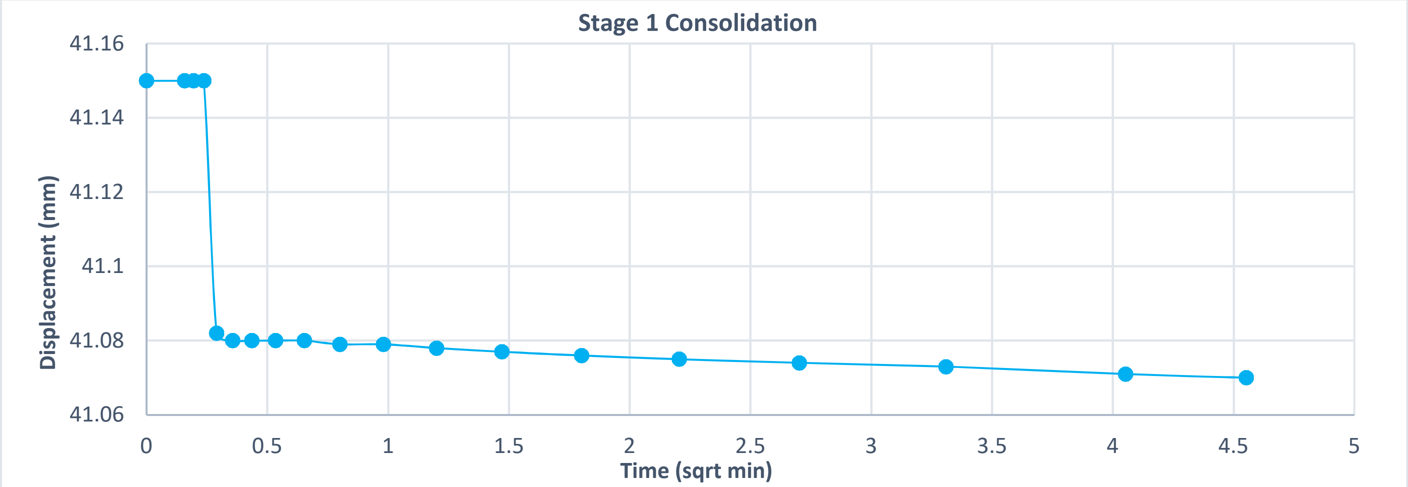
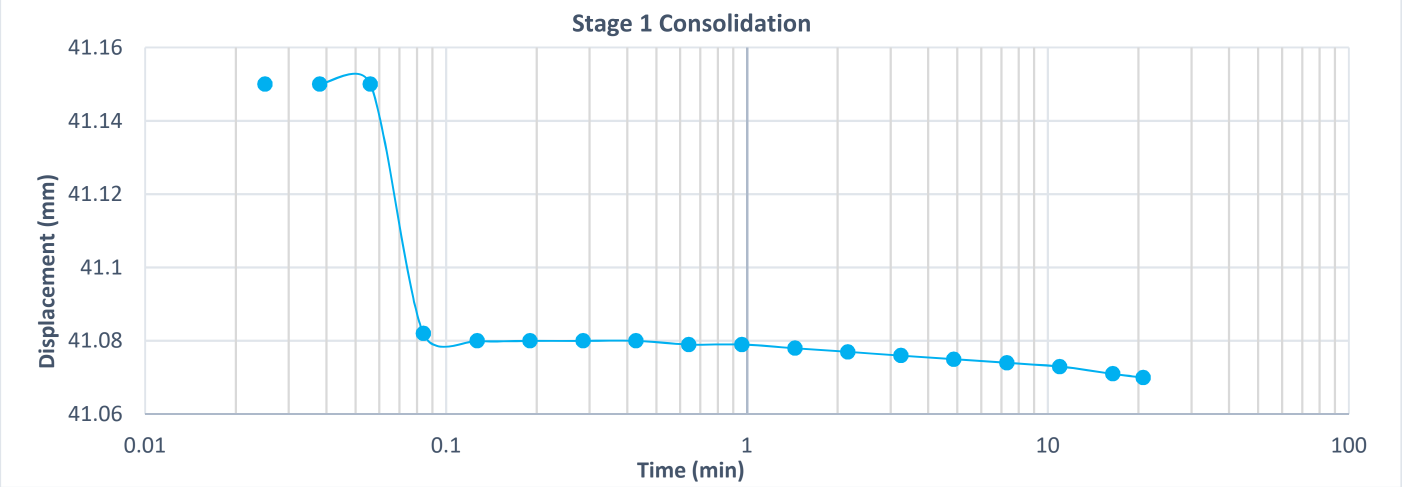
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





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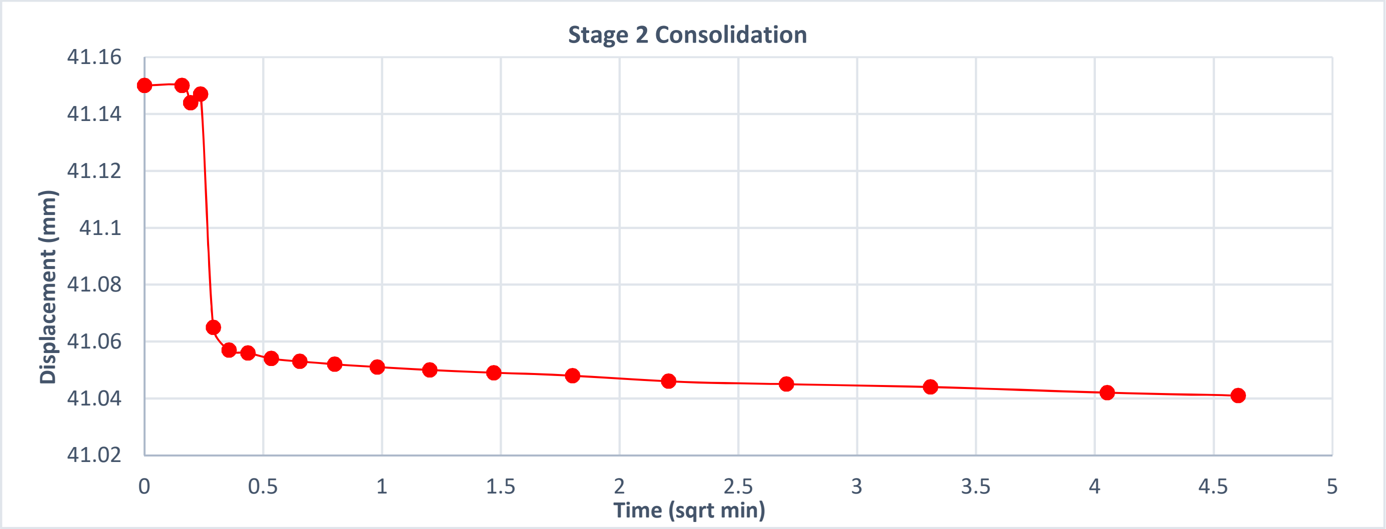
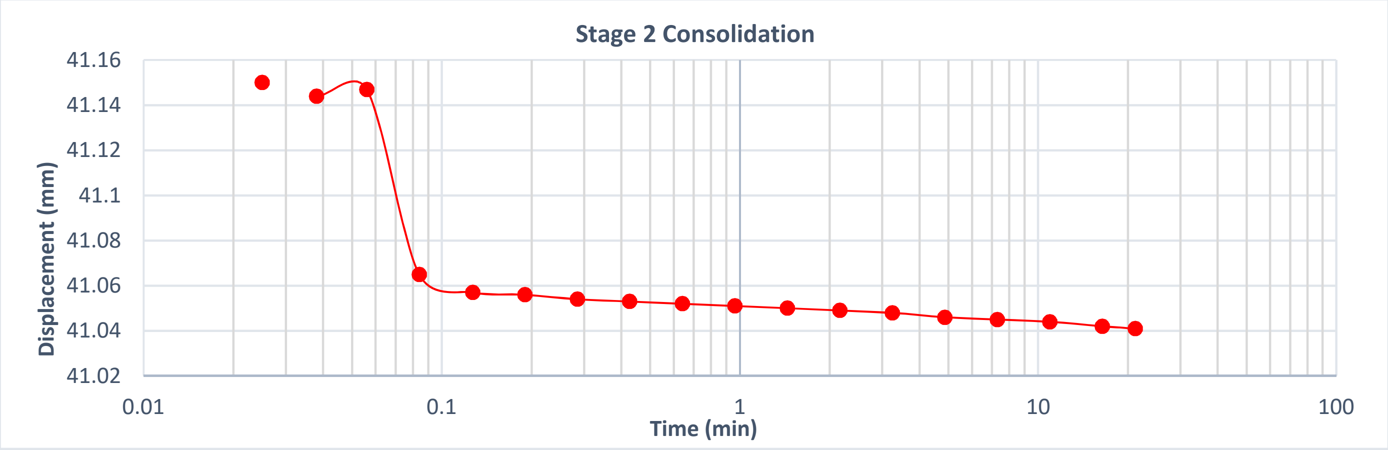
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





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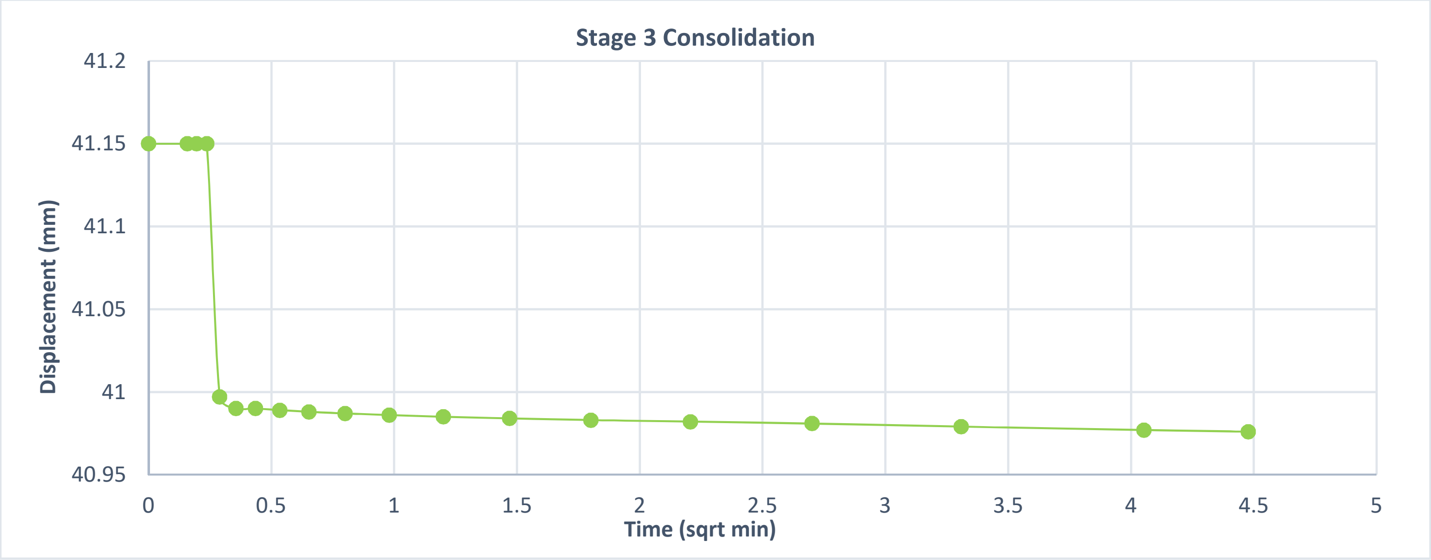
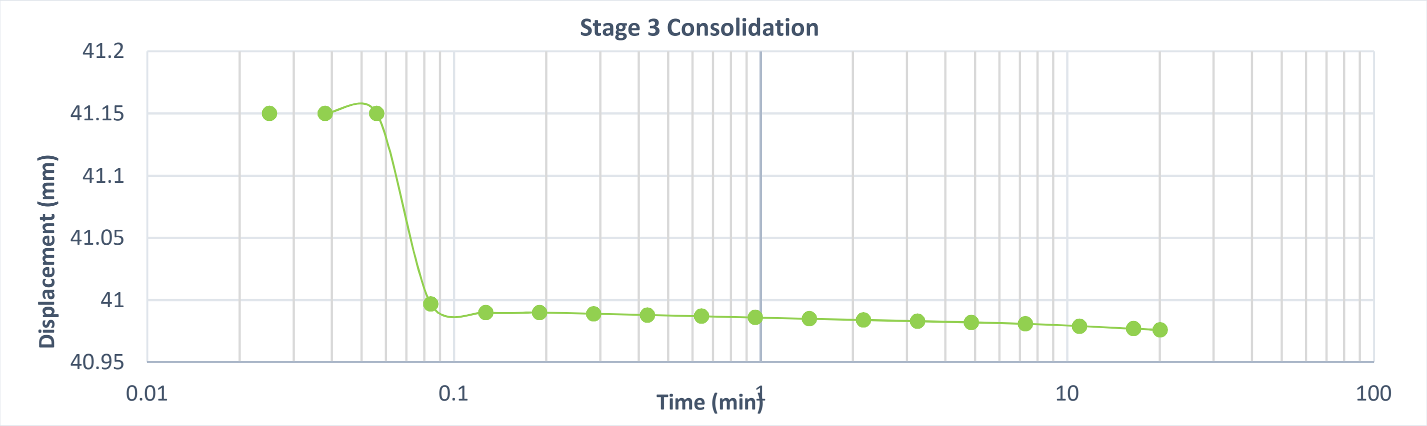
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**7/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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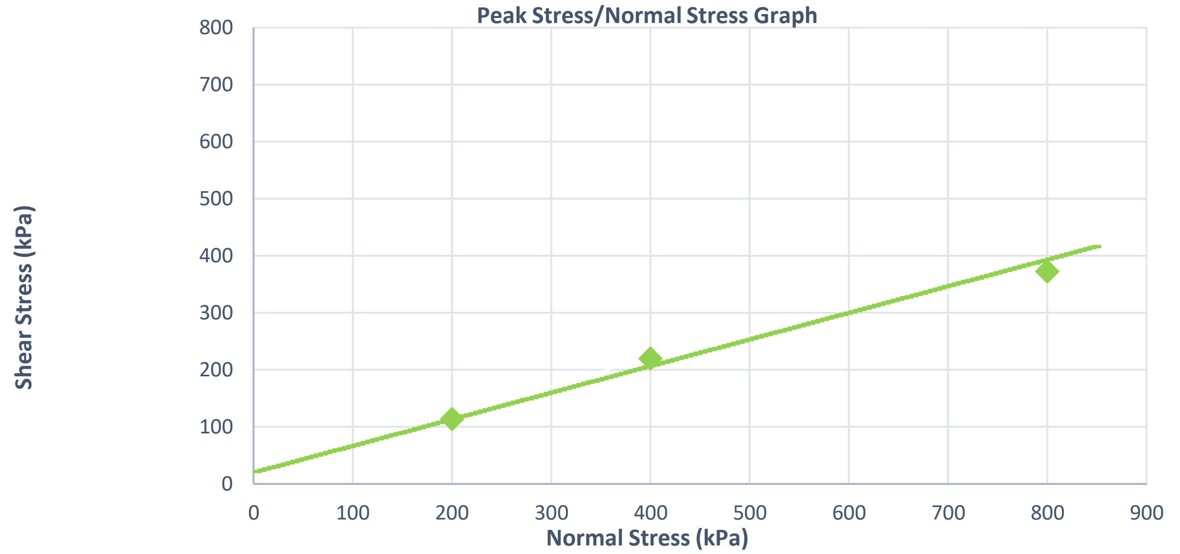
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**7/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-31**		**Page 1**

Borehole: STX1903G Sample ID: Shear-31 Depth From: 38.96 Depth To: 39.16

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	6/11/2019	Wet Density	2.31	2.32	2.32
Sampled By:	Cardno	Dry Density	2.17	2.18	2.17
Sampling Method:	AS 1289 1.2.1	Moisture (%)	6.6	6.3	6.6
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Sandstone	Peak Shear Stress (kPa)	114	220	373
Sample Type:	Core	Primary Consolidation (mm)	0.4	0.2	0.3
Lab Ref Number:	19-5353A	Strain Rate (mm/min)	0.123	0.110	0.104



Effective Cohesion C' (kPa):	20.0
Effective Angle of Friction ϕ' (Degrees):	25.0
Failure Criteria:	Peak Shear Stress

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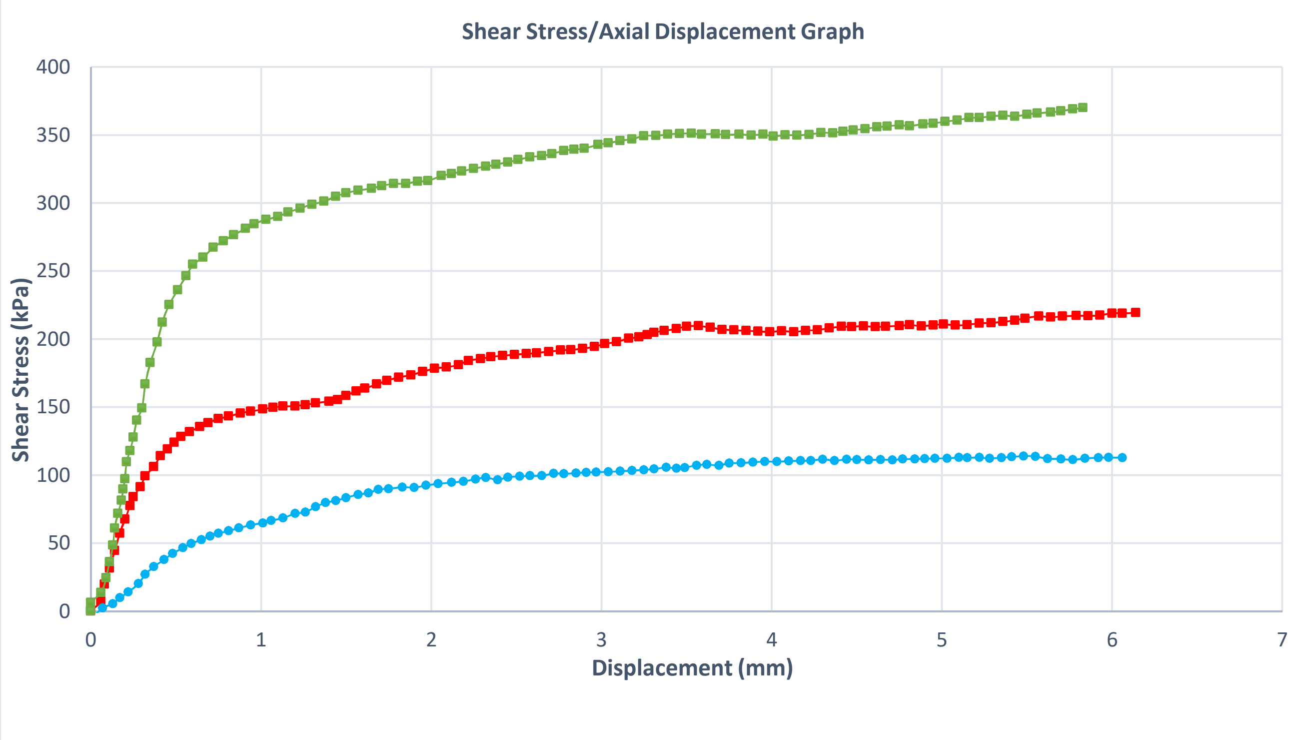
Address: **Level 17, 240 Queen Street, Brisbane, QLD**
Project Number: **M30863**
Project Name: **CQ Coal Styx Basin Geotechnical Investigati**
Location: **STX1903G**

Report Number: **19-5353A**
Report Date: **7/11/2019**
Order Number: **-**
Test Method **AS 1289.6.2.2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	114	5.48	53
2	400	220	6.35	58
3	800	373	6.33	60

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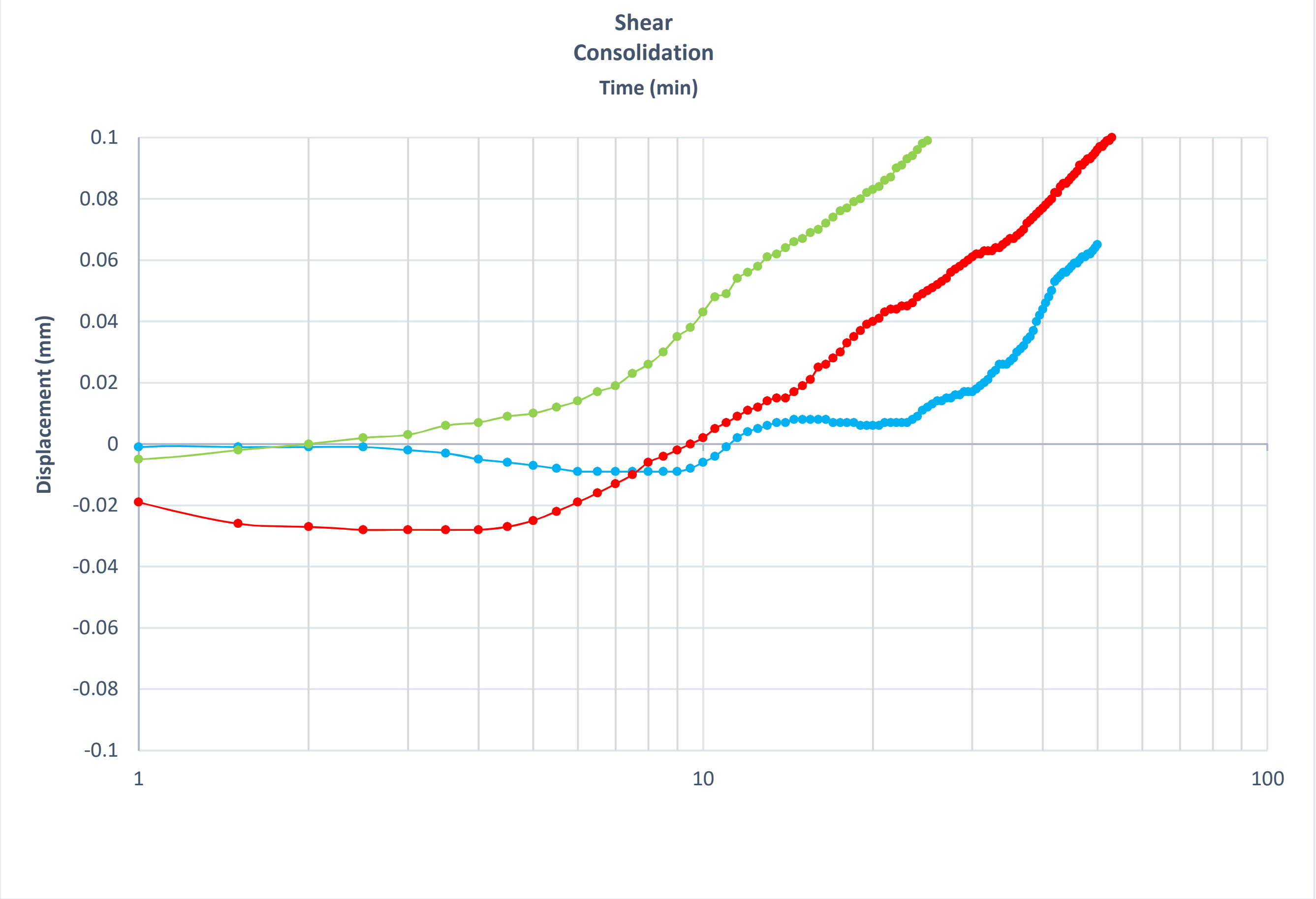
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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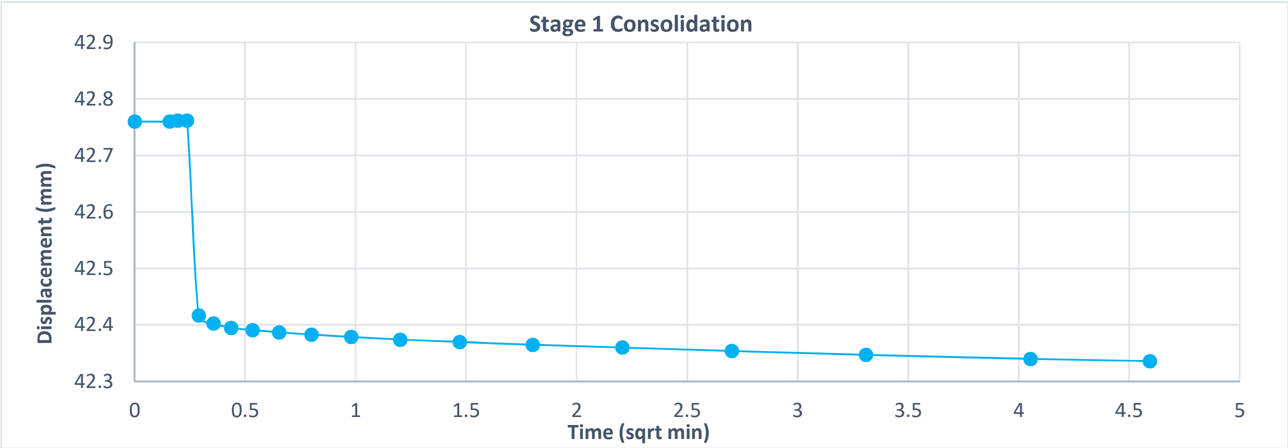
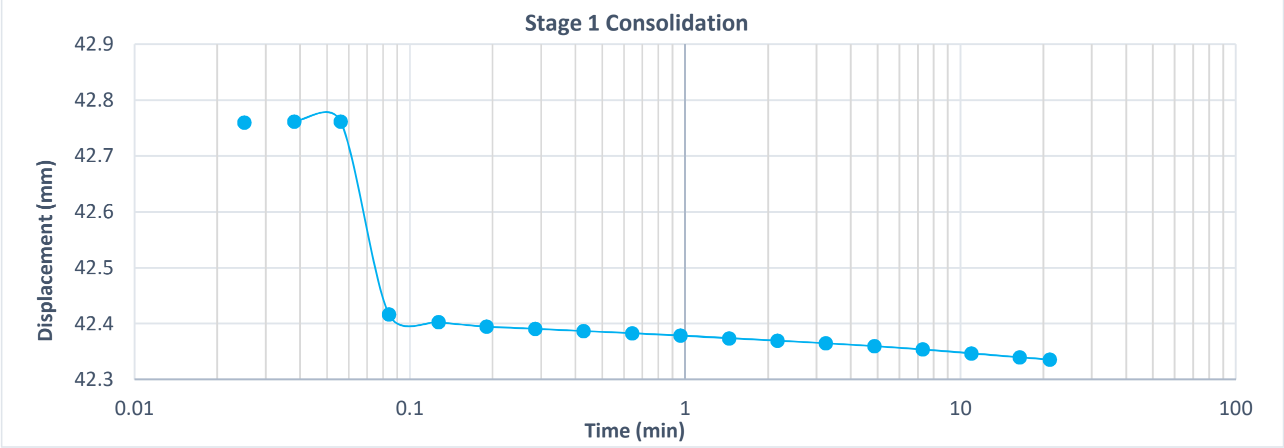
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





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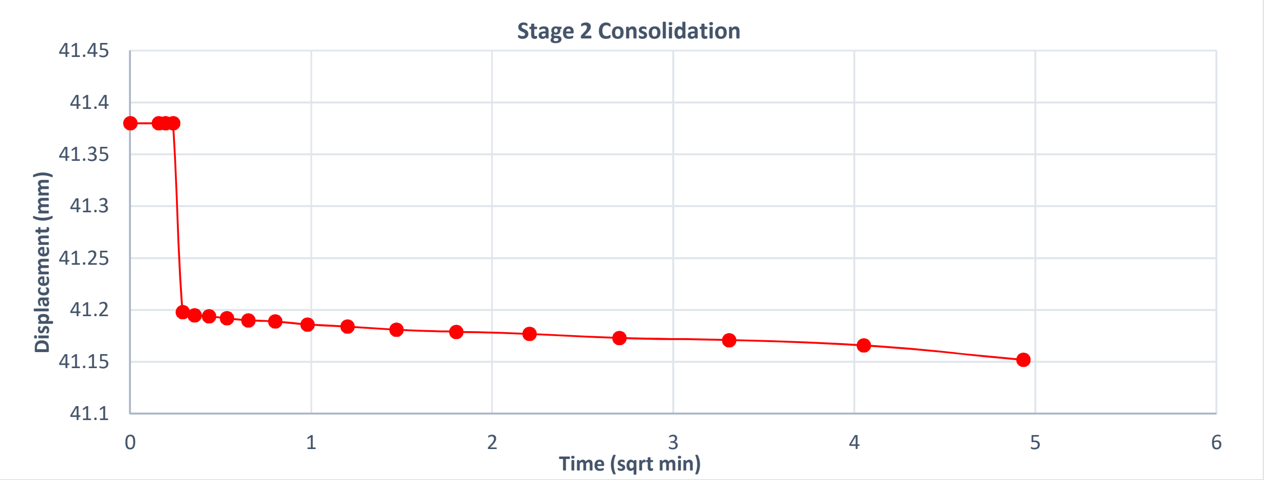
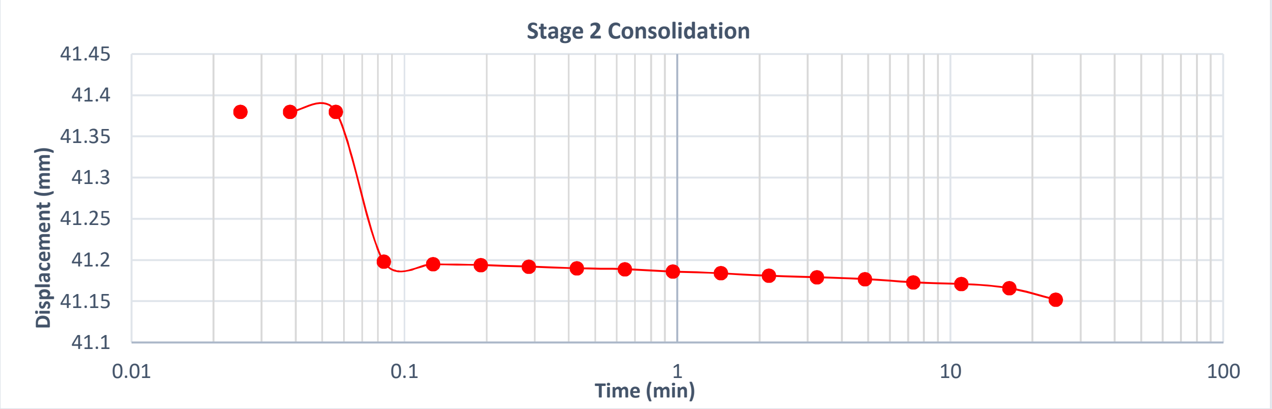
Project Number: **M30863**
Project Name: **CQ Coal Styx Basin Geotechnical Investigatio**
Location: **STX1903G**

Report Number: **19-5353A**
Report Date: **7/11/2019**
Order Number: **-**
Test Method **AS 1289.6.2.2**
Page 5





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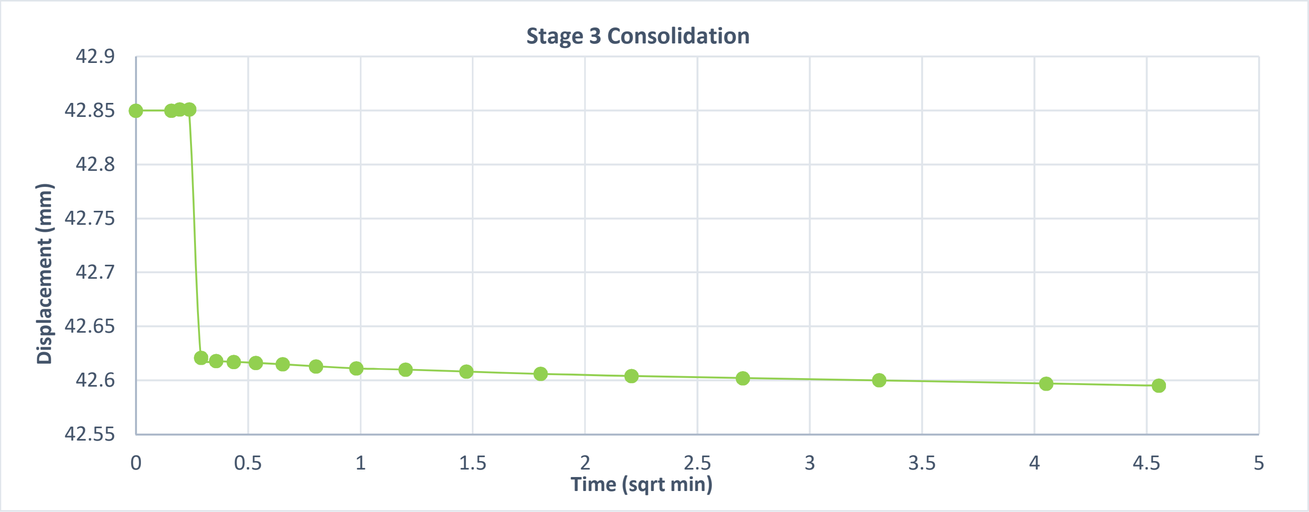
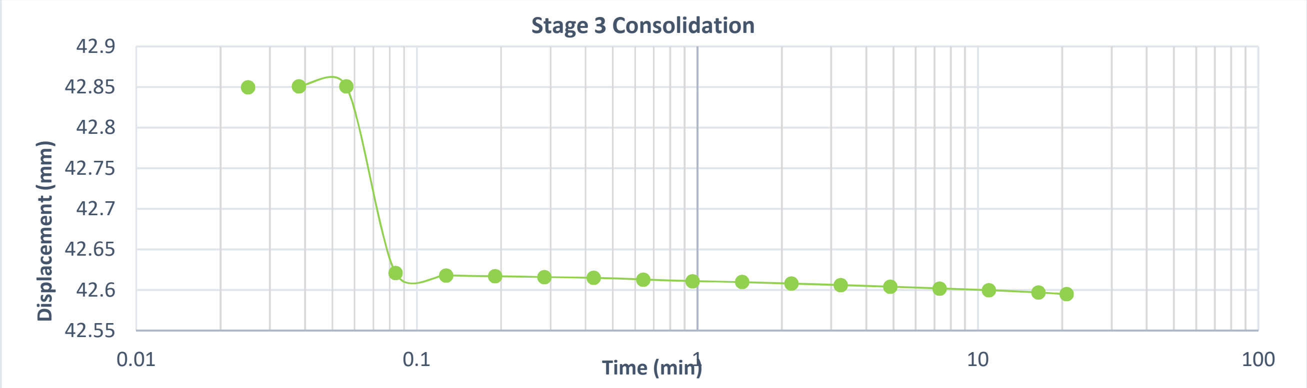
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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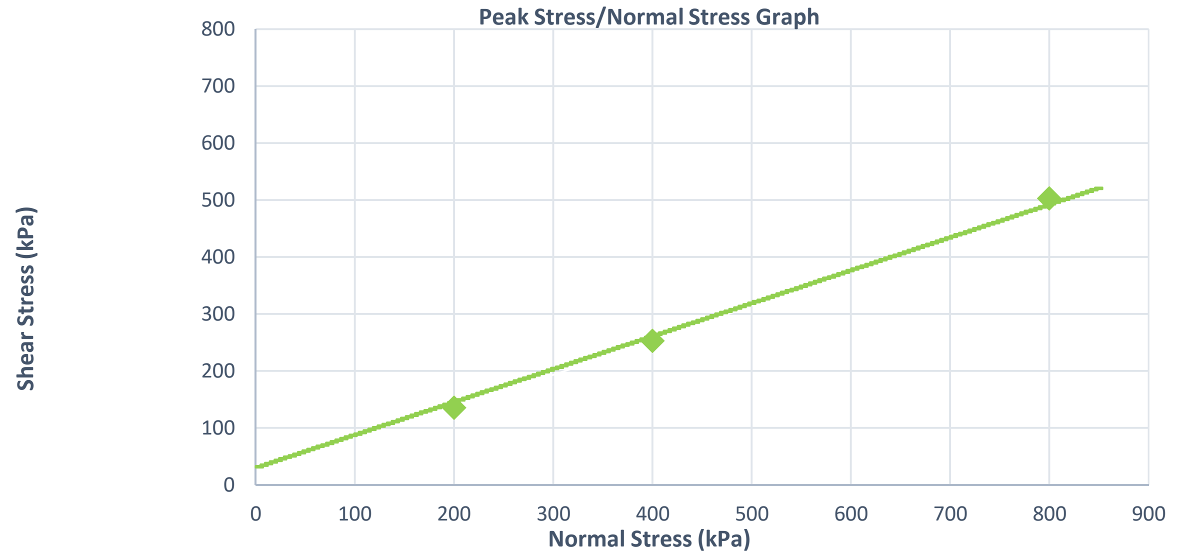
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5360A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**8/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-38**		**Page 1**

Borehole: STX1903G Sample ID: Shear-38 Depth From: 43.42 Depth To: 43.78

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	7/11/2019	Wet Density	2.40	2.23	2.25
Sampled By:	Cardno	Dry Density	2.32	2.14	2.17
Sampling Method:	AS 1289 1.2.1	Moisture (%)	3.5	4.1	3.6
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Sandstone	Peak Shear Stress (kPa)	136	253	503
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.2	0.3
Lab Ref Number:	19-5360A	Strain Rate (mm/min)	0.117	0.108	0.097



Effective Cohesion C' (kPa):	30.0
Effective Angle of Friction ϕ' (Degrees):	30.0
Failure Criteria:	Peak Shear Stress

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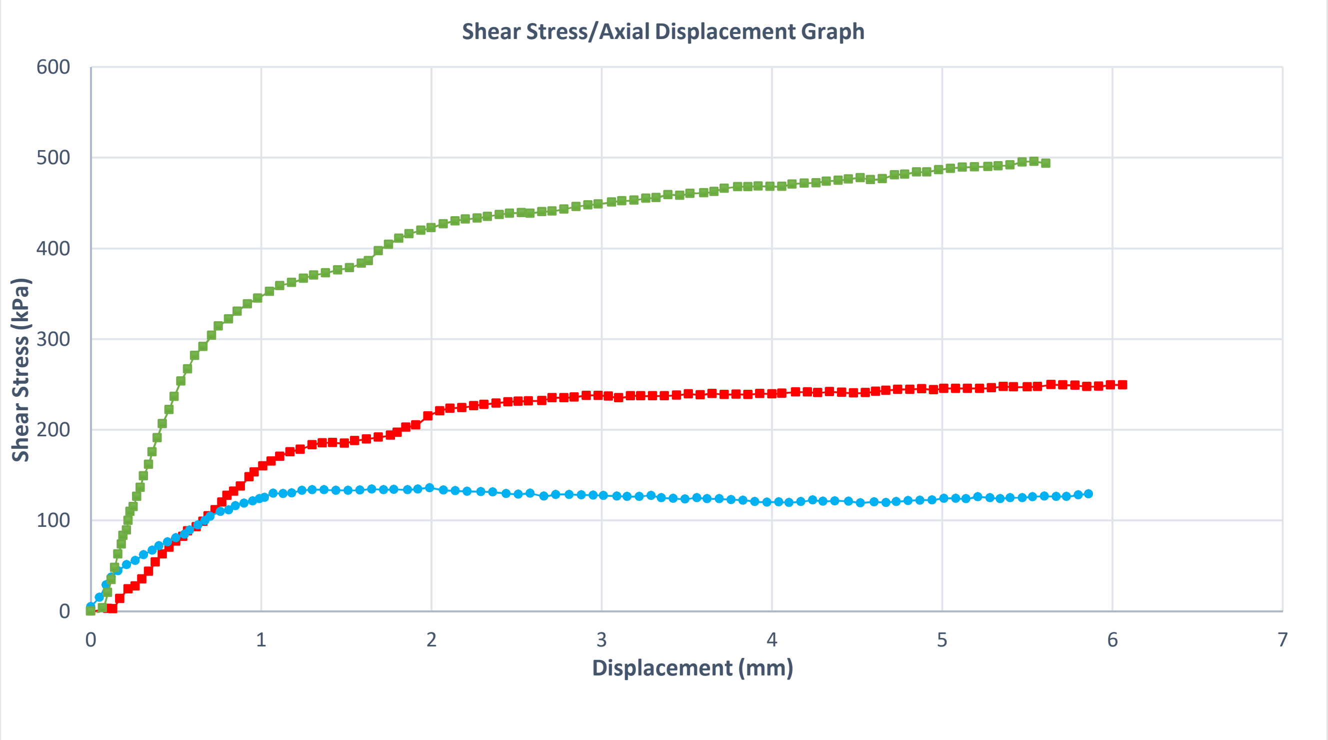
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	136	1.99	61
2	400	253	7.24	59
3	800	503	6.87	61

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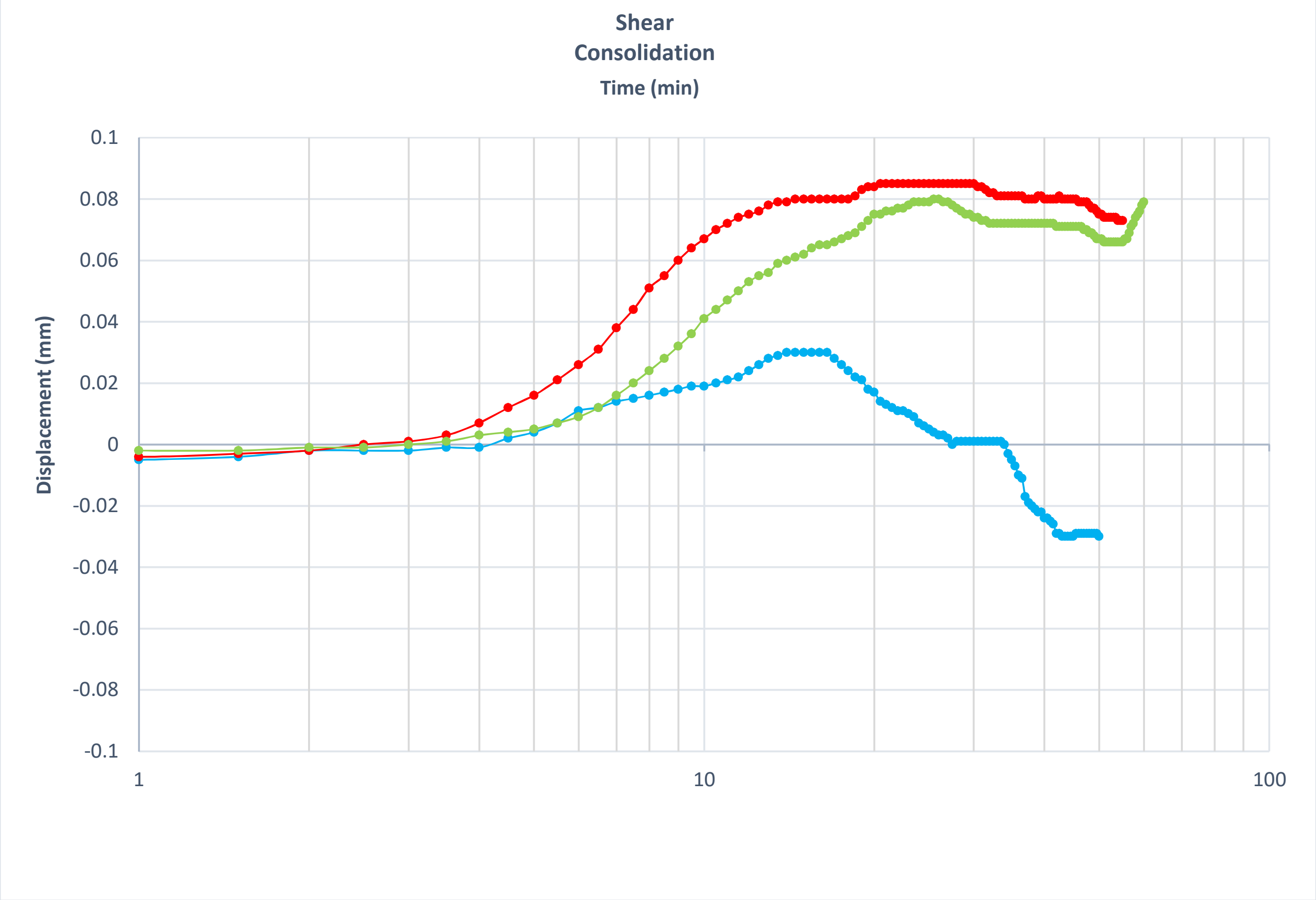
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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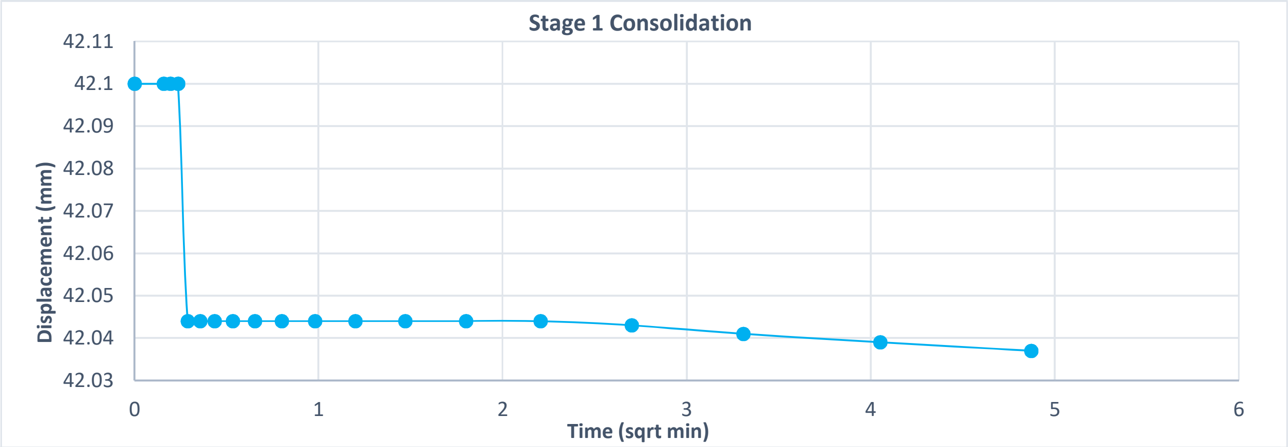
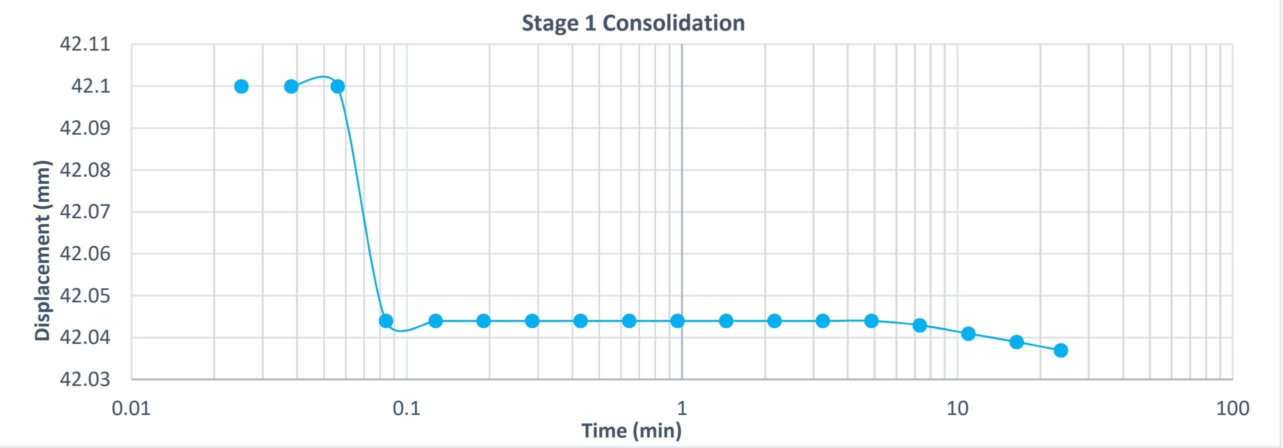
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**8/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





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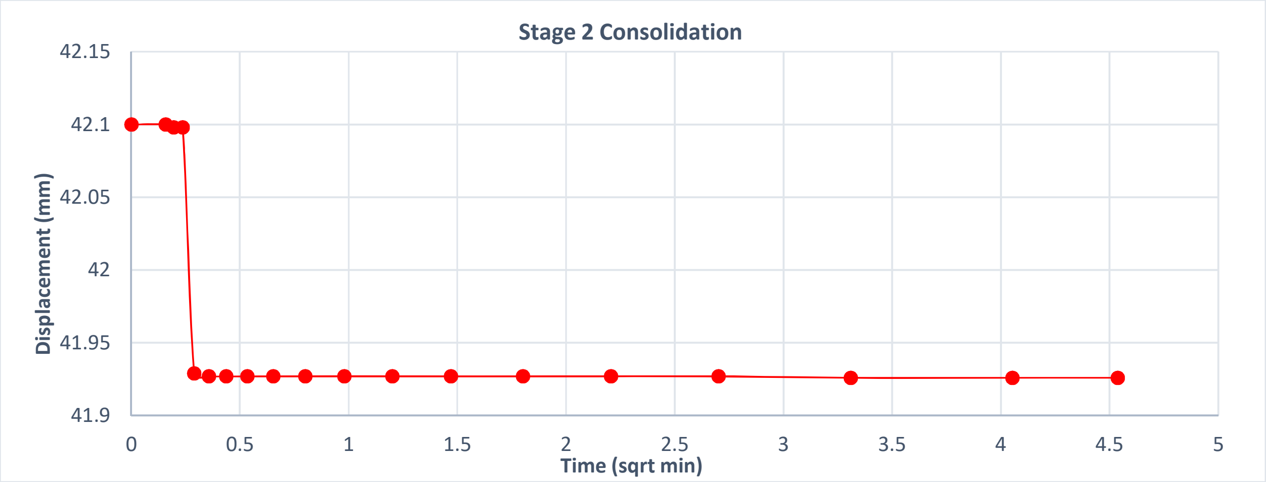
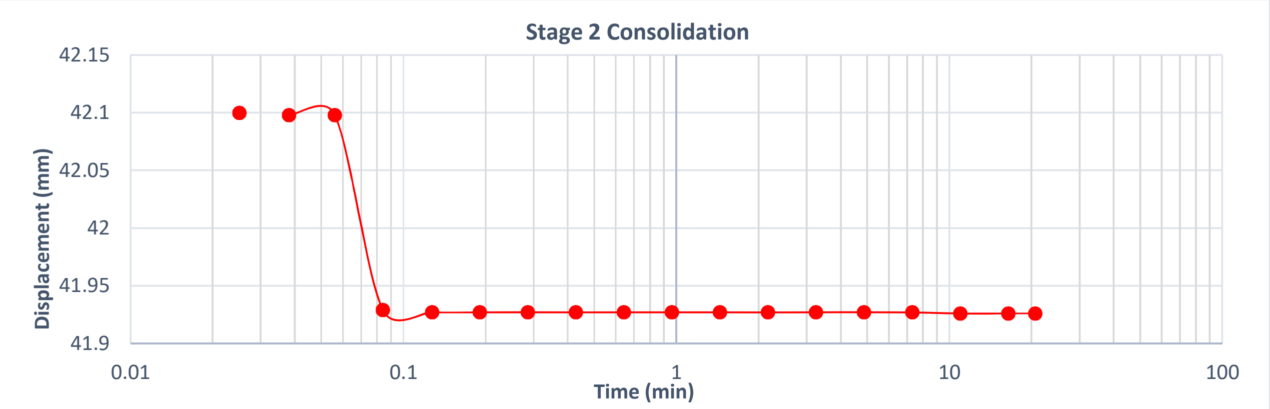
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5360A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**8/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





Sample/s supplied by Cardno Note: Graph not to scale

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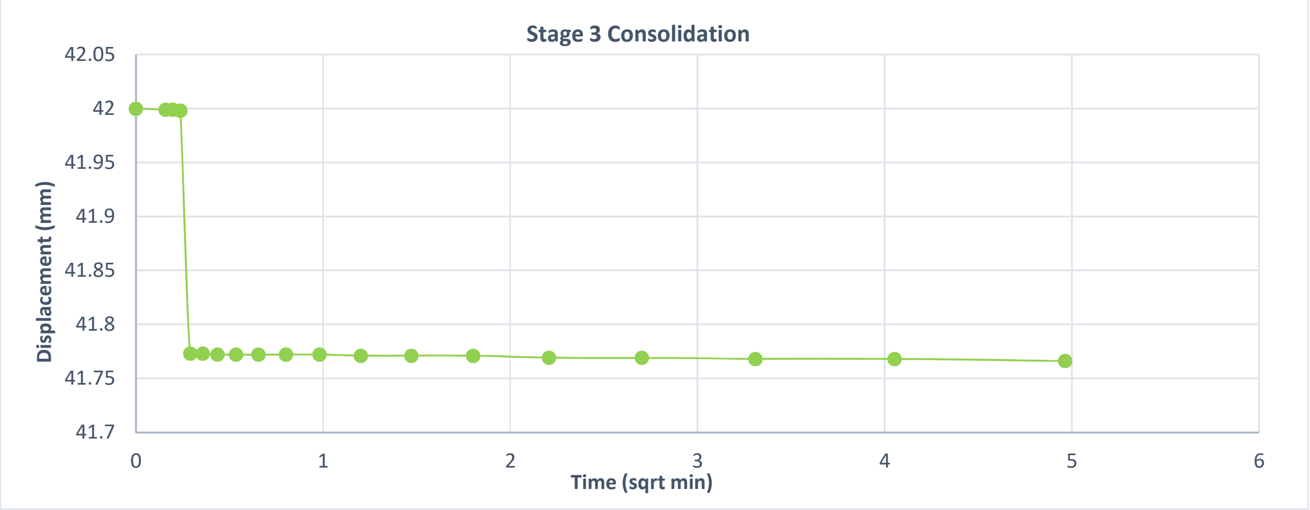
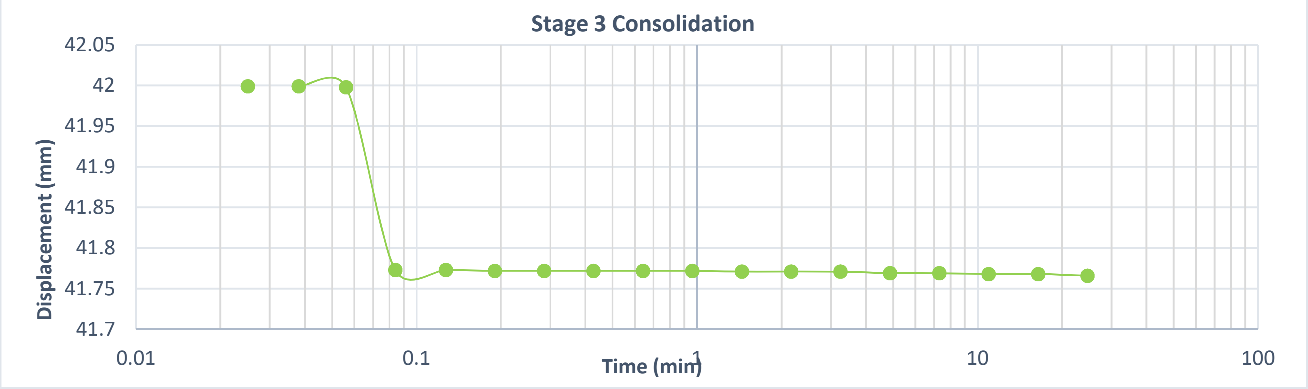
Location:	**STX1903G**		**Page 6**





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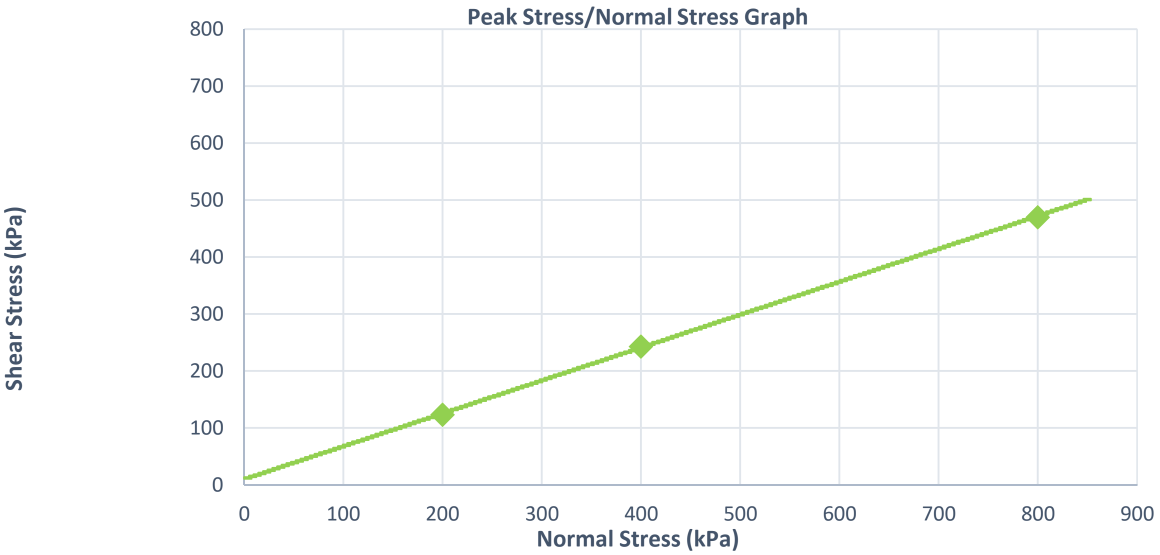
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-45**		**Page 1**

Borehole: STX1903G Sample ID: Shear-45 Depth From: 48.96 Depth To: 49.22

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	7/11/2019	Wet Density	2.53	2.44	2.49
Sampled By:	Cardno	Dry Density	2.43	2.34	2.39
Sampling Method:	AS 1289 1.2.1	Moisture (%)	4.3	4.3	4.3
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Sandstone	Peak Shear Stress (kPa)	123	243	470
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.1	0.2
Lab Ref Number:	19-5367A	Strain Rate (mm/min)	0.123	0.108	0.103



Effective Cohesion C' (kPa):	10.0
Effective Angle of Friction ϕ' (Degrees):	30.0
Failure Criteria:	Peak Shear Stress

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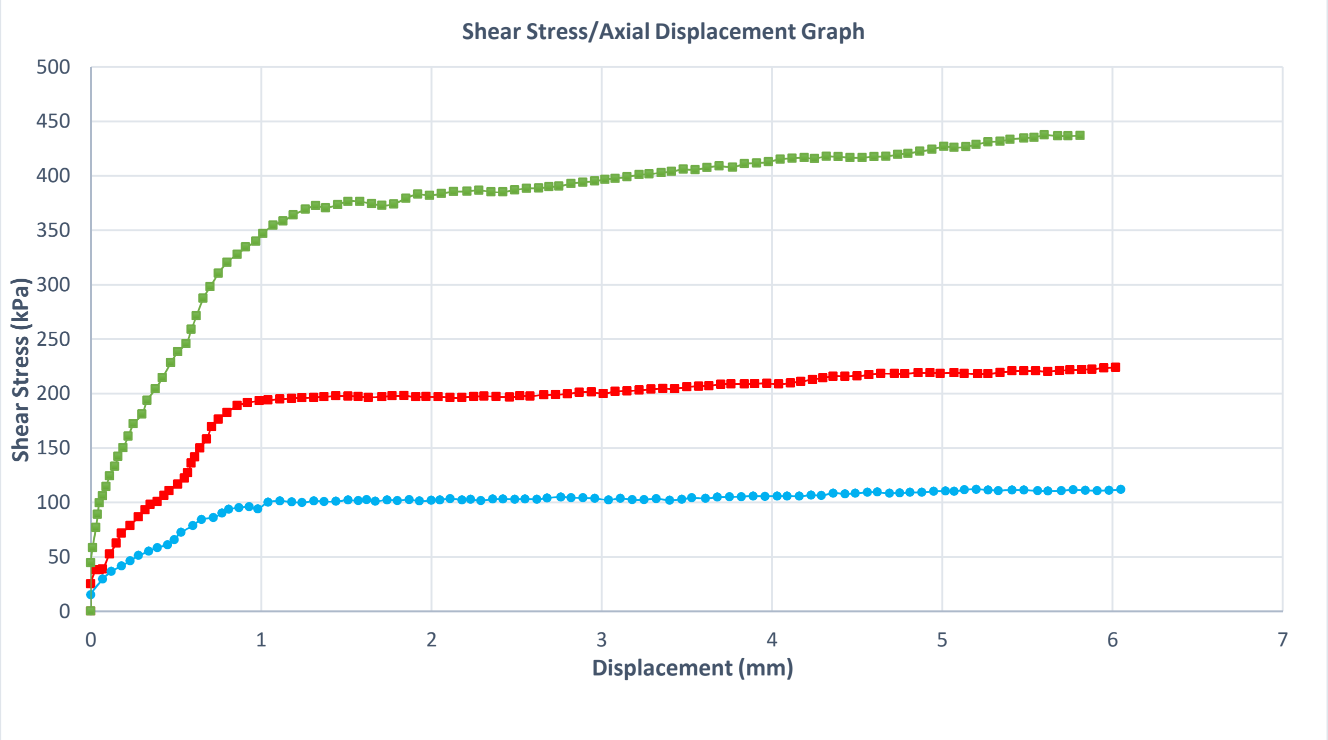
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	123	7.85	65
2	400	243	7.90	64
3	800	470	7.93	66

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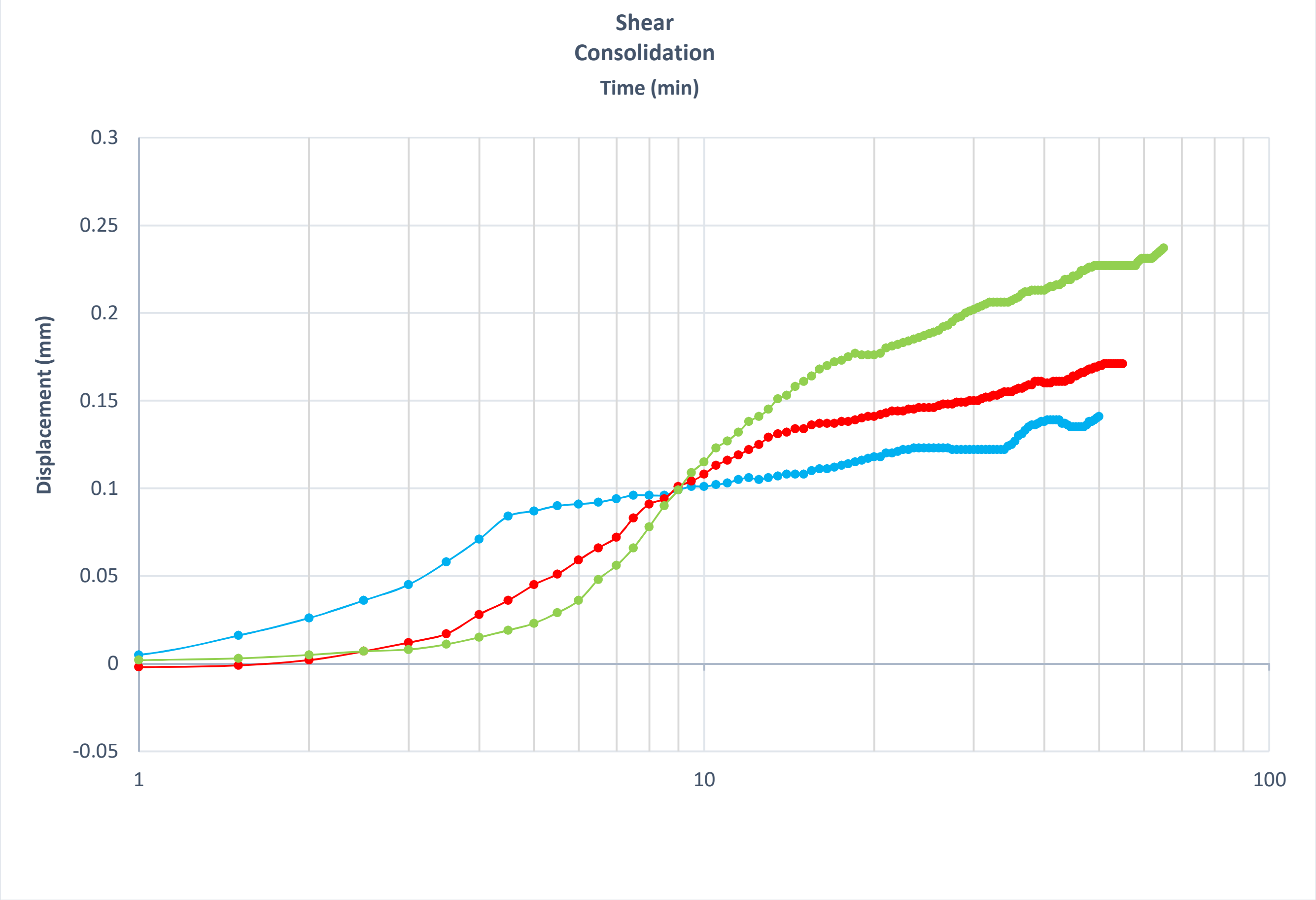
Location:	**STX1903G**		**Page 3**



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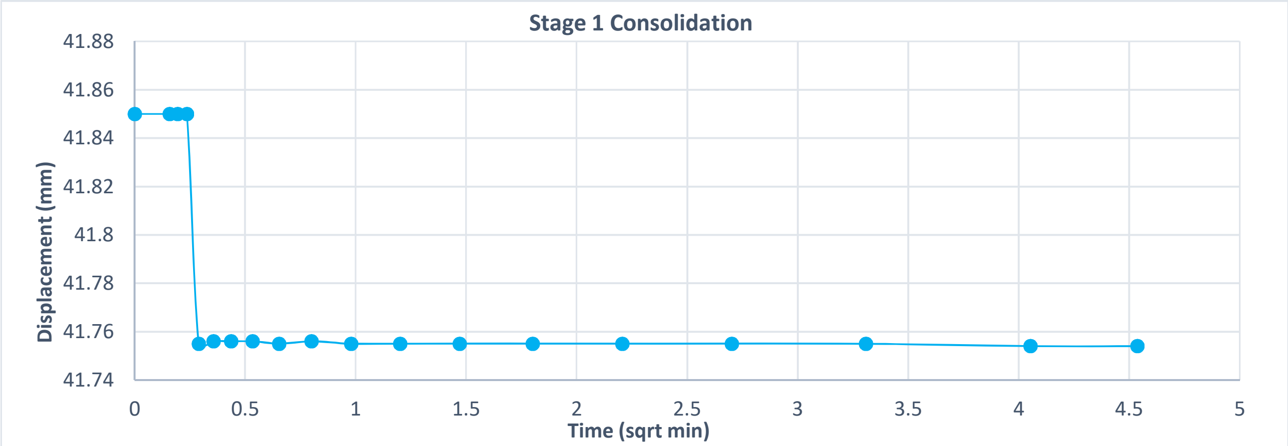
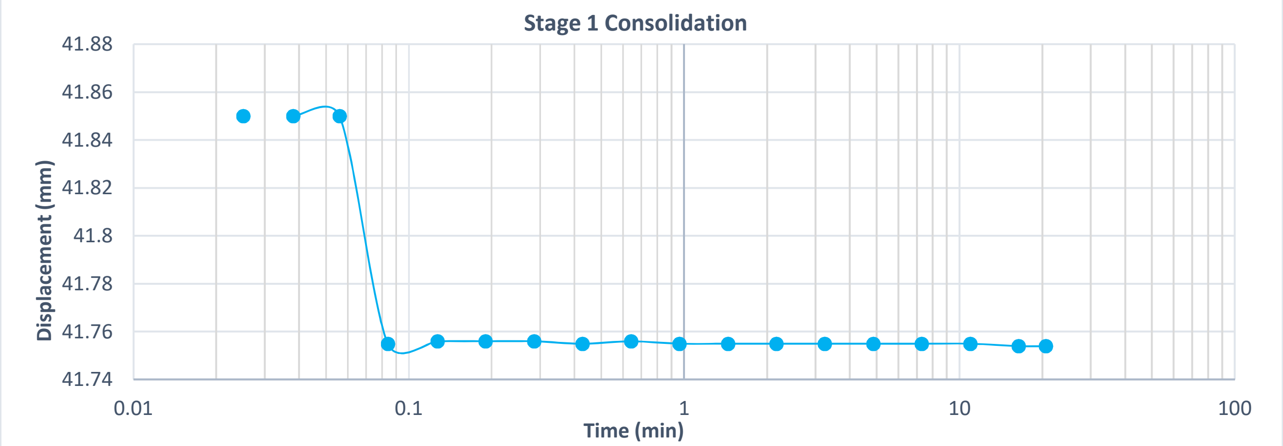
Location:	**STX1903G**		**Page 4**





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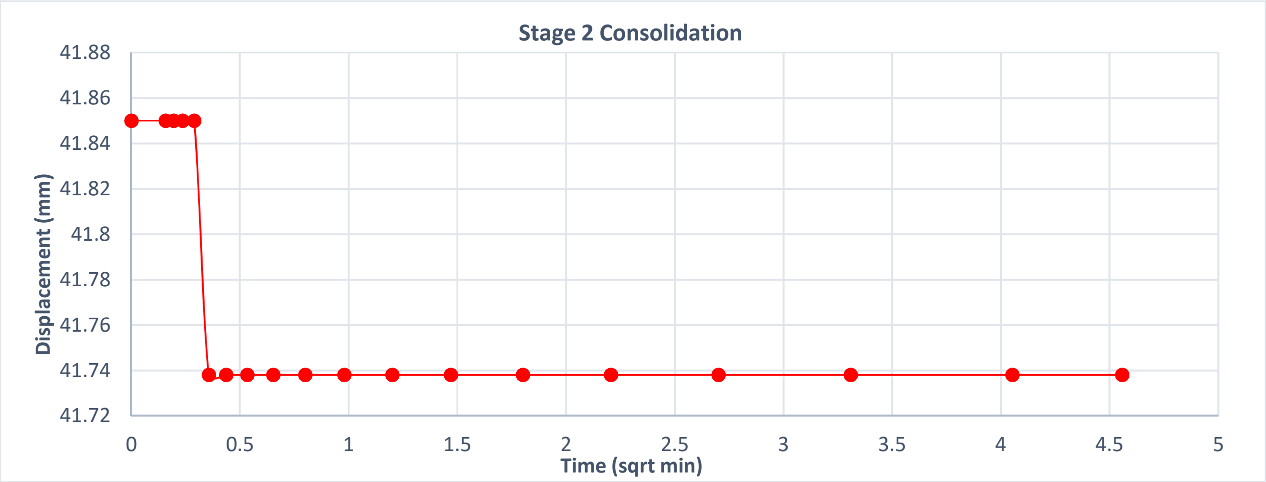
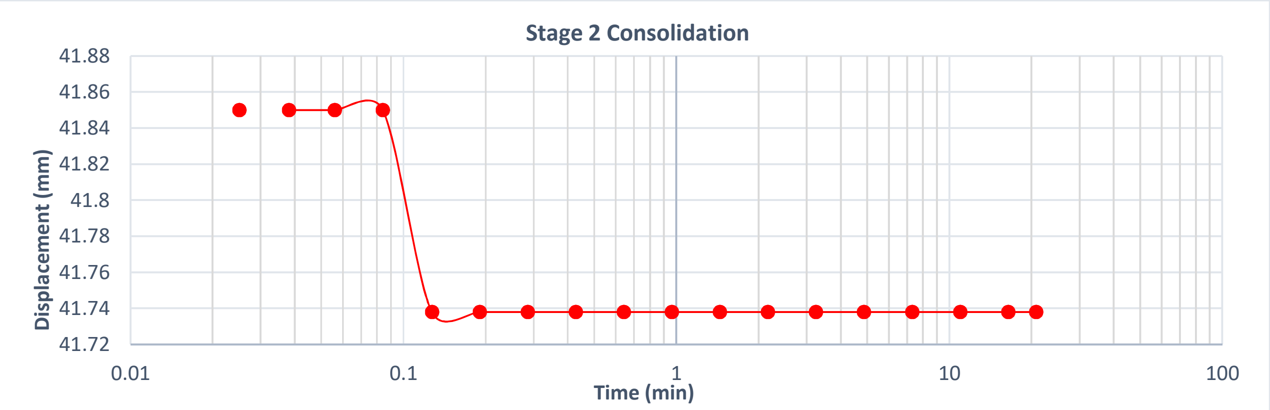
Location:	**STX1903G**		**Page 5**





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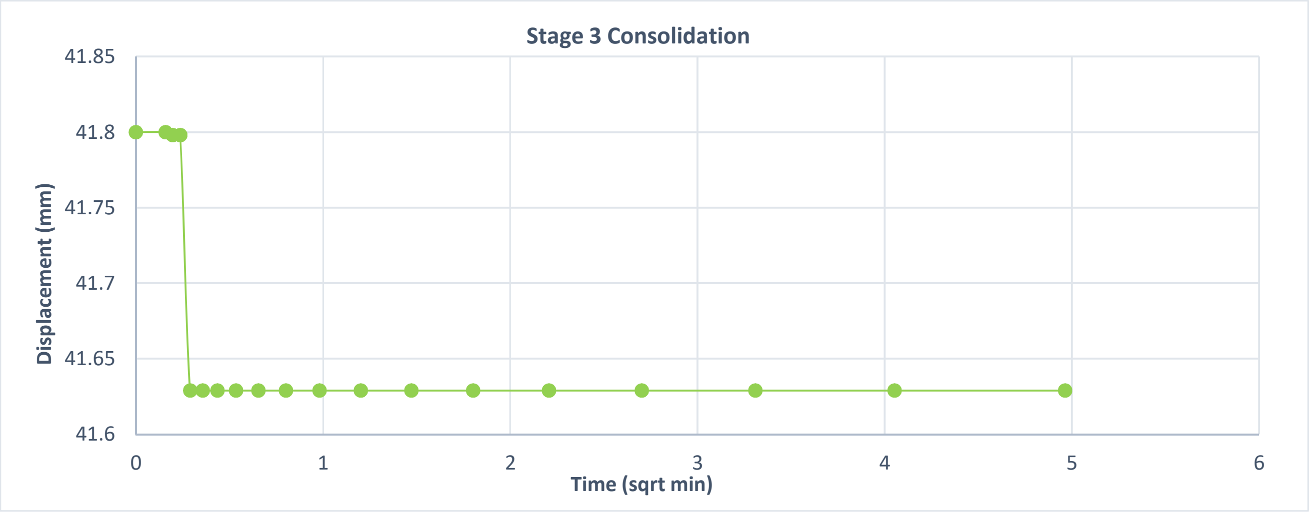
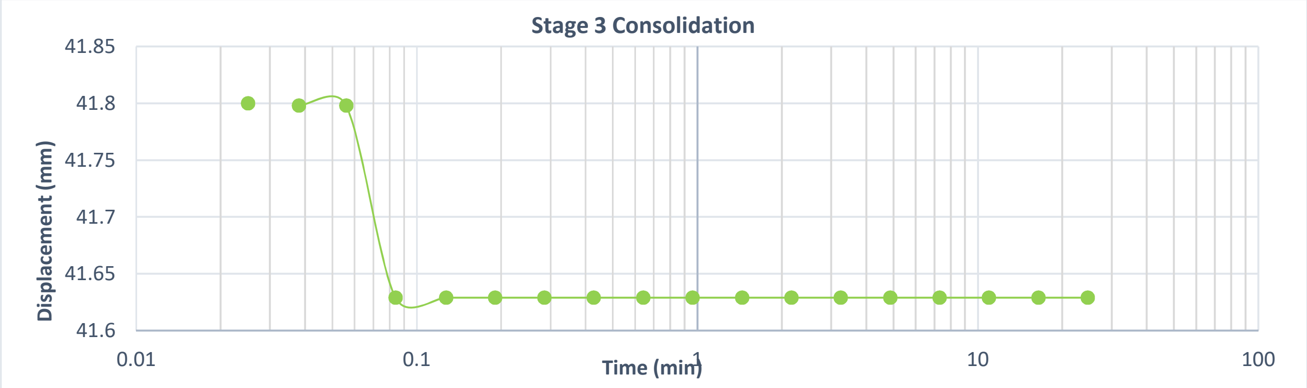
Location:	**STX1903G**		**Page 6**





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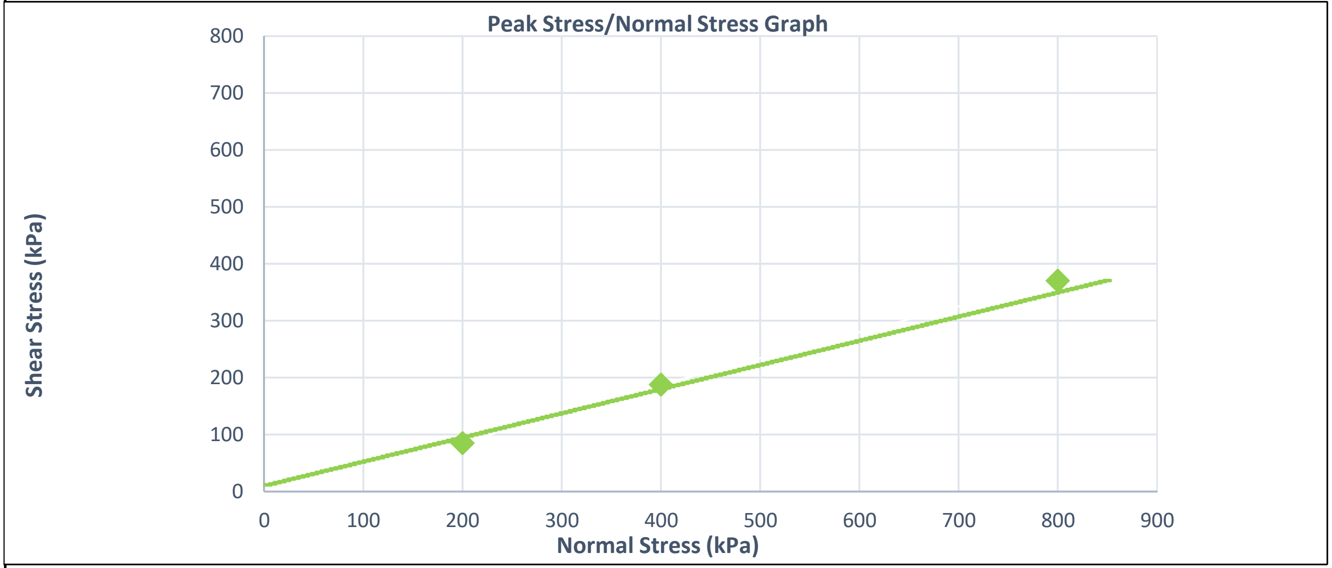
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-51**		**Page 1**

Borehole: STX1903G Sample ID: Shear-51 Depth From: 51.46 Depth To: 51.6

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	7/11/2019	Wet Density	1.29	1.30	1.29
Sampled By:	Cardno	Dry Density	1.22	1.24	1.23
Sampling Method:	AS 1289 1.2.1	Moisture (%)	5.9	4.9	4.8
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Coal	Peak Shear Stress (kPa)	85	188	371
Sample Type:	Core	Primary Consolidation (mm)	0.2	0.4	0.2
Lab Ref Number:	19-5373A	Strain Rate (mm/min)	0.127	0.116	0.105



Effective Cohesion C' (kPa):	10.0
Effective Angle of Friction ϕ' (Degrees):	23.0
Failure Criteria:	Peak Shear Stress

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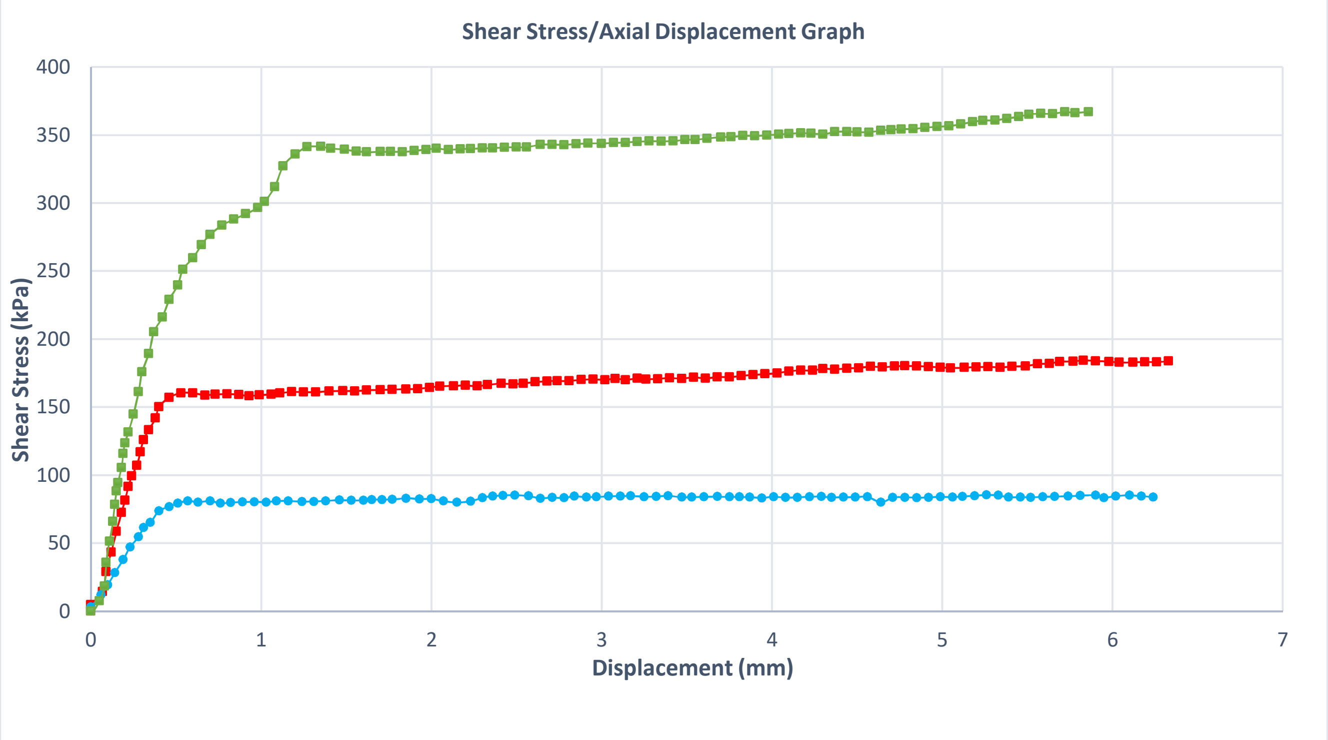
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	85	5.26	54
2	400	188	7.15	57
3	800	371	6.67	57

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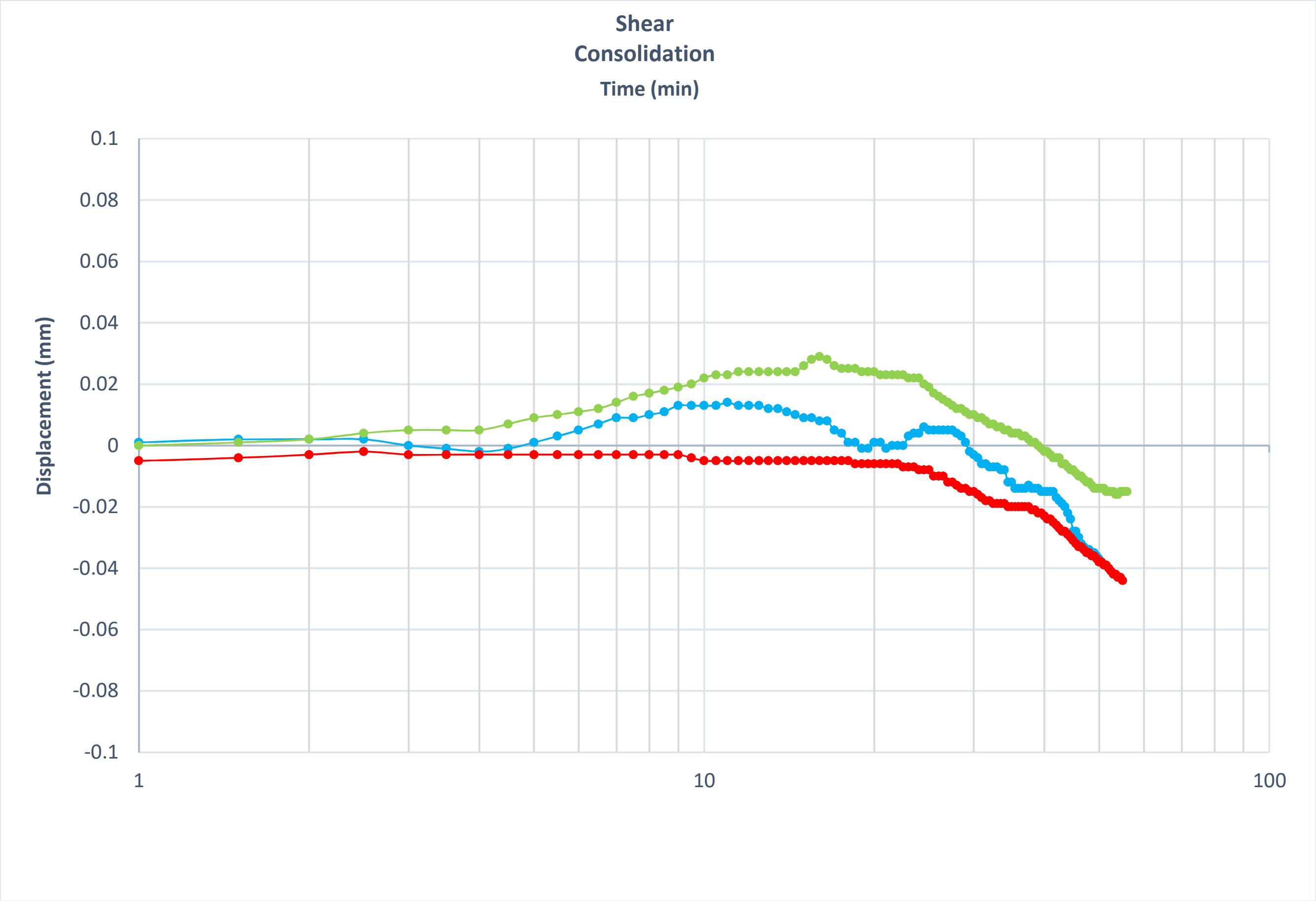
Location:	**STX1903G**		**Page 3**



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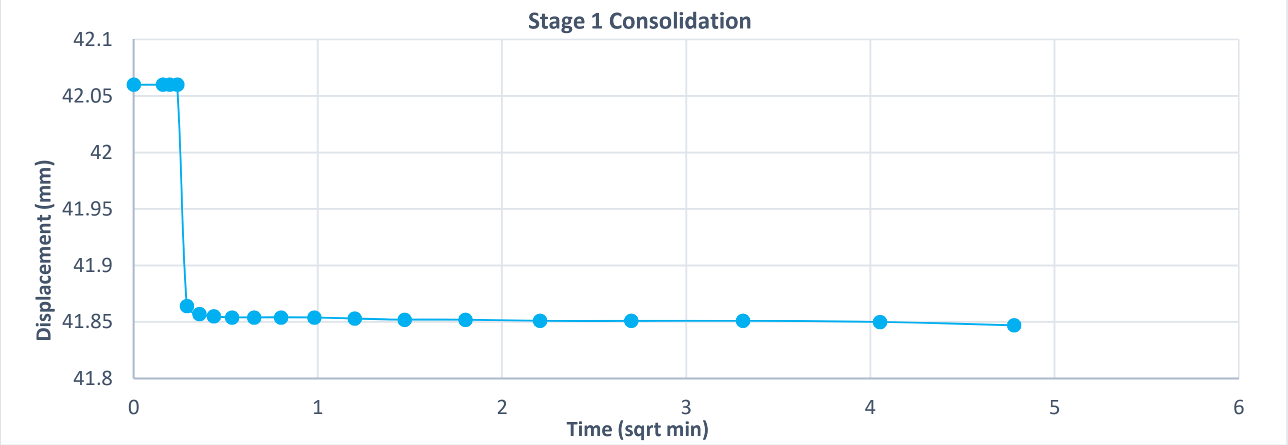
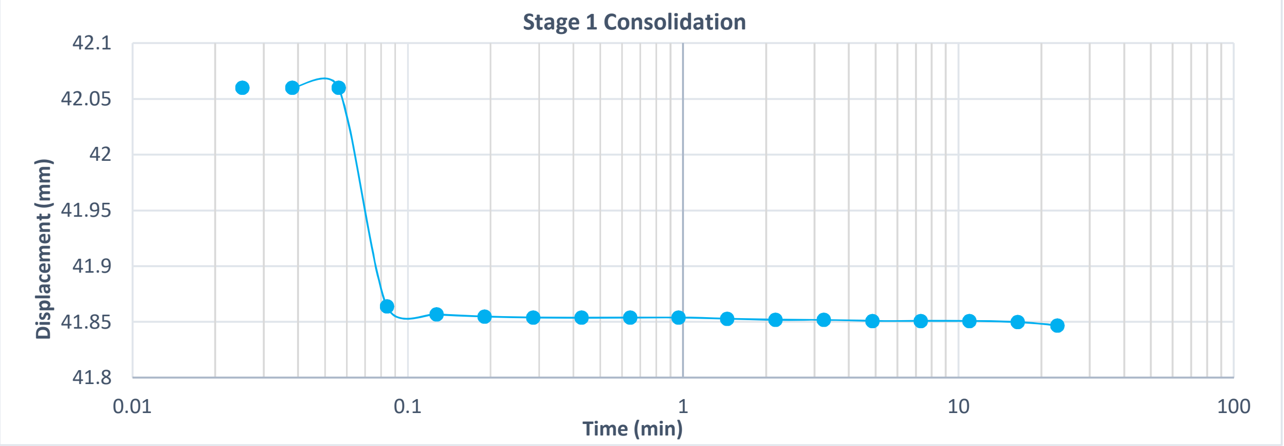
Location:	**STX1903G**		**Page 4**





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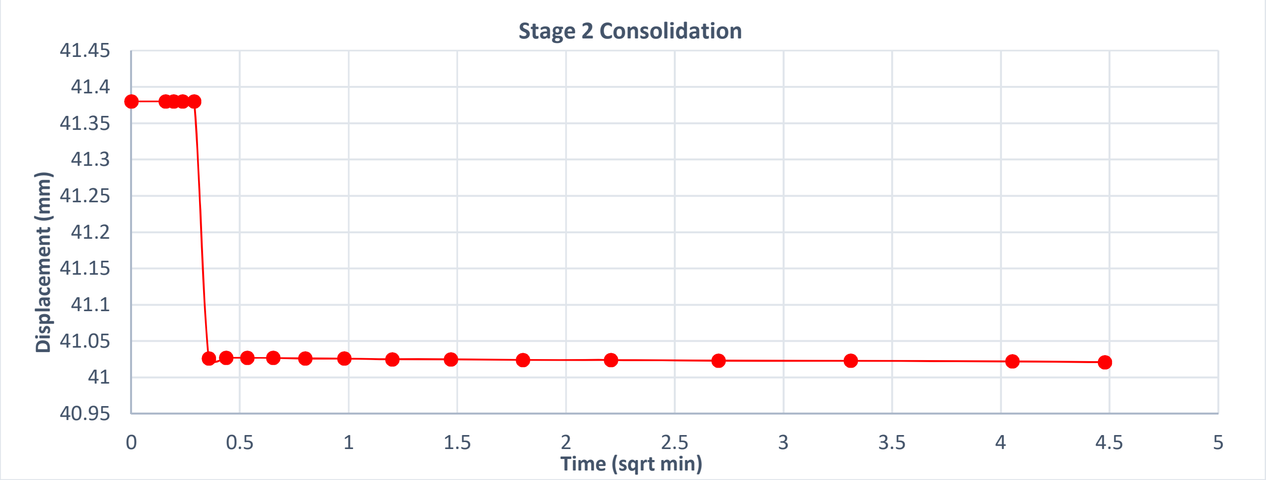

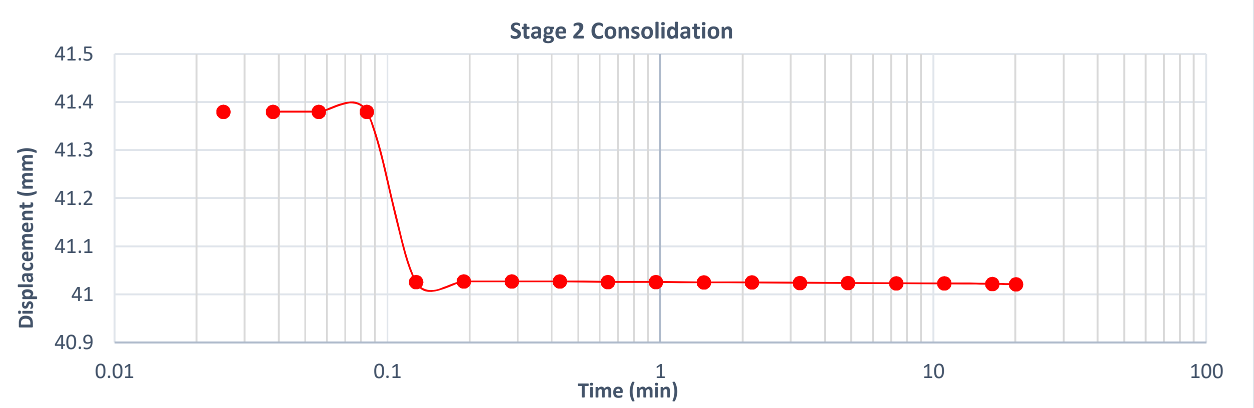

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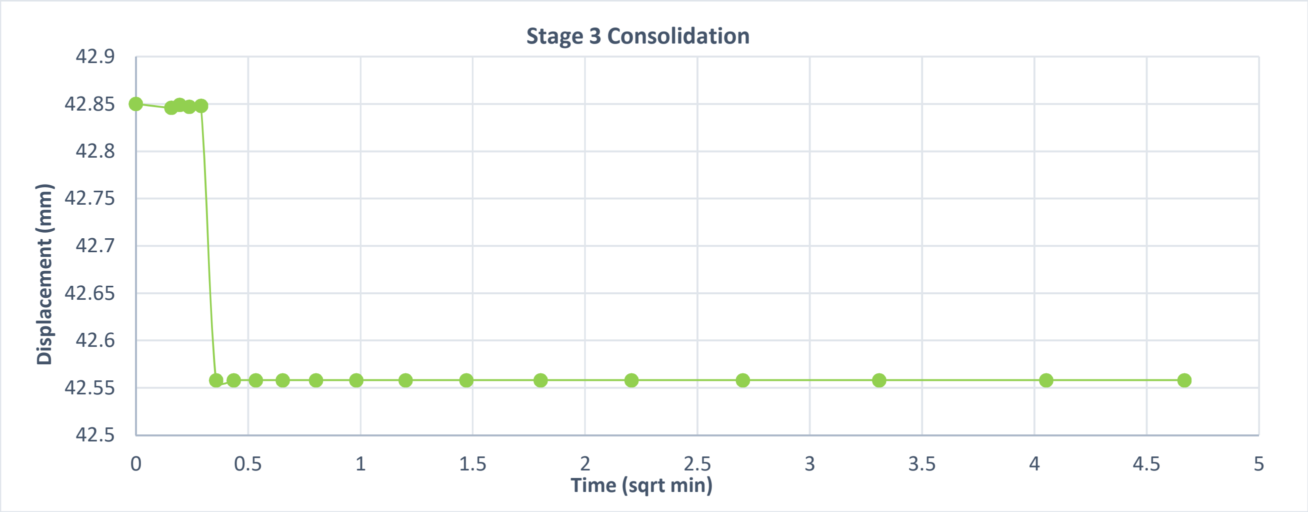

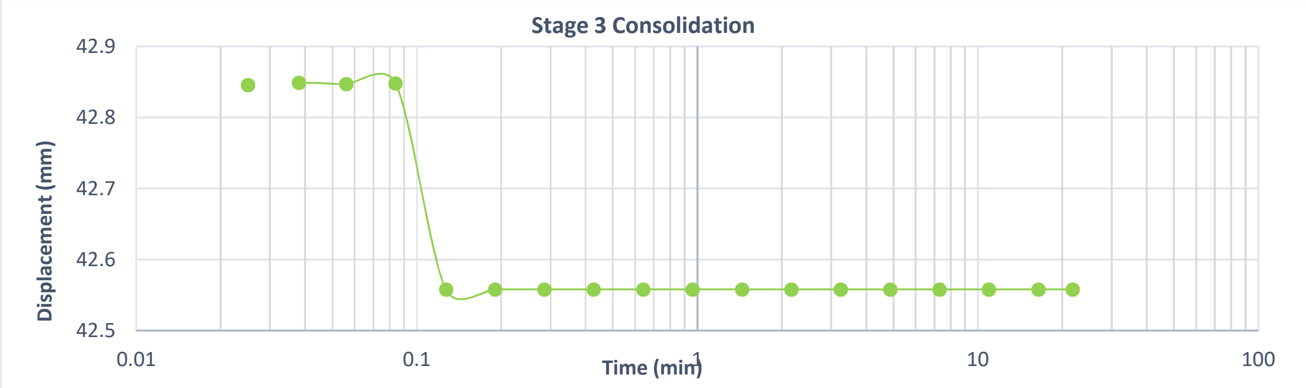

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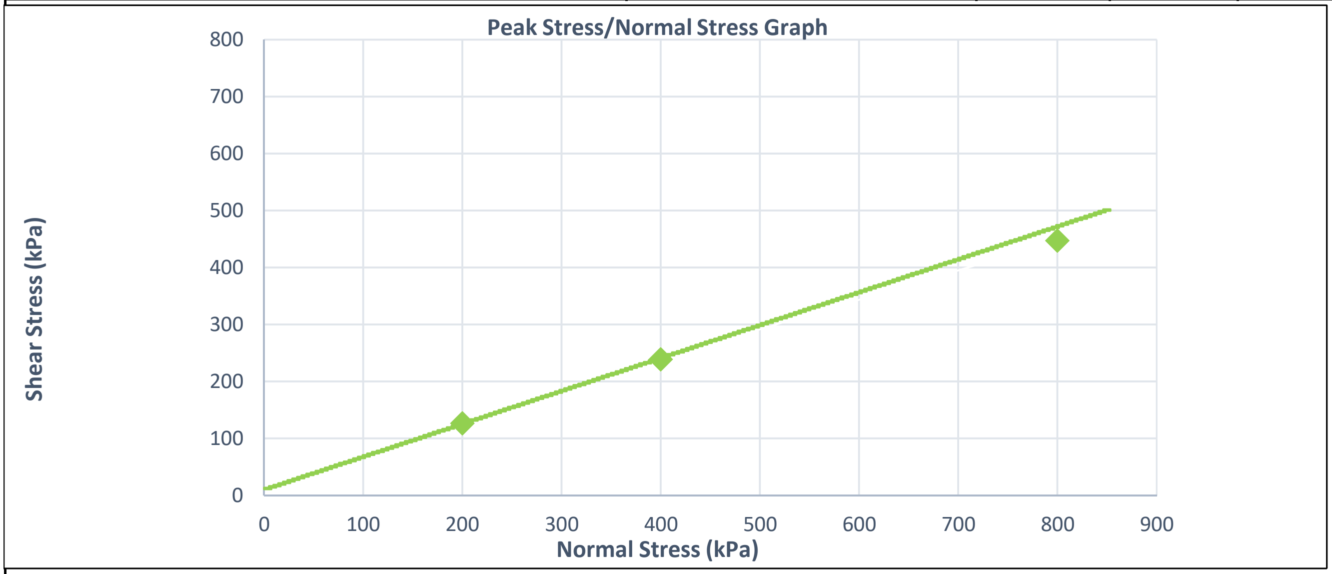
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5387A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**9/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-65**		**Page 1**

Borehole: STX1903G Sample ID: Shear-65 Depth From: 62.31 Depth To: 62.55

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	8/11/2019	Wet Density	2.45	2.36	2.33
Sampled By:	Cardno	Dry Density	2.33	2.23	2.21
Sampling Method:	AS 1289 1.2.1	Moisture (%)	5.1	5.9	5.6
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Tuffaceoussandstone	Peak Shear Stress (kPa)	127	239	447
Sample Type:	Core	Primary Consolidation (mm)	0.2	0.2	0.3
Lab Ref Number:	19-5387A	Strain Rate (mm/min)	0.120	0.110	0.103



Effective Cohesion C' (kPa):	10.0
Effective Angle of Friction ϕ' (Degrees):	30.0
Failure Criteria:	Peak Shear Stress

Sample/s supplied by Cardn(Note: Graph not to scale

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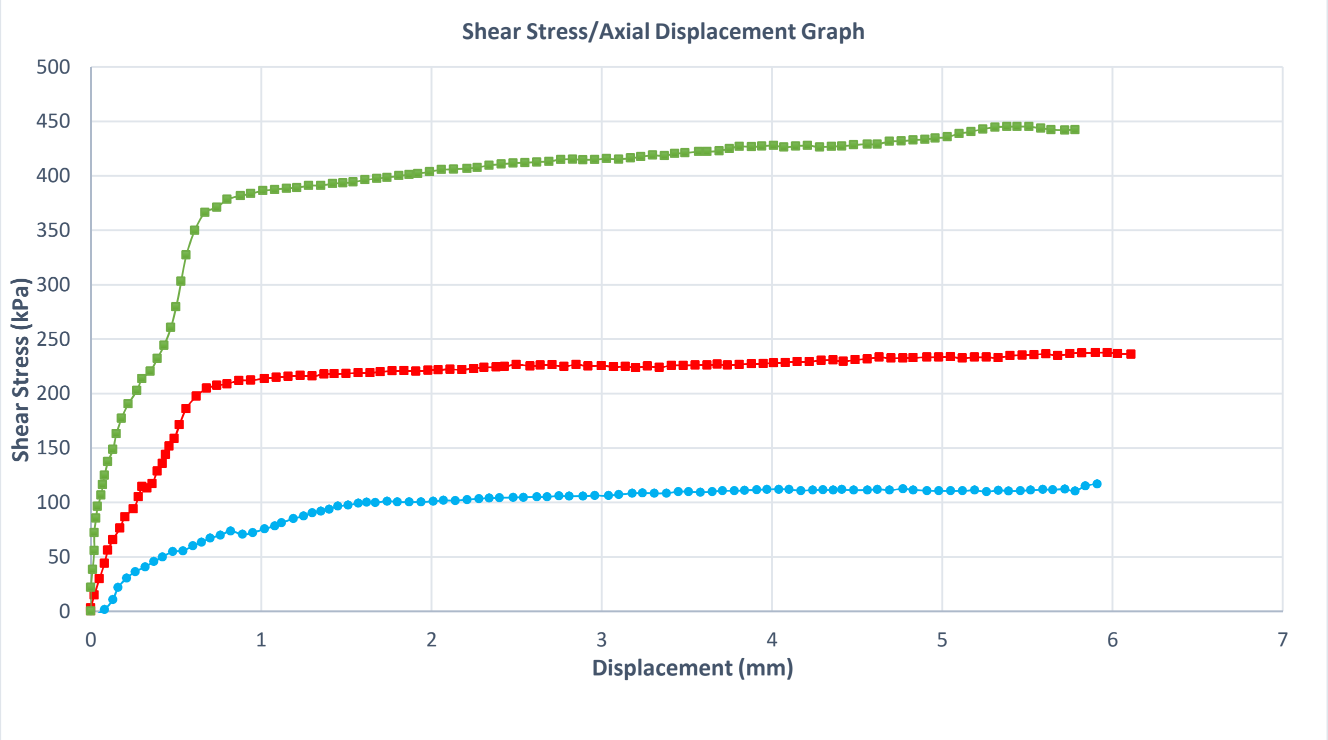
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5387A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**9/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	127	7.85	62
2	400	239	6.30	54
3	800	447	6.56	57

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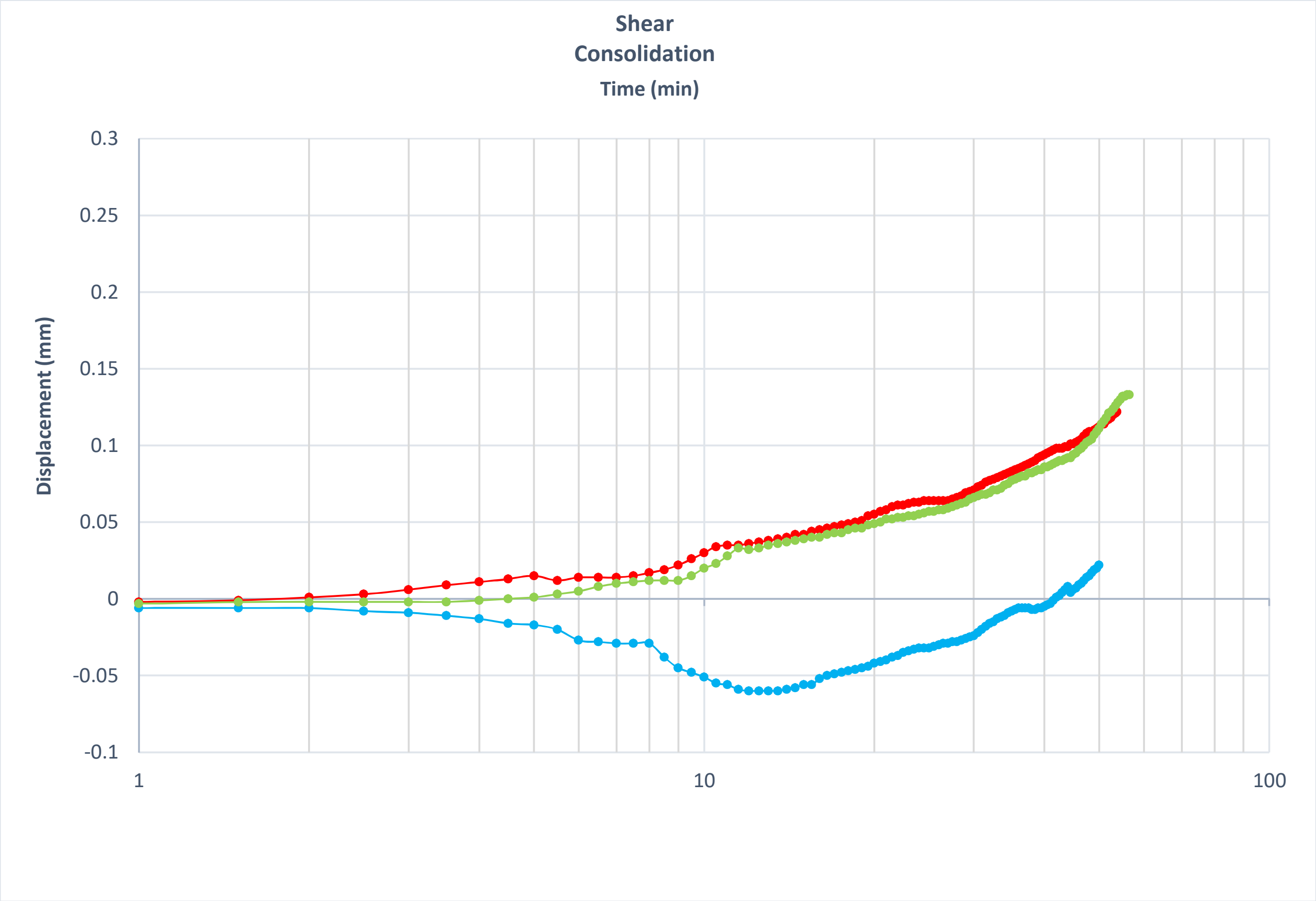
Location:	**STX1903G**		**Page 3**



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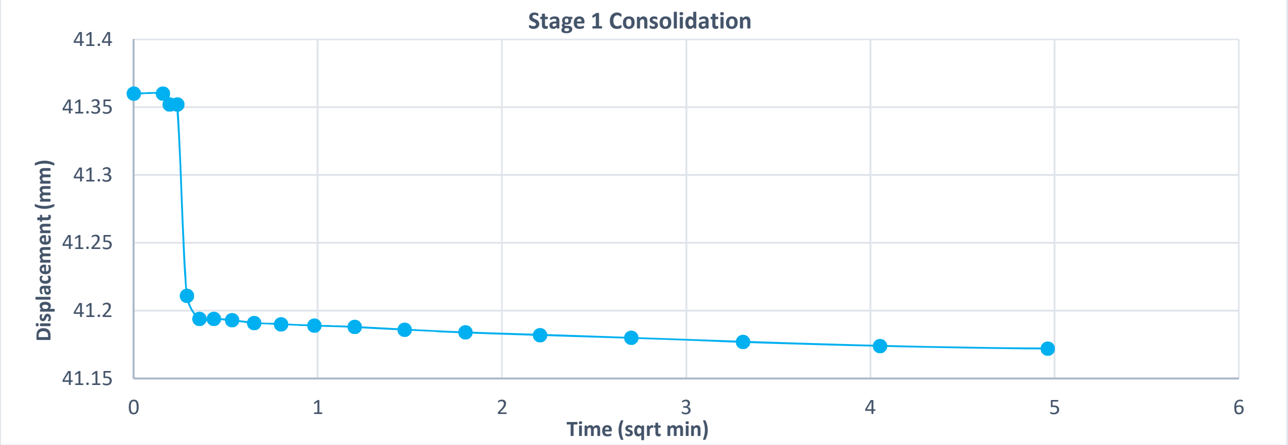
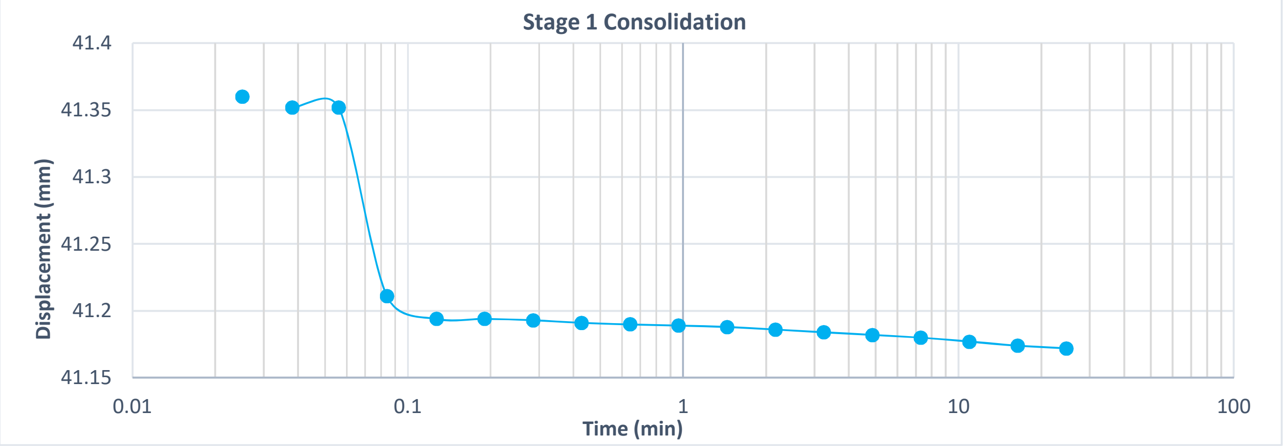
Location:	**STX1903G**		**Page 4**





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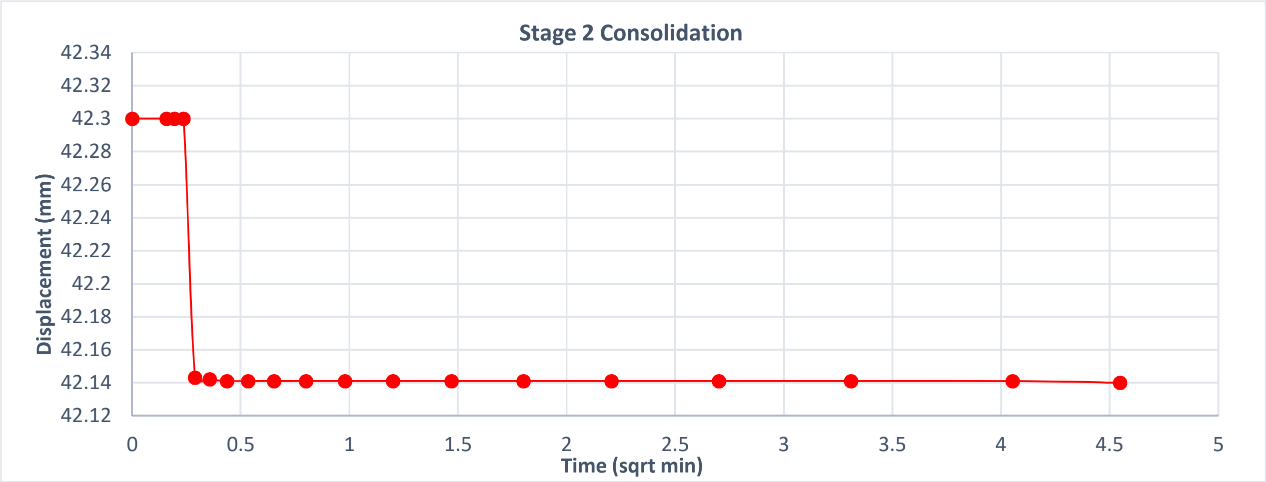
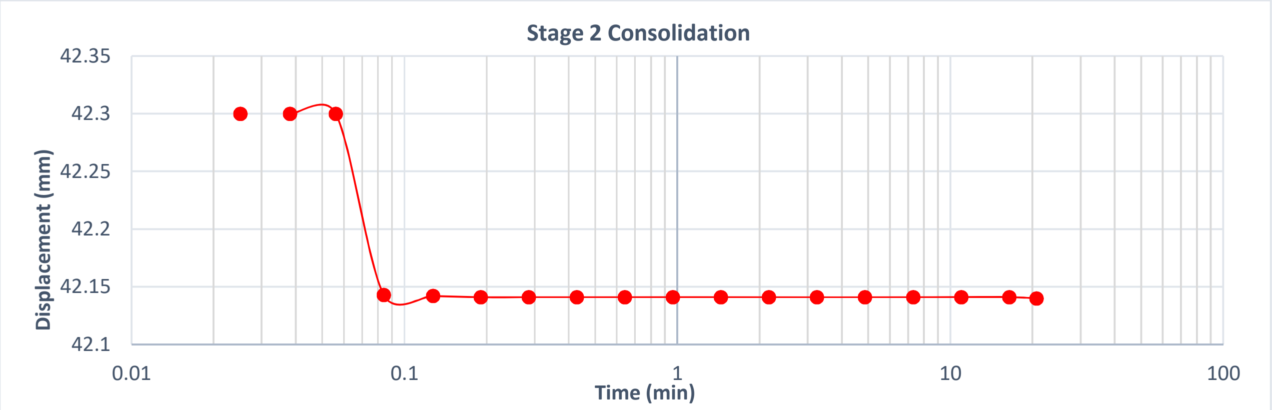
Location:	**STX1903G**		**Page 5**





Sample/s supplied by	Cardno	Note:	Graph not to scale

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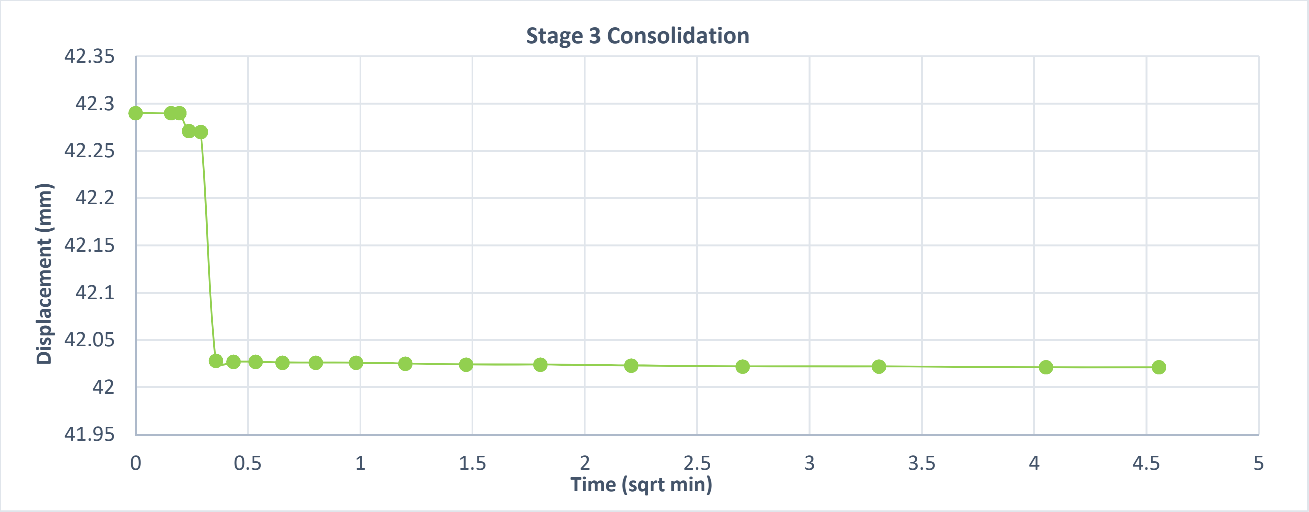
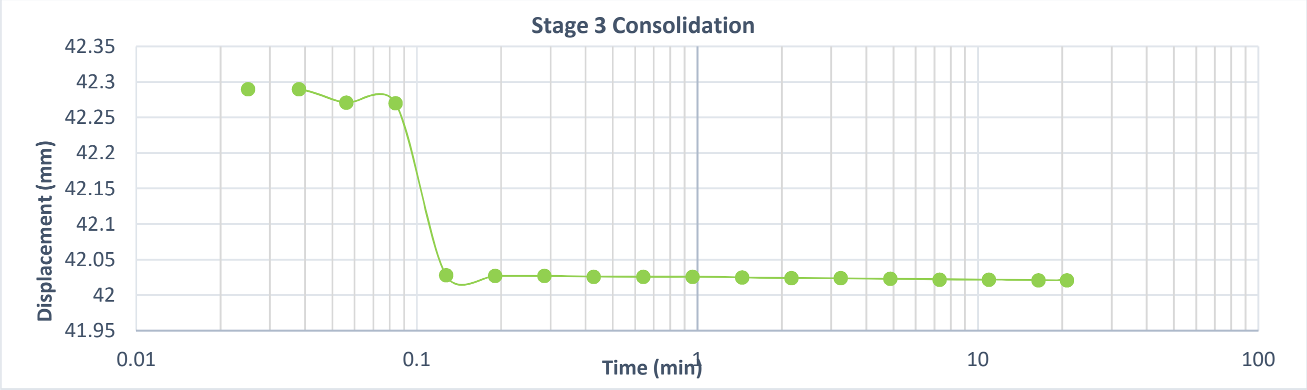
Location:	**STX1903G**		**Page 6**





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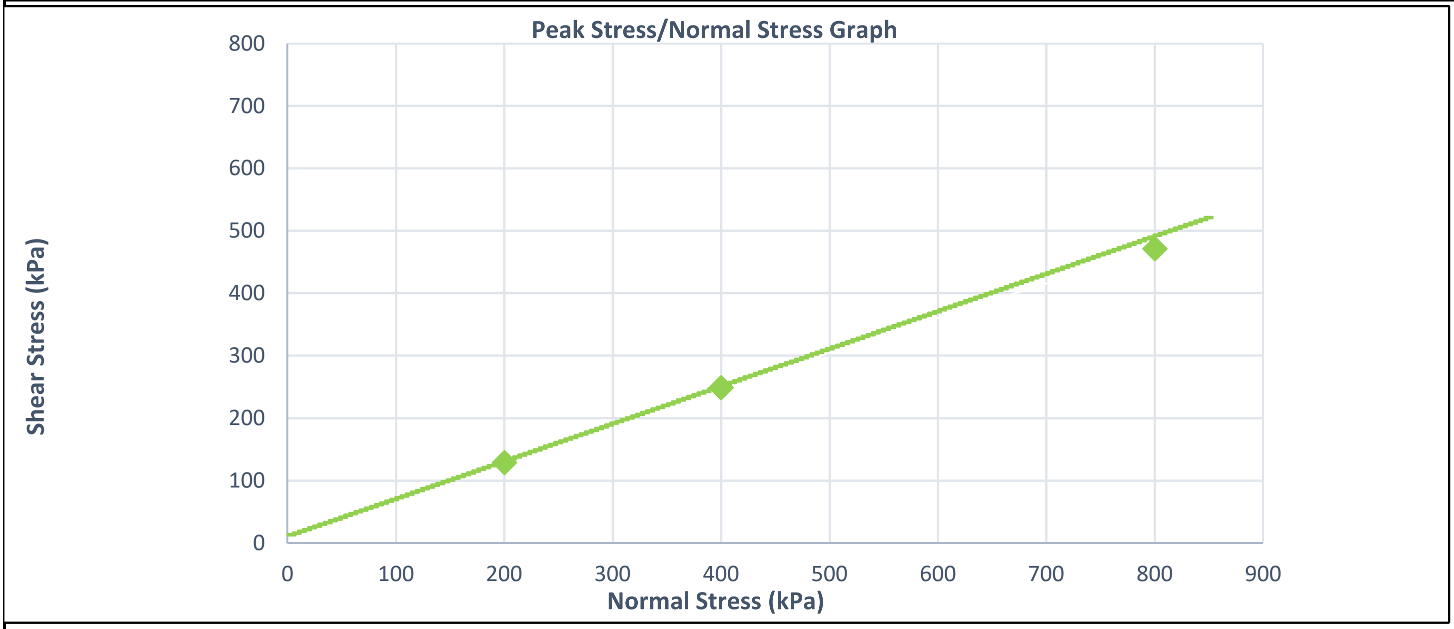
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-67**		**Page 1**

Borehole: STX1903G Sample ID: Shear-67 Depth From: 63.72 Depth To: 63.95

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	8/11/2019	Wet Density	2.39	2.37	2.45
Sampled By:	Cardno	Dry Density	2.25	2.23	2.30
Sampling Method:	AS 1289 1.2.1	Moisture (%)	6.3	6.7	6.2
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Sandstone	Peak Shear Stress (kPa)	129	249	471
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.2	0.3
Lab Ref Number:	19-5389A	Strain Rate (mm/min)	0.123	0.113	0.103



Effective Cohesion C' (kPa):	10.0
Effective Angle of Friction ϕ' (Degrees):	31.0
Failure Criteria:	Peak Shear Stress

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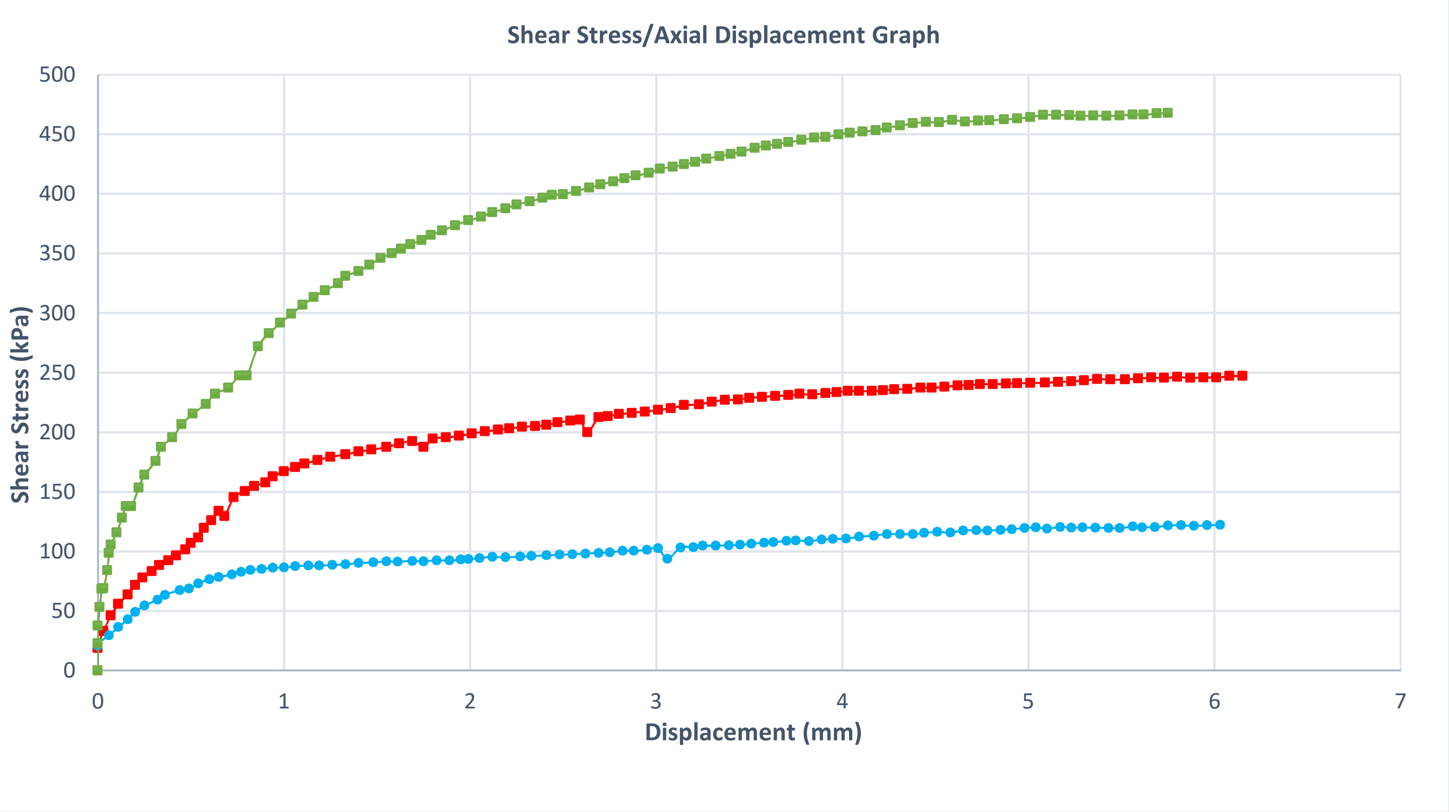
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	129	7.43	58
2	400	249	6.66	54
3	800	471	6.17	54

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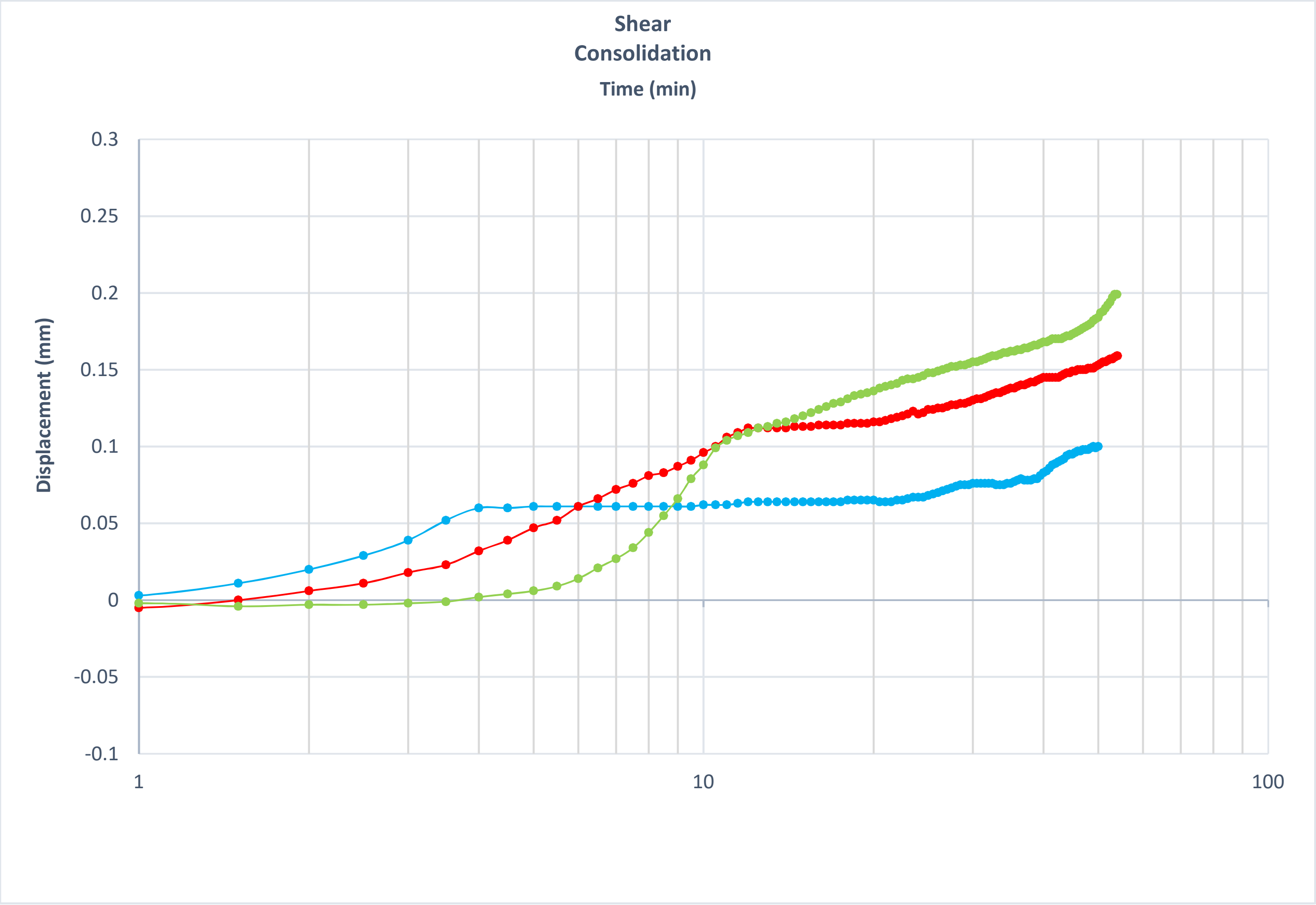
Location:	**STX1903G**		**Page 3**



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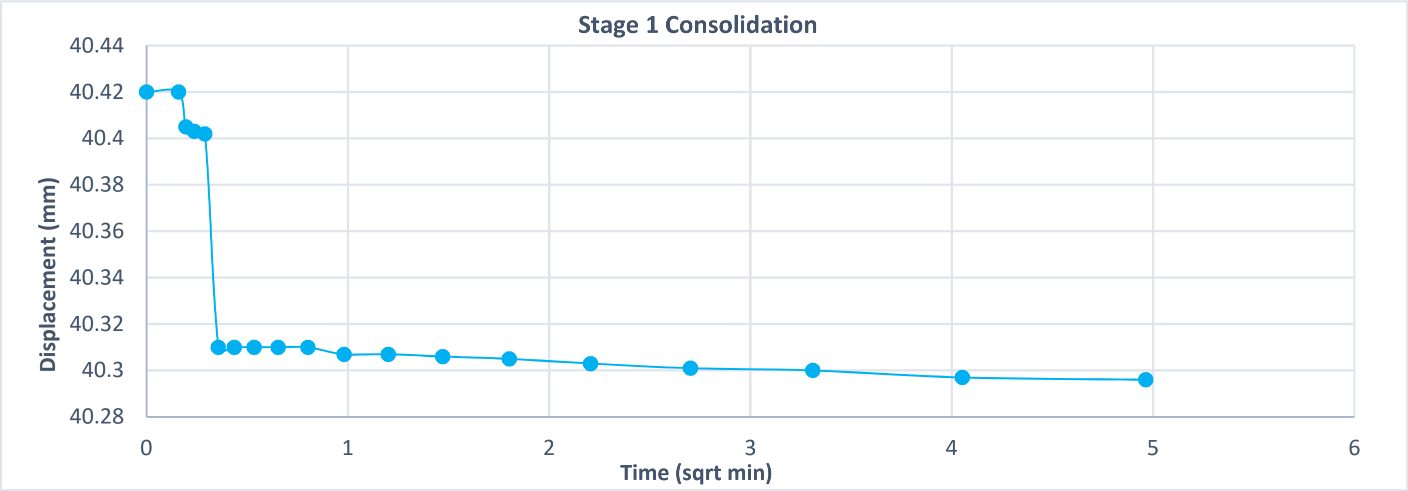
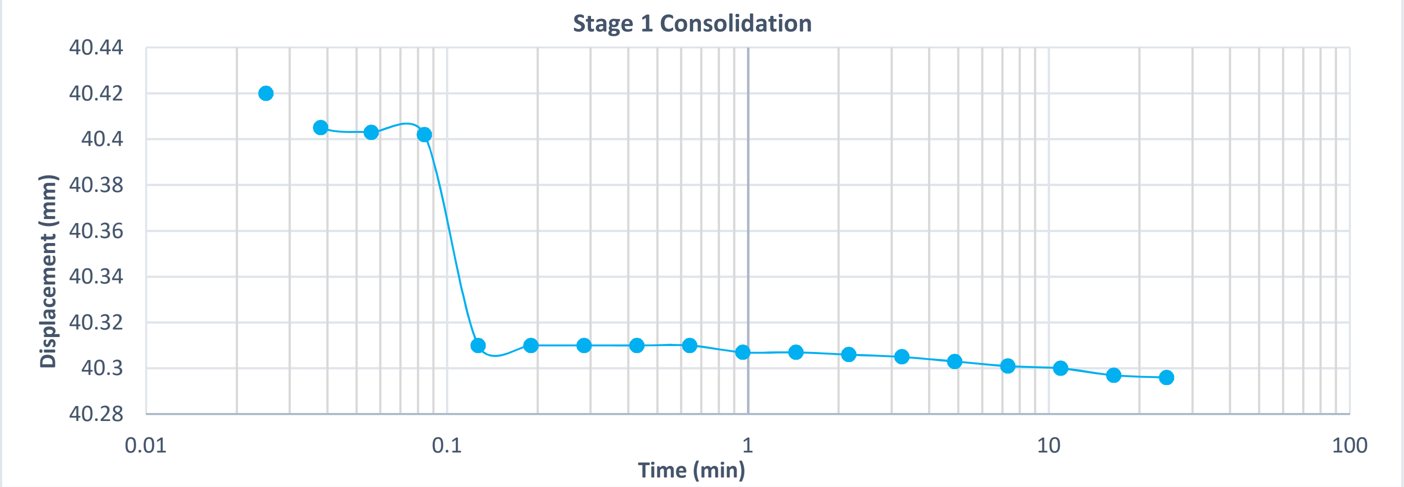
Location:	**STX1903G**		**Page 4**





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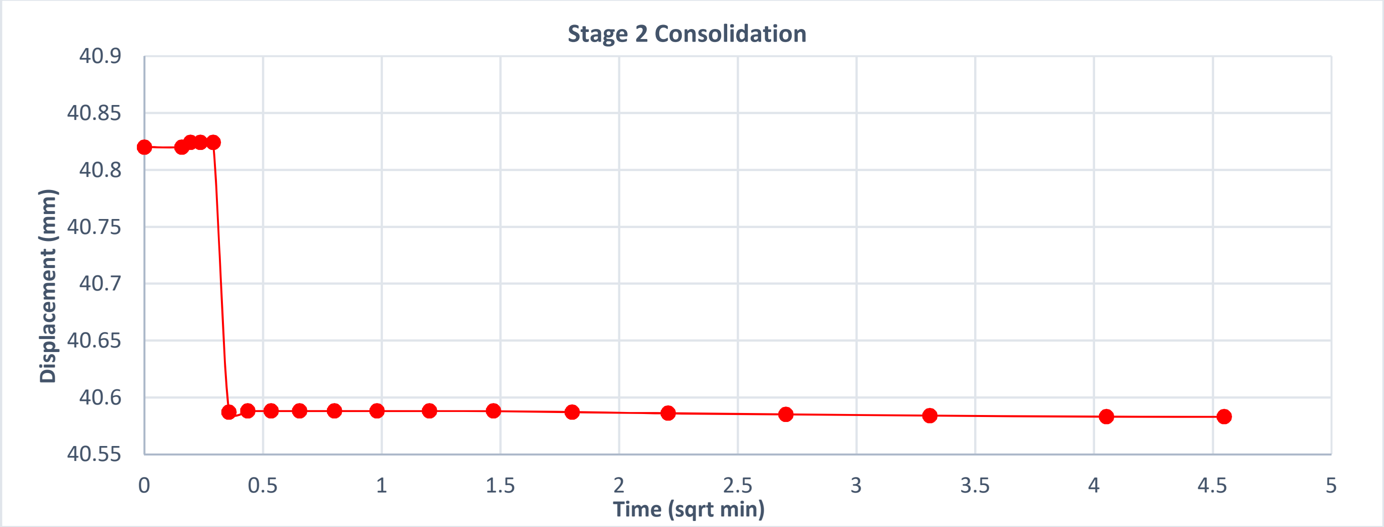
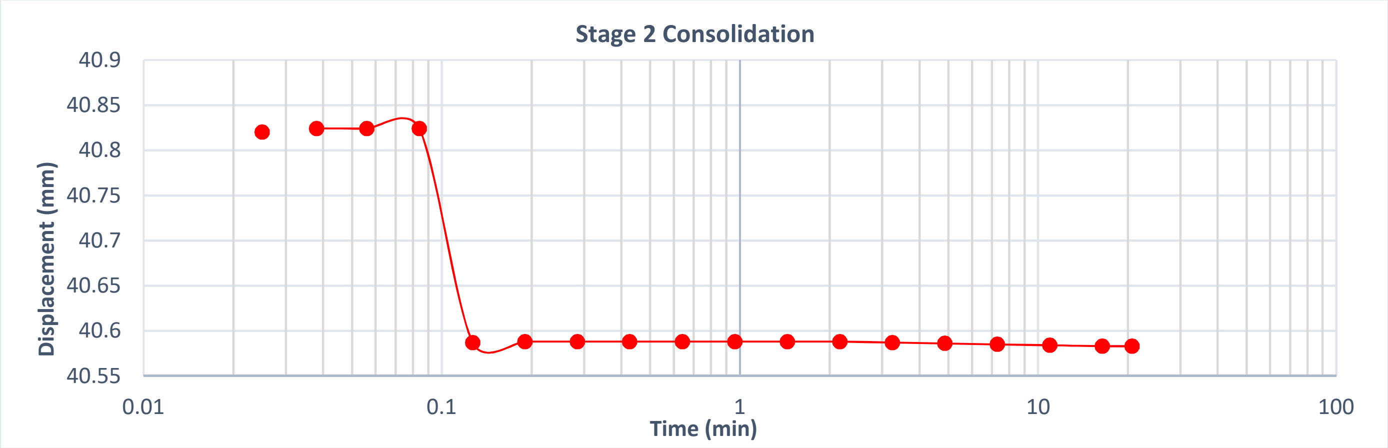
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





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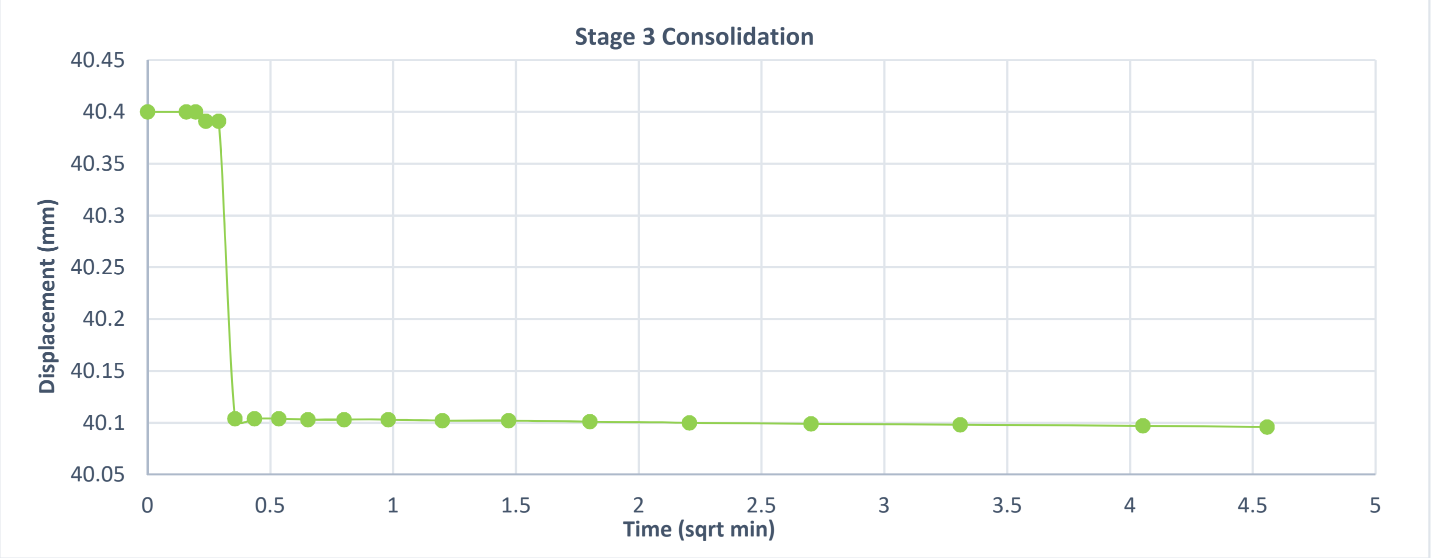
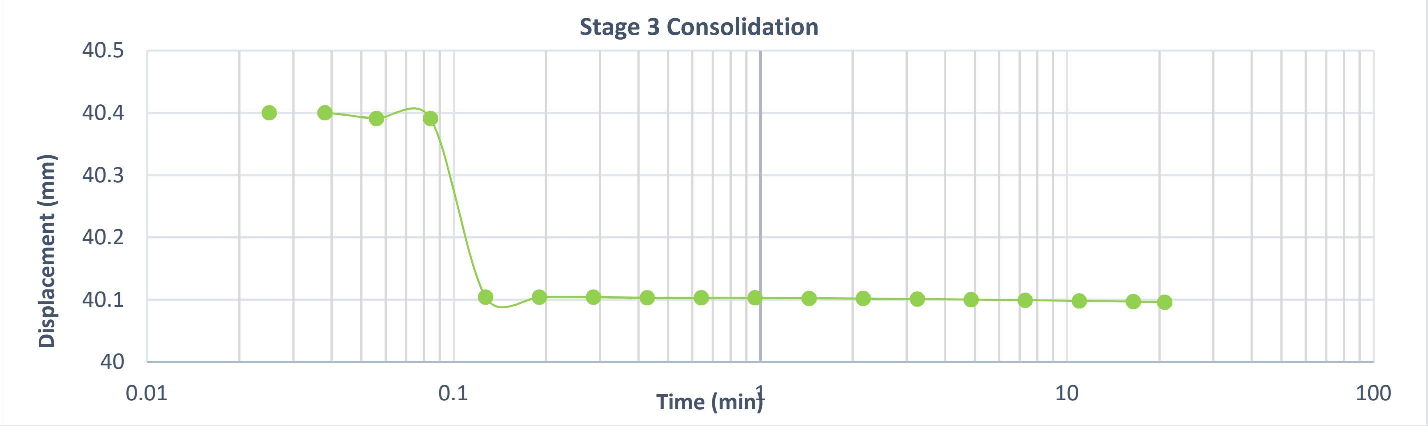
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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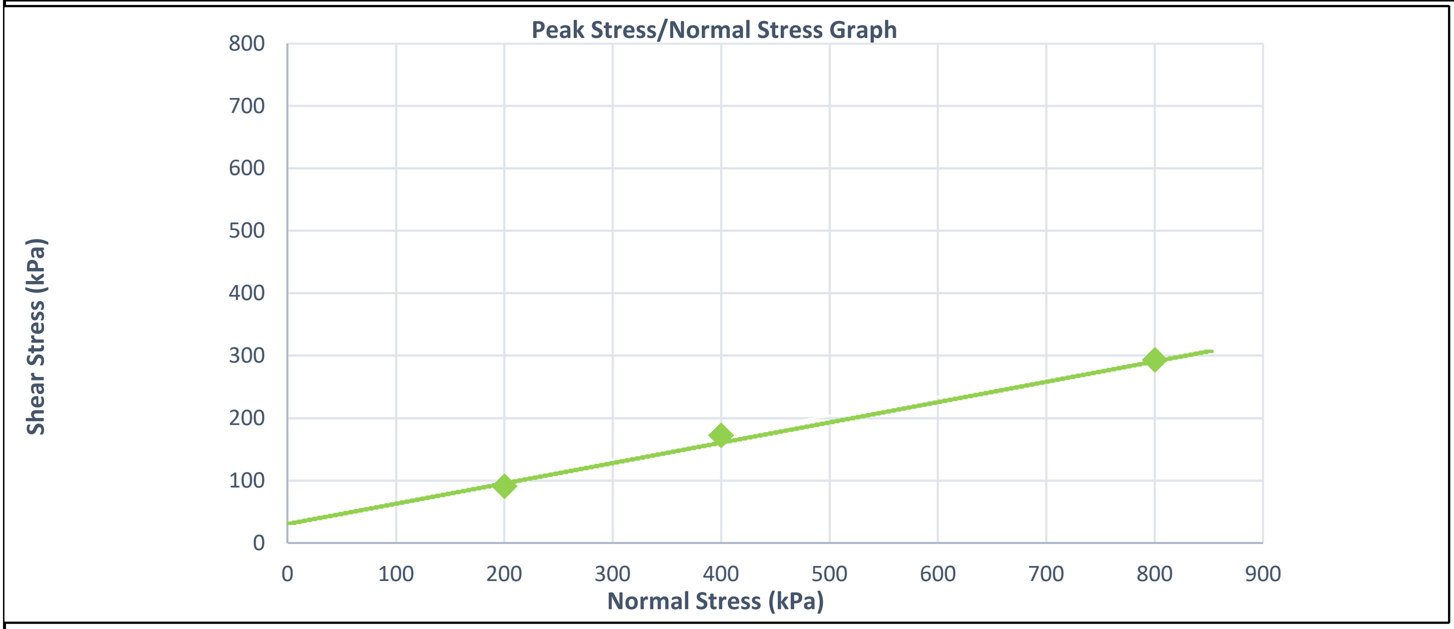
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-77**		**Page 1**

Borehole: **STX1903G** **Sample ID:** **Shear-77** **Depth From:** **72.00** **Depth To:** **72.2**

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	11/11/2019	Wet Density	2.27	2.27	2.25
Sampled By:	Cardno	Dry Density	2.14	2.13	2.10
Sampling Method:	AS 1289 1.2.1	Moisture (%)	6.4	6.8	7.0
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Carbonaceous Siltstone	Peak Shear Stress (kPa)	91	172	294
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.4	0.2
Lab Ref Number:	19-5399A	Strain Rate (mm/min)	0.129	0.114	0.107



Effective Cohesion C' (kPa):	30.0
Effective Angle of Friction ϕ' (Degrees):	18.0
Failure Criteria:	Peak Shear Stress

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Location: **STX1903G**

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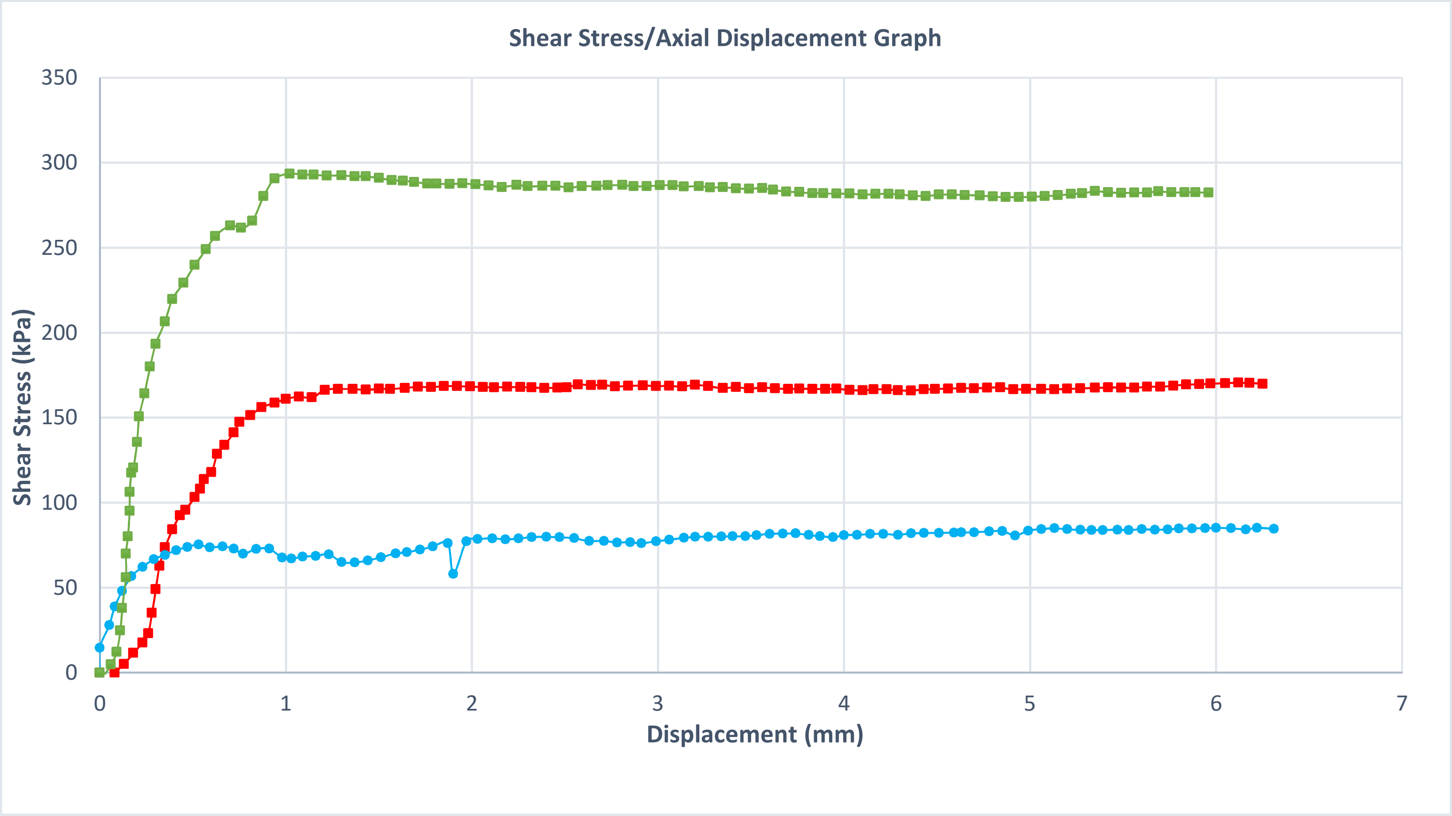
Order Number: **-**
Test Method **AS 1289.6.2.2**
Page 2



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	91	7.22	57
2	400	172	6.72	55
3	800	294	1.02	53

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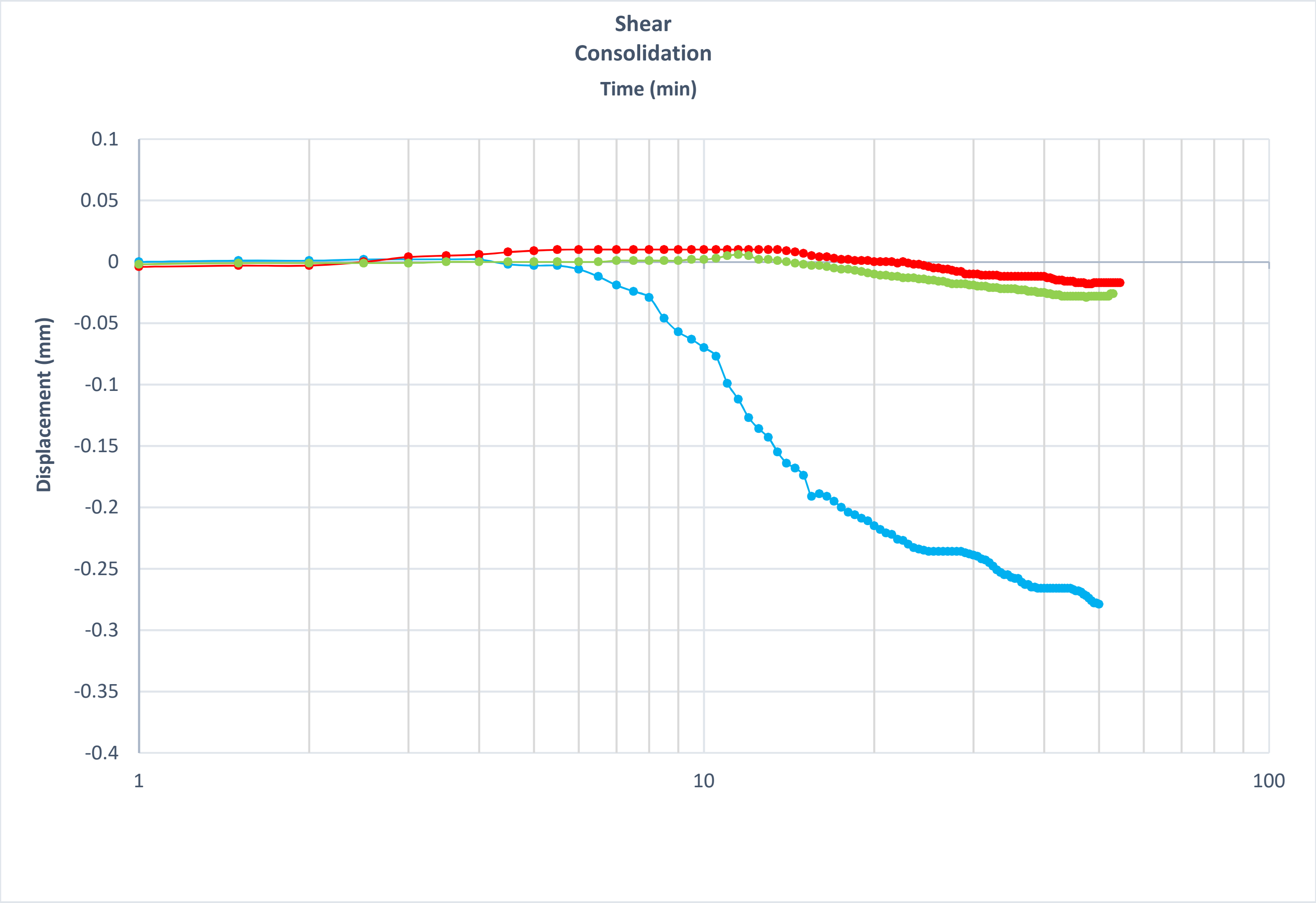

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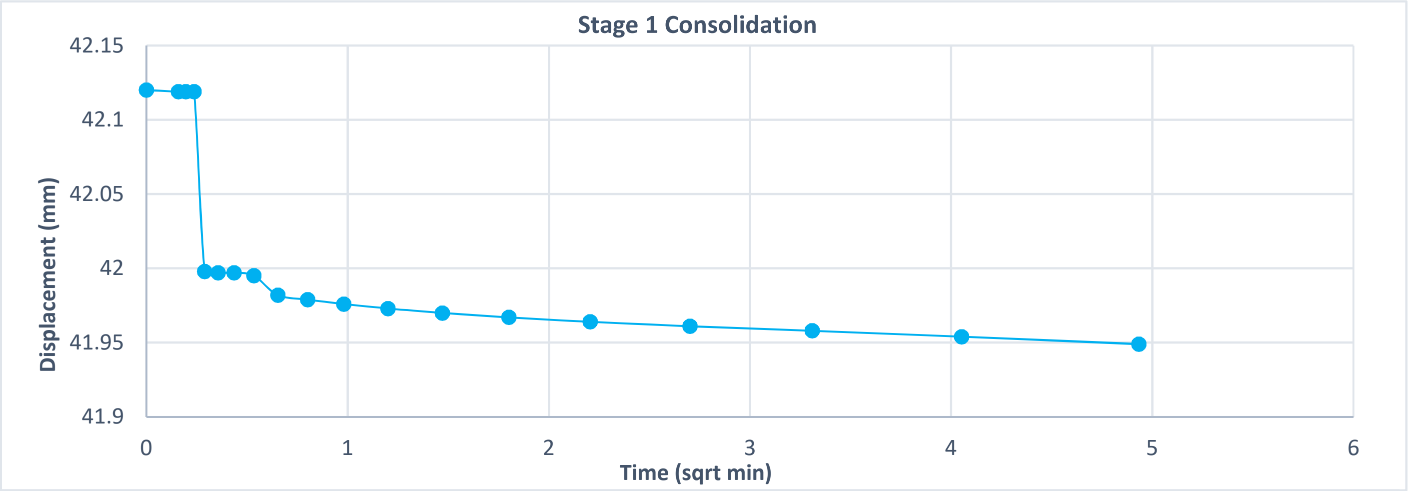

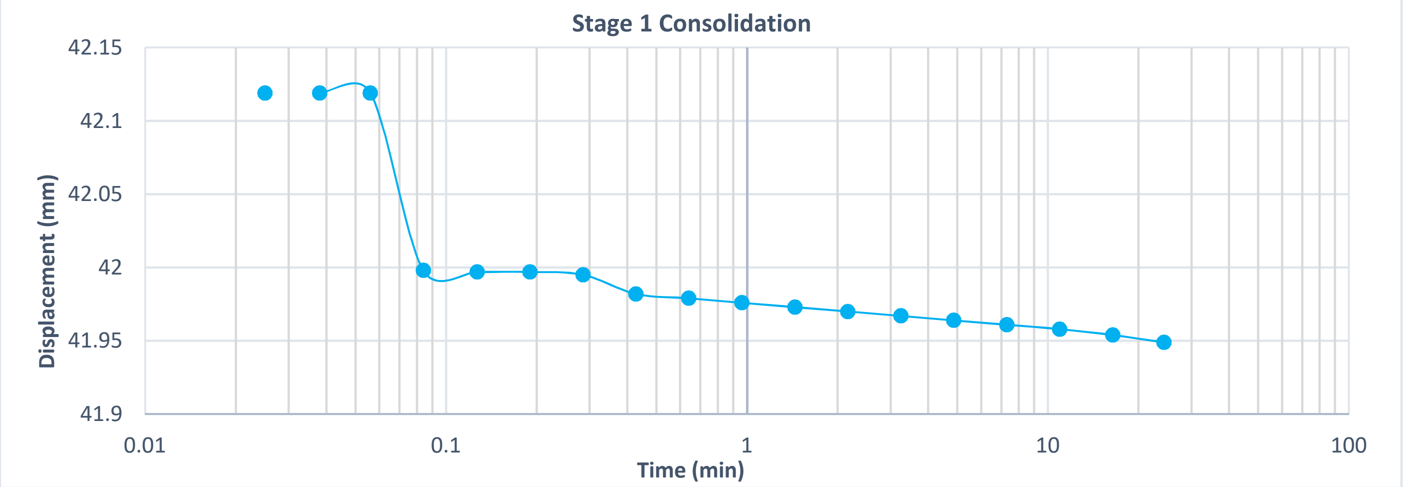

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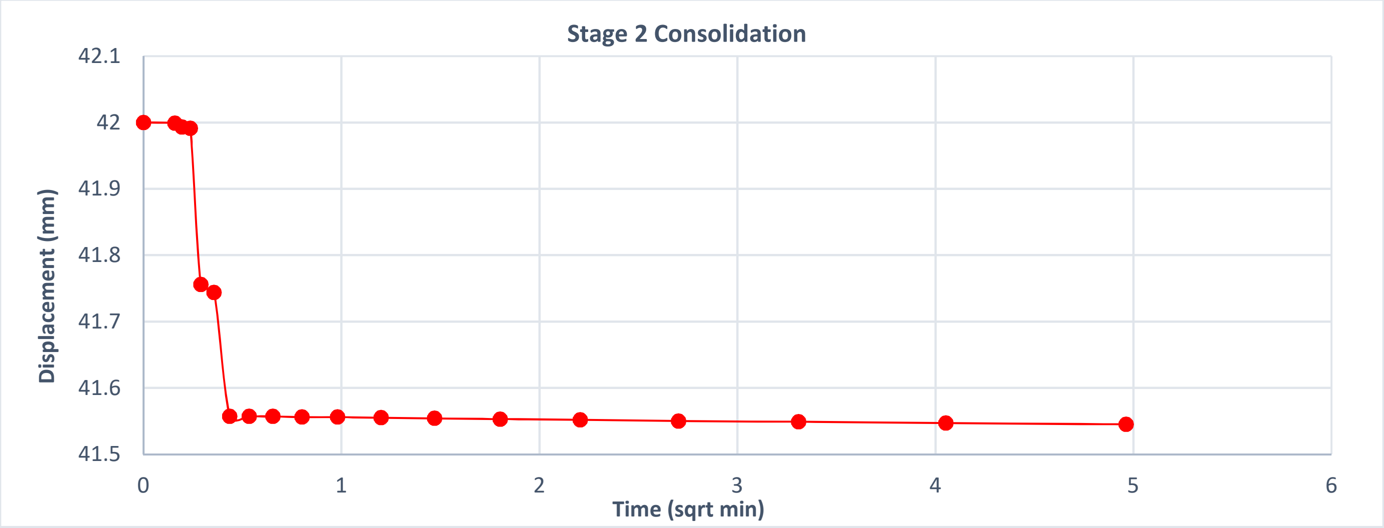
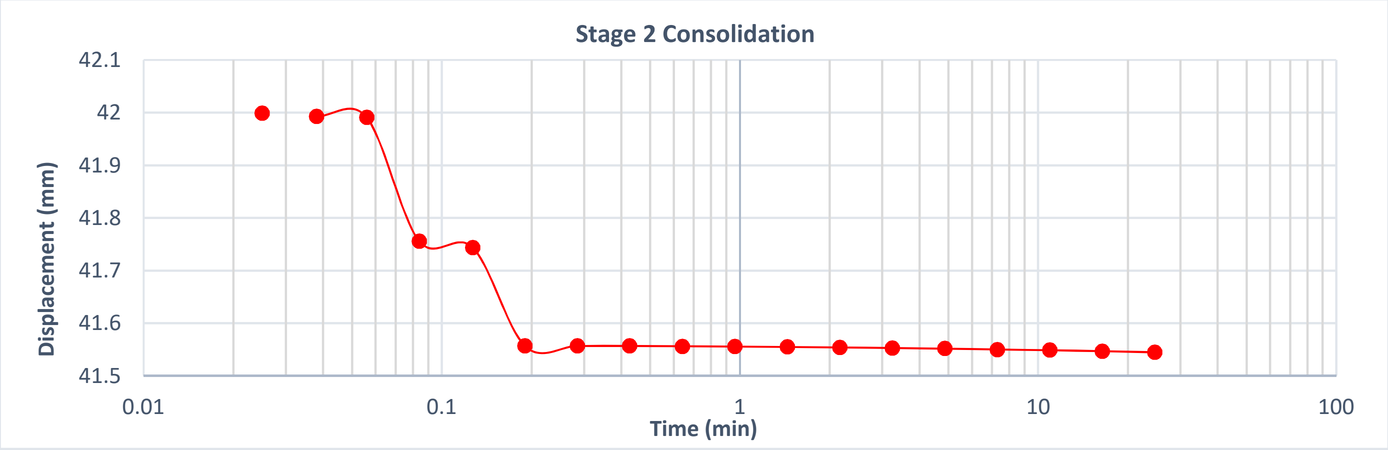
Location:	**STX1903G**		**Page 5**





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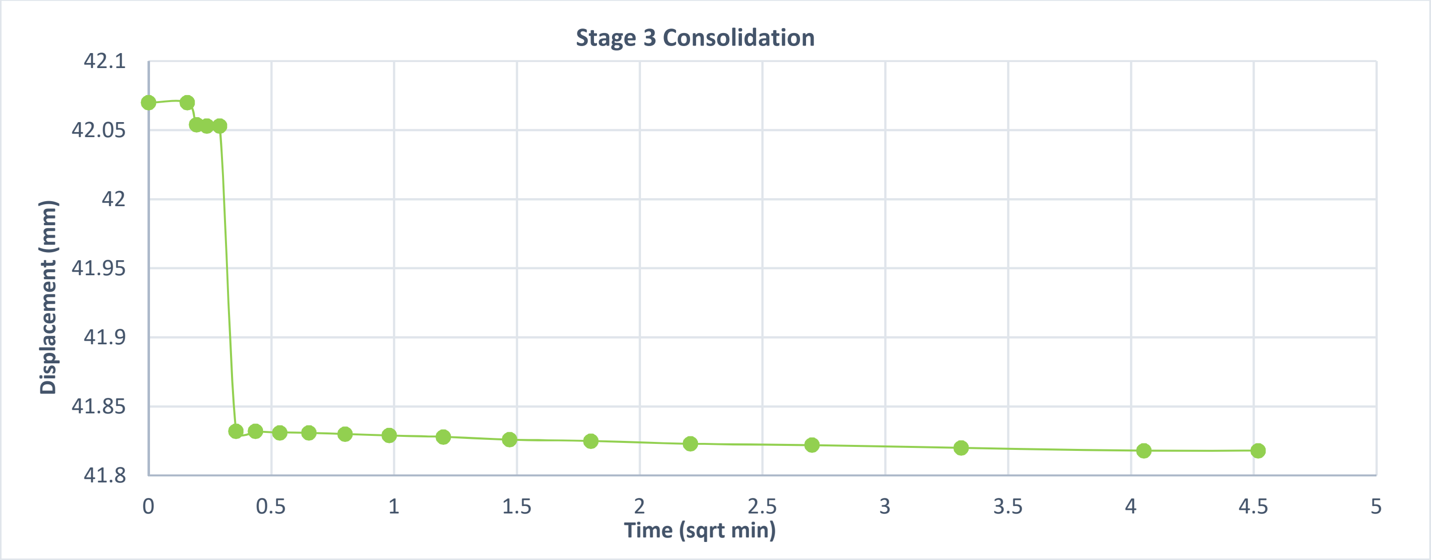
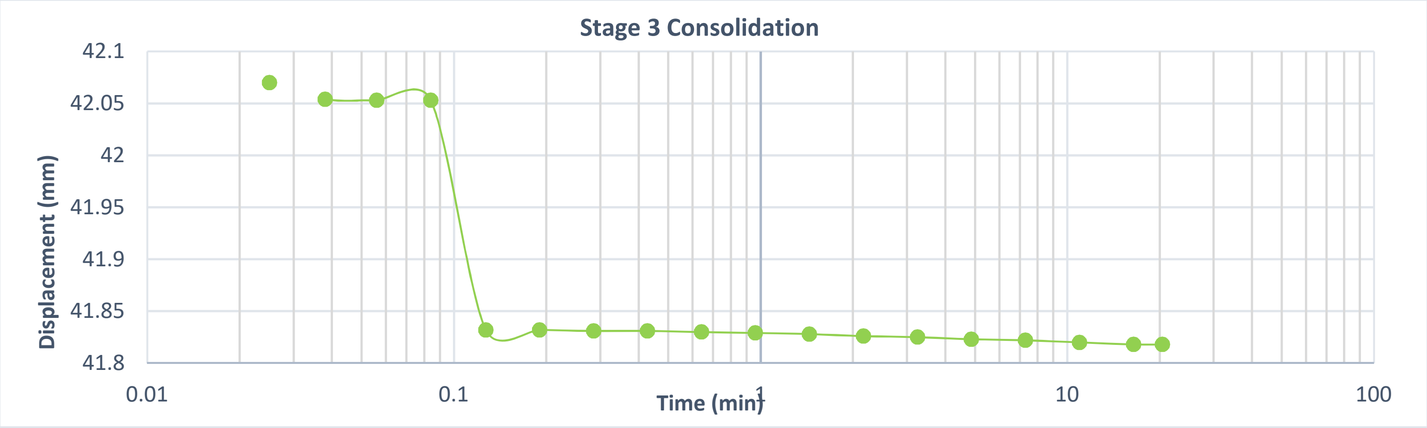
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





Sample/s supplied by Cardno Note: Graph not to scale

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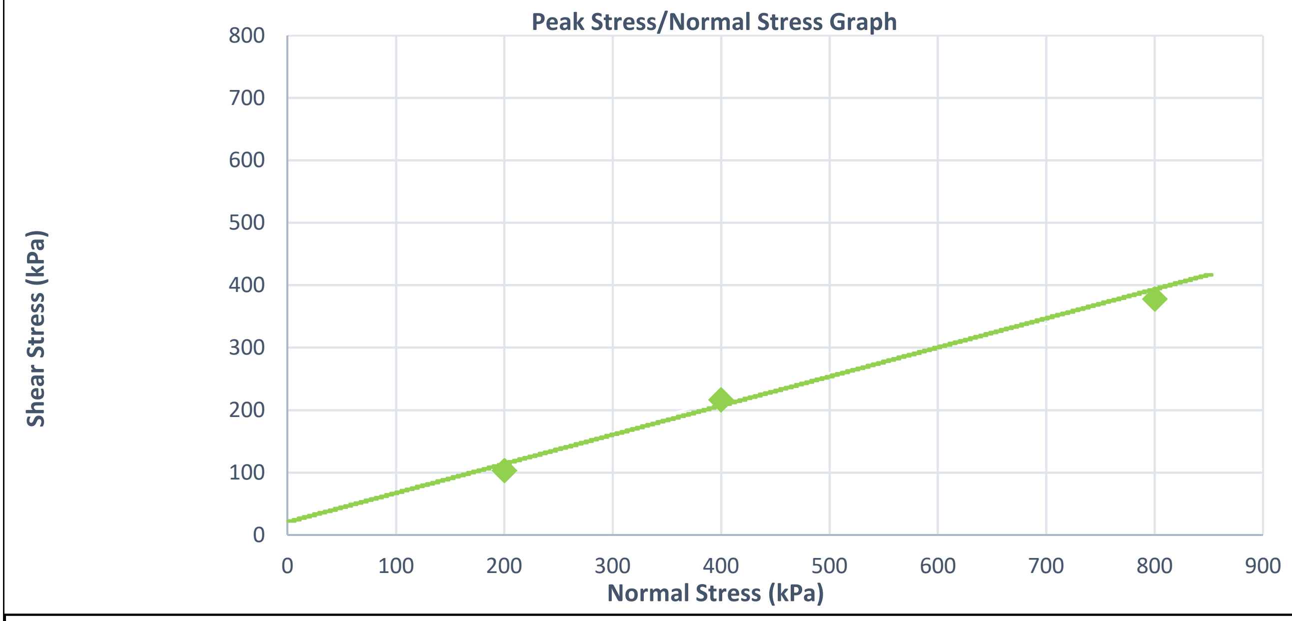
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5409A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-87**		**Page 1**

Borehole: STX1903G Sample ID: Shear-87 Depth From: 75.71 Depth To: 75.93

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	11/11/2019	Wet Density	2.30	2.38	2.27
Sampled By:	Cardno	Dry Density	2.17	2.24	2.15
Sampling Method:	AS 1289 1.2.1	Moisture (%)	5.7	6.3	5.5
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Carbonaceous Siltstone	Peak Shear Stress (kPa)	103	216	378
Sample Type:	Core	Primary Consolidation (mm)	0.2	0.2	0.3
Lab Ref Number:	19-5409A	Strain Rate (mm/min)	0.125	0.114	0.106



Effective Cohesion C' (kPa):	20.0
Effective Angle of Friction ϕ' (Degrees):	25.0
Failure Criteria:	Peak Shear Stress

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Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**

Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	103	6.49	50
2	400	216	1.04	50
3	800	378	5.62	49

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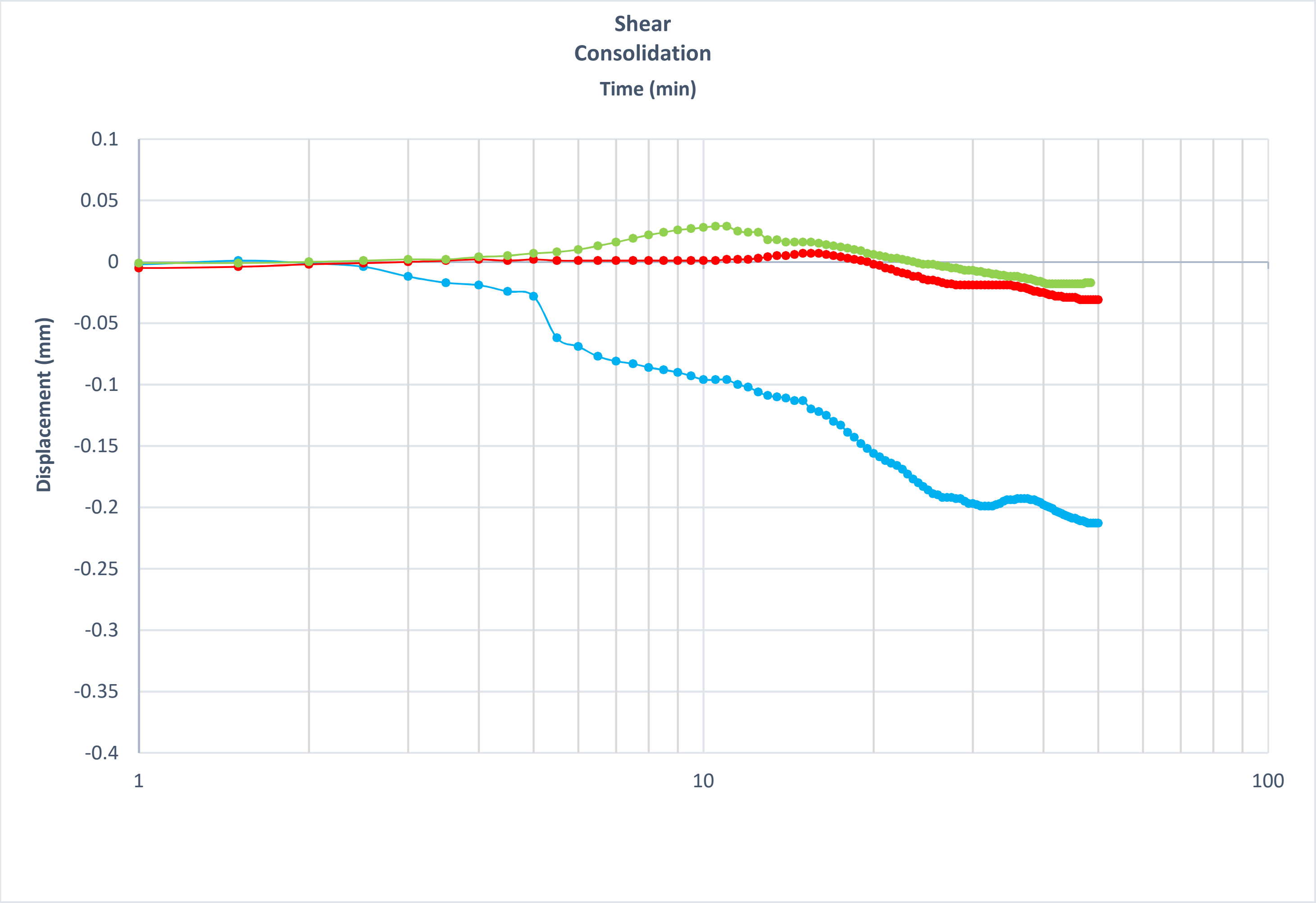
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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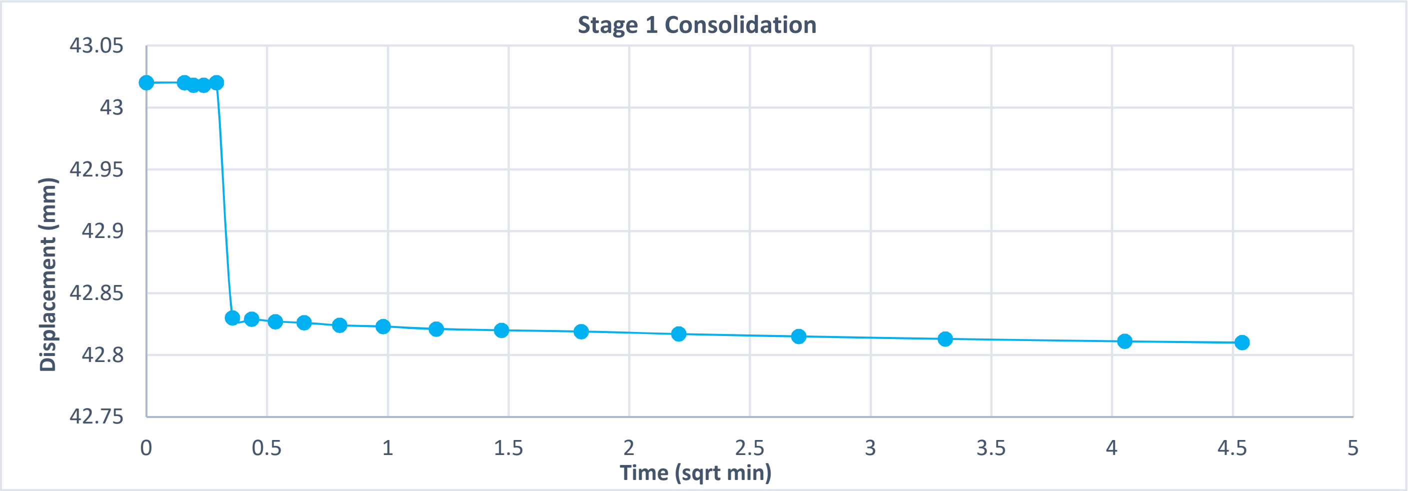
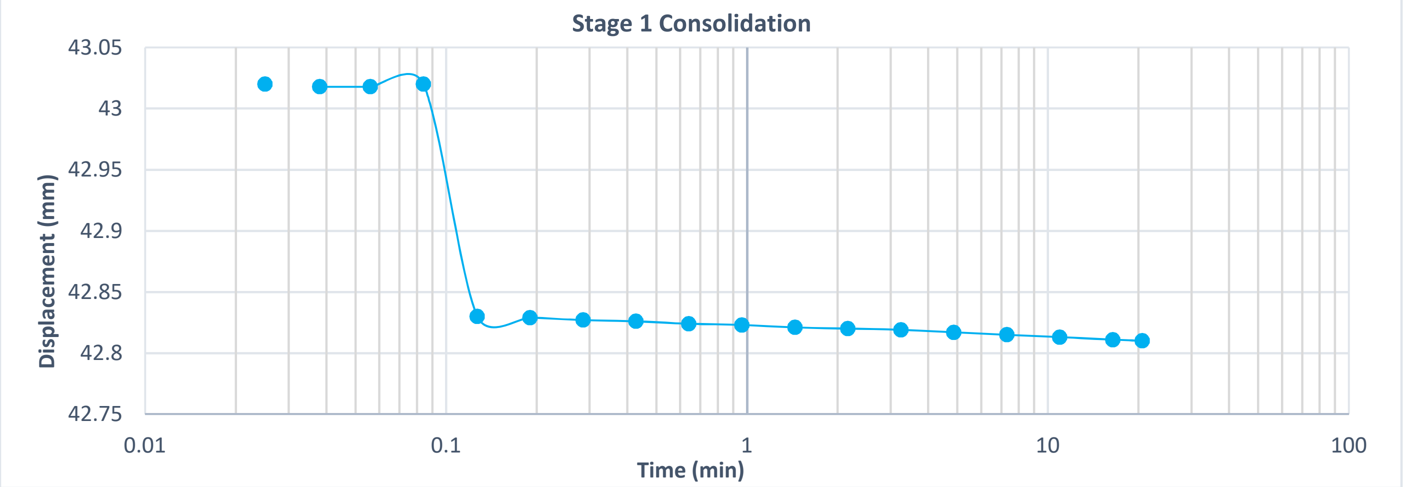
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





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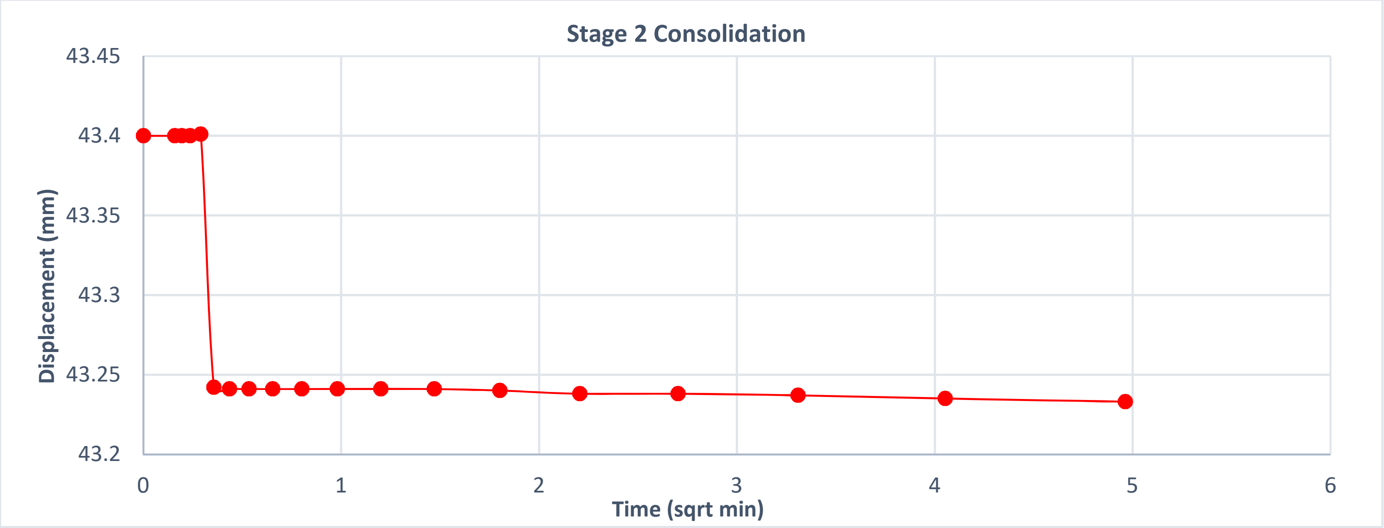
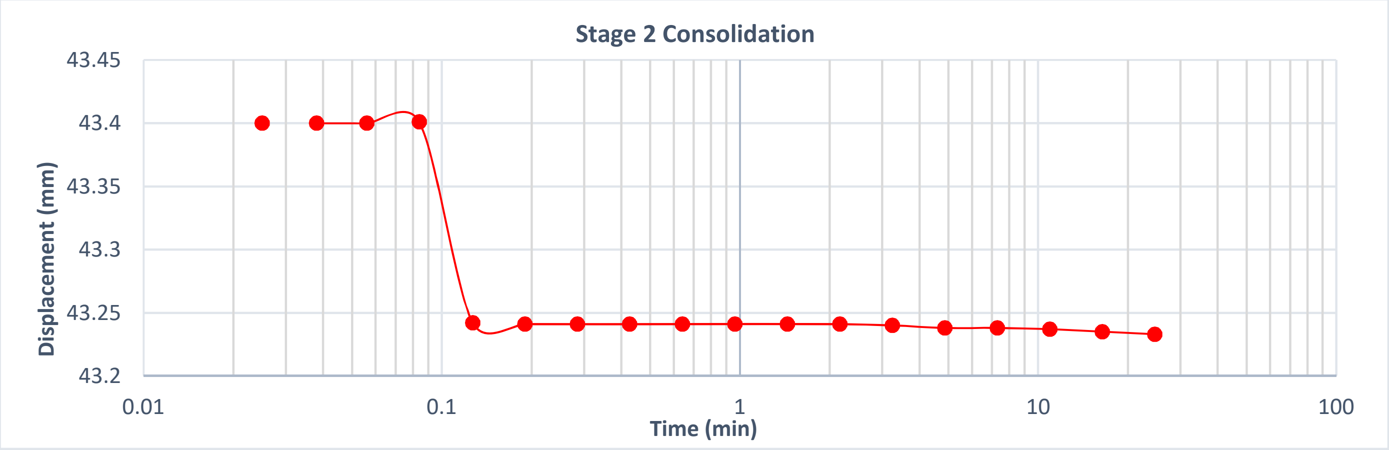
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





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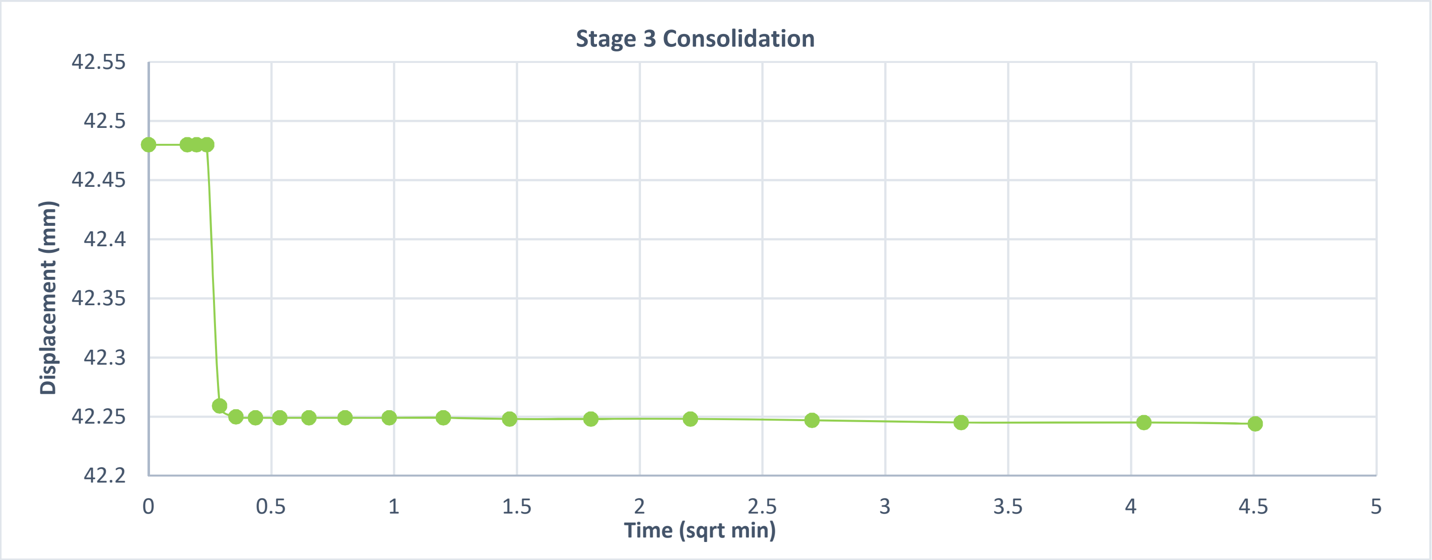
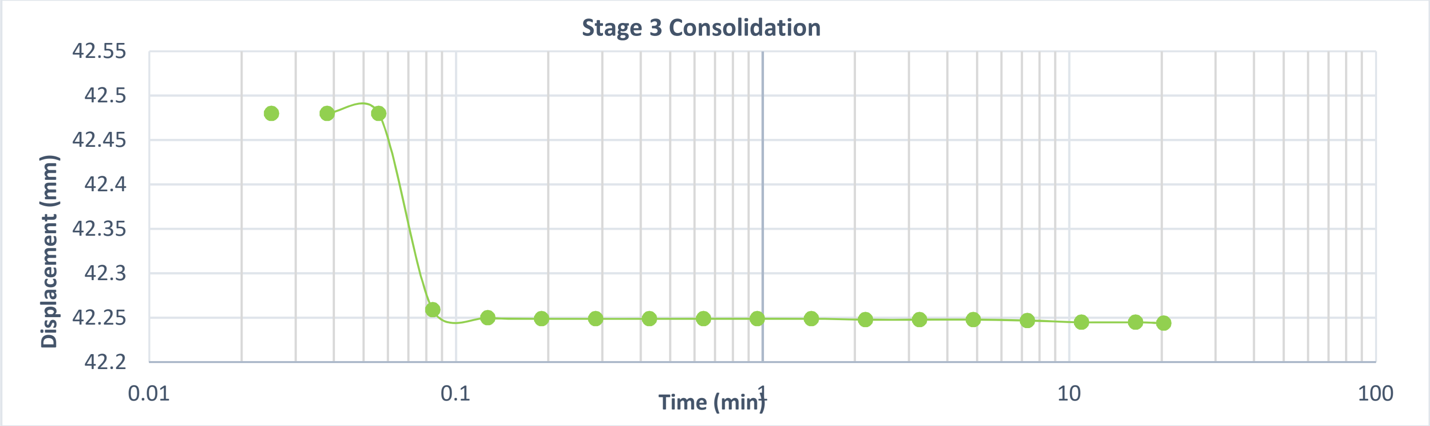
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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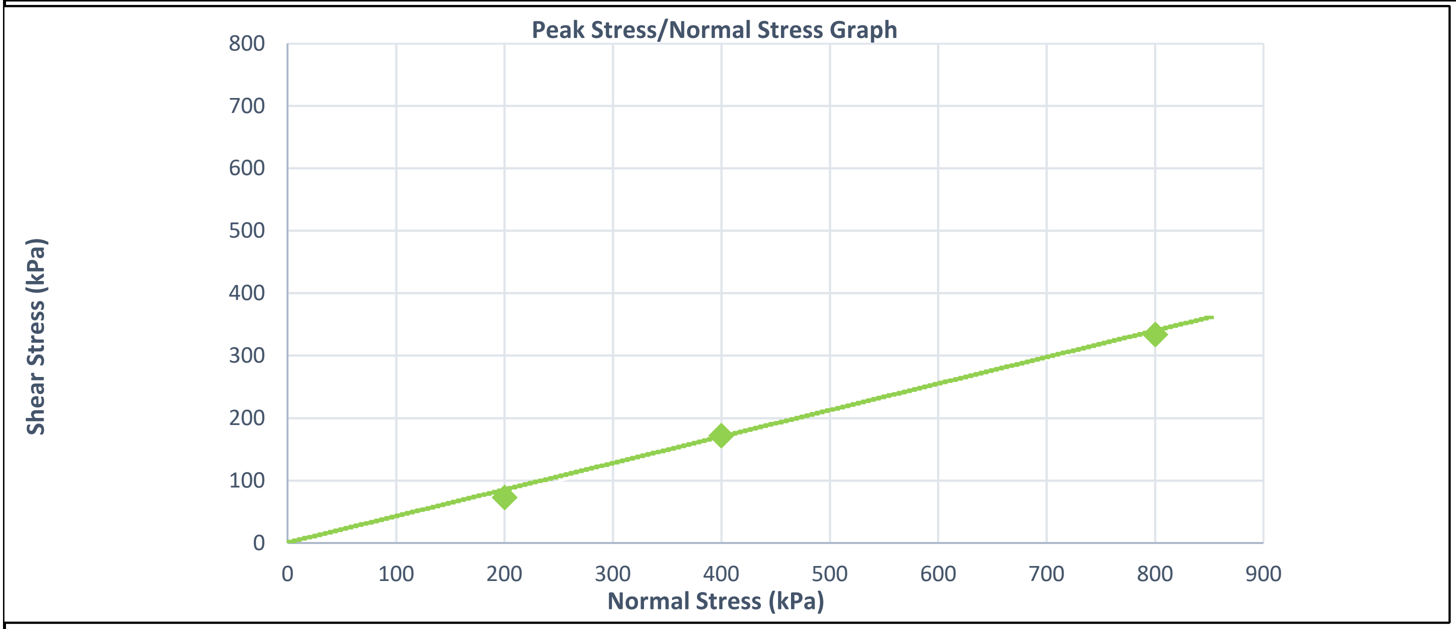
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5413**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-91**		**Page 1**

Borehole: **STX1903G** **Sample ID:** **Shear-91** **Depth From:** **82.08** **Depth To:** **82.29**

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	11/11/2019	Wet Density	2.27	2.32	2.44
Sampled By:	Cardno	Dry Density	2.14	2.19	2.31
Sampling Method:	AS 1289 1.2.1	Moisture (%)	6.0	6.0	5.6
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Carbonaceous Siltstone	Peak Shear Stress (kPa)	73	172	334
Sample Type:	Core	Primary Consolidation (mm)	0.2	0.4	0.4
Lab Ref Number:	19-5413	Strain Rate (mm/min)	0.131	0.116	0.113



Effective Cohesion C' (kPa):	0.0
Effective Angle of Friction ϕ' (Degrees):	23.0
Failure Criteria:	Peak Shear Stress

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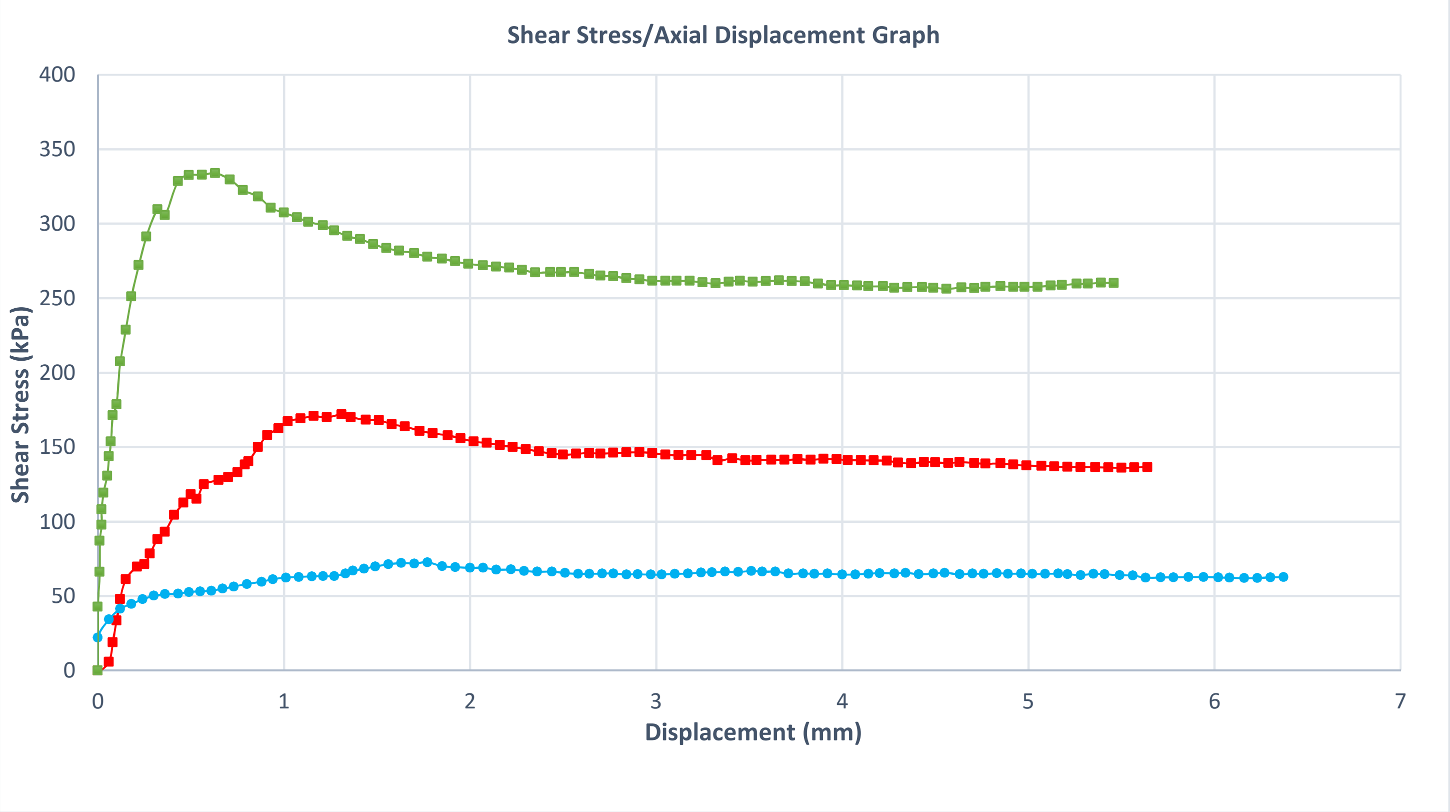
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	73	1.77	52
2	400	172	1.31	53
3	800	334	0.63	50

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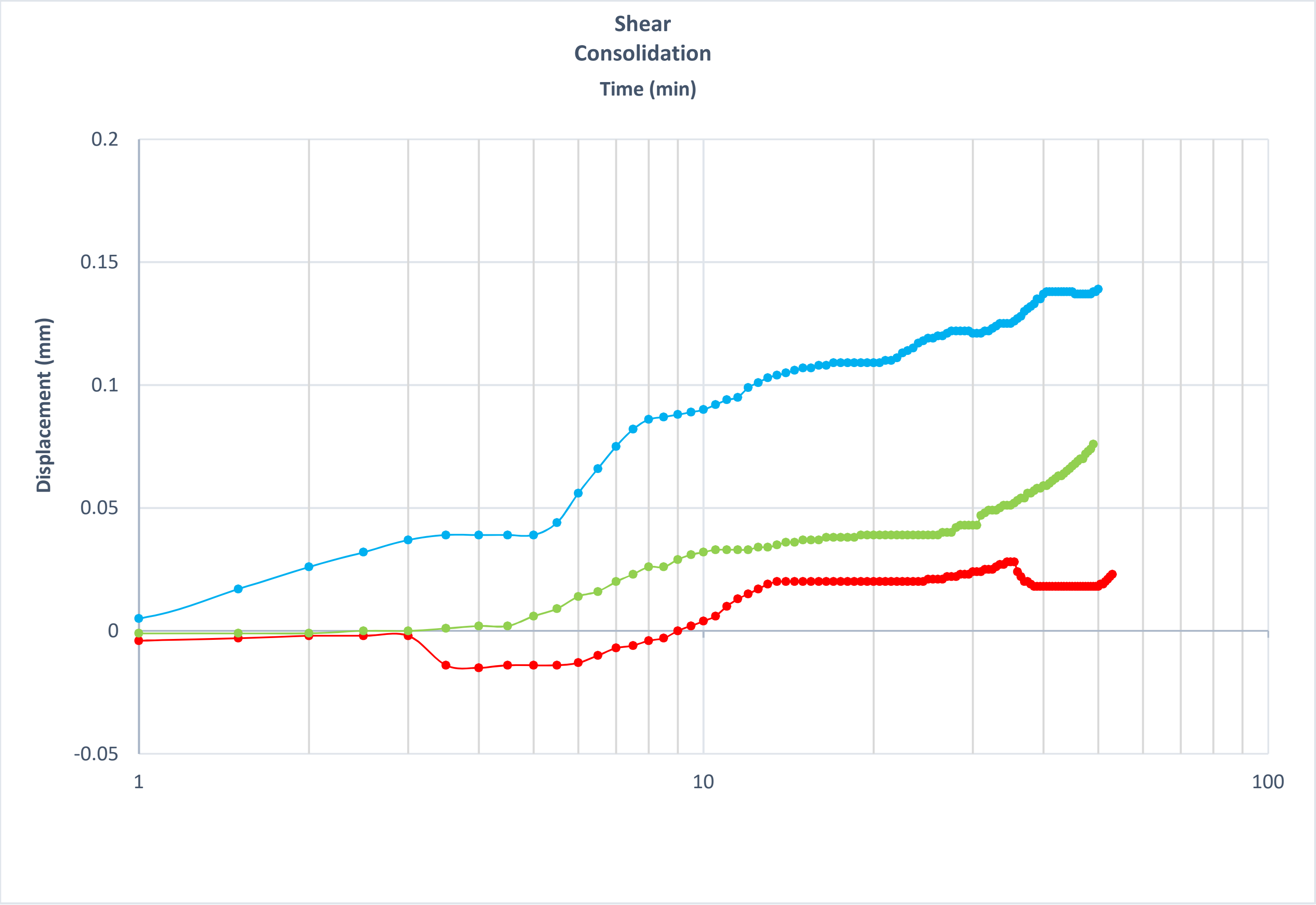
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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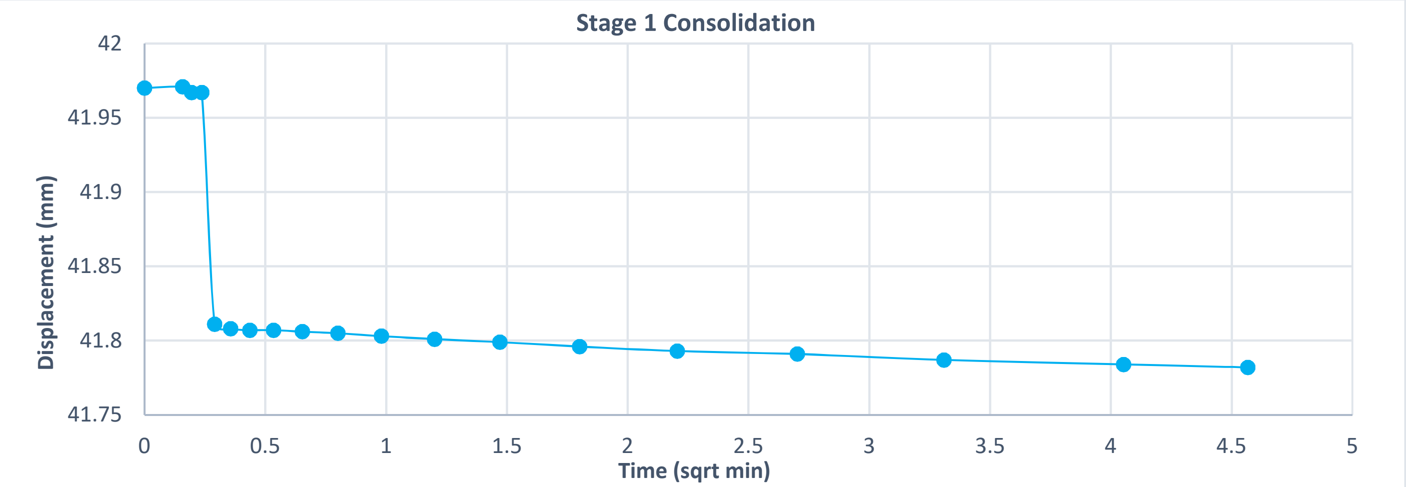
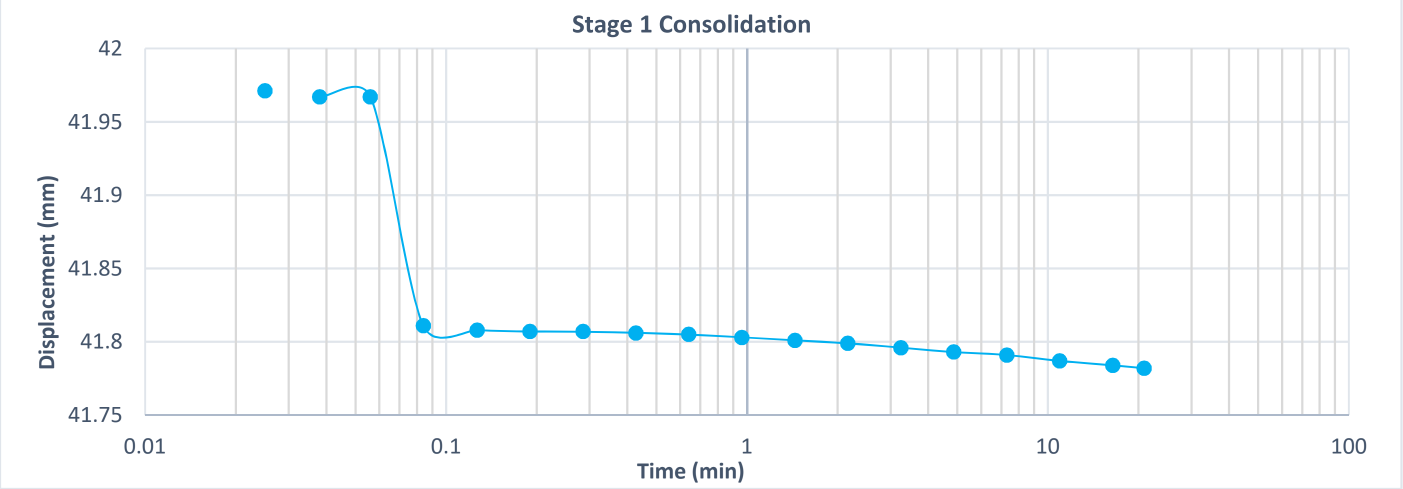
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





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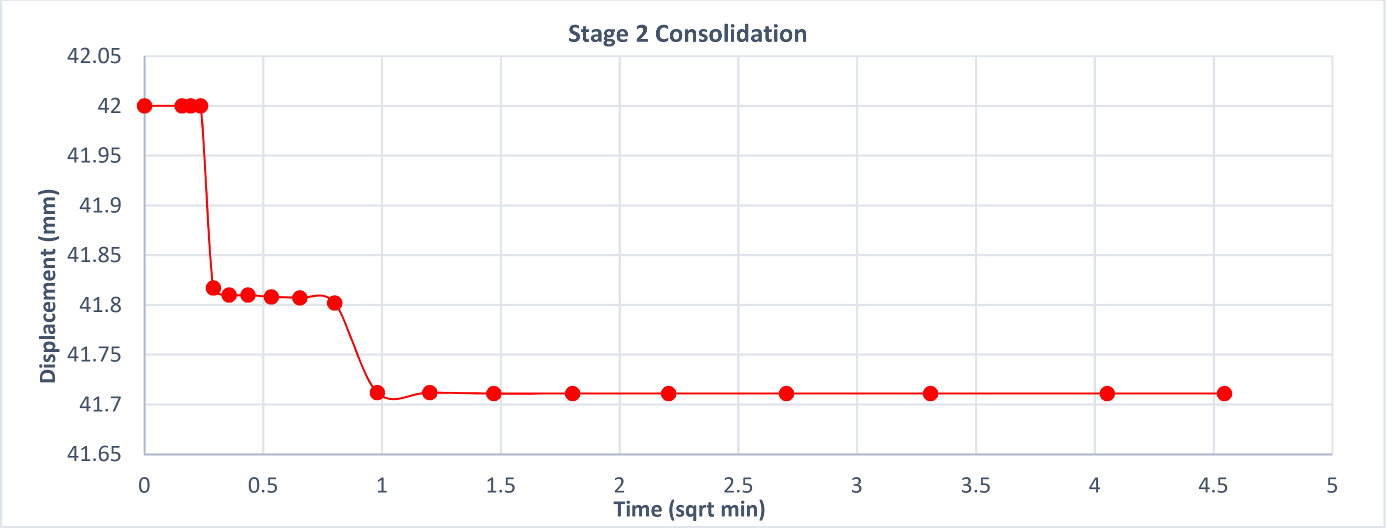
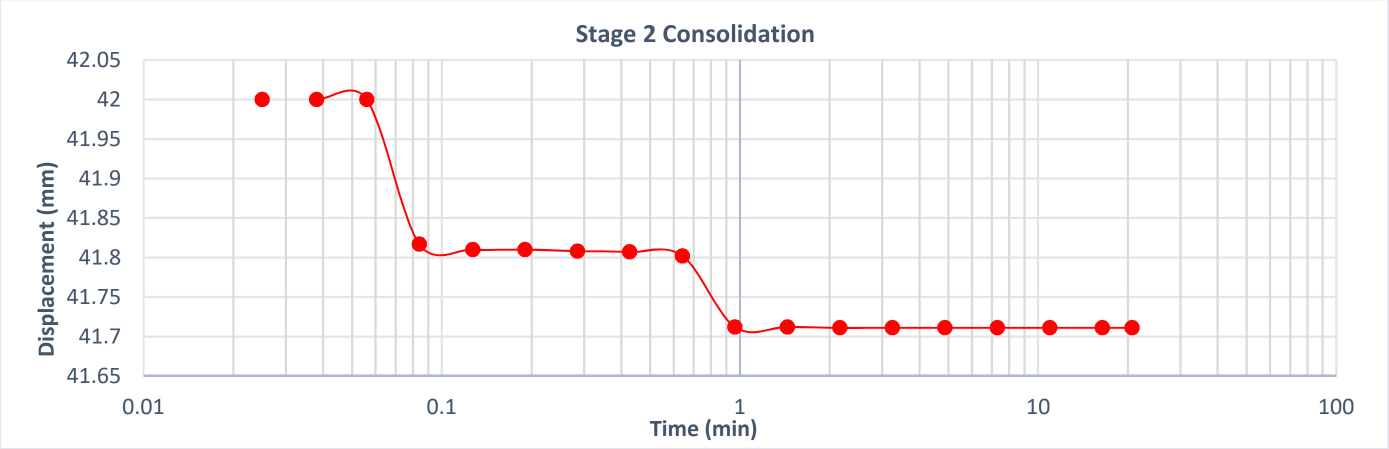
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





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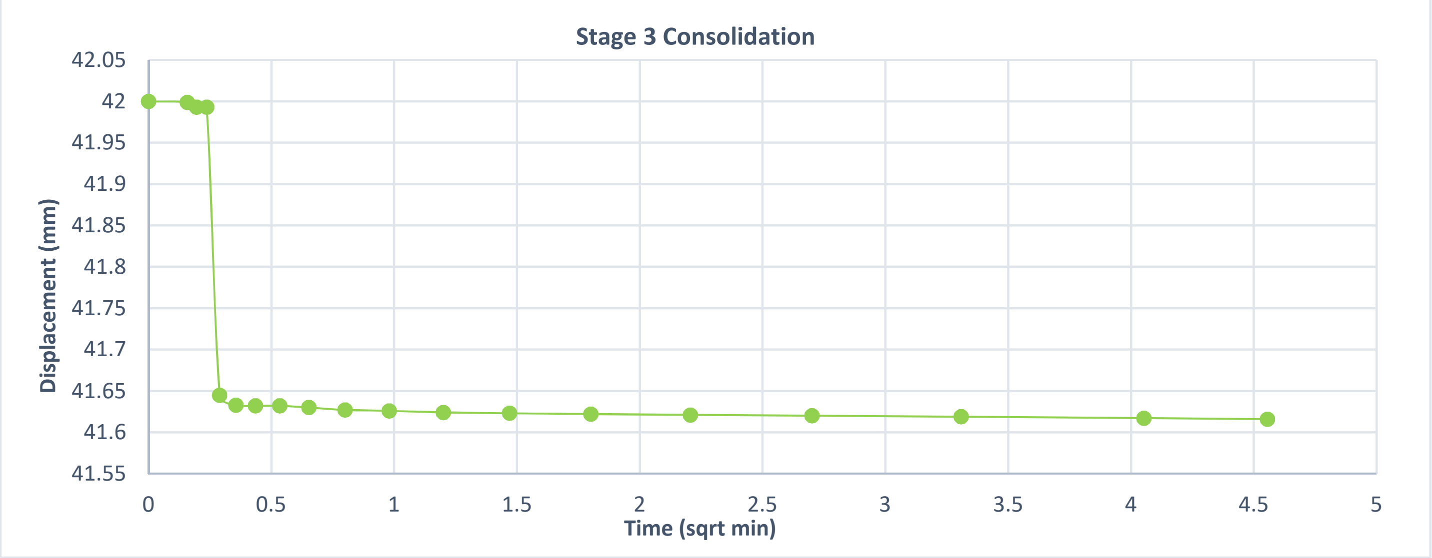
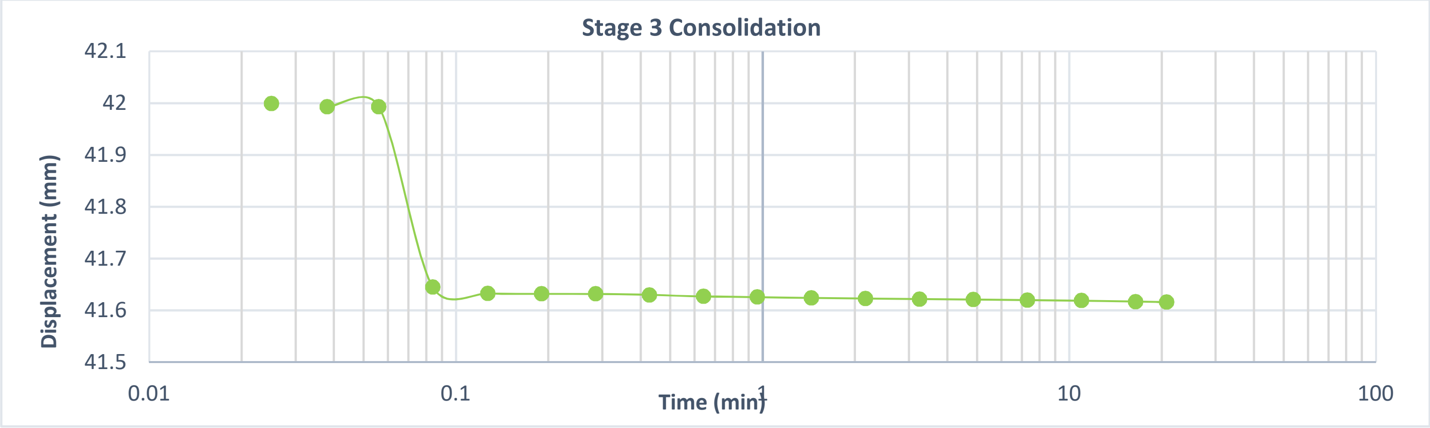
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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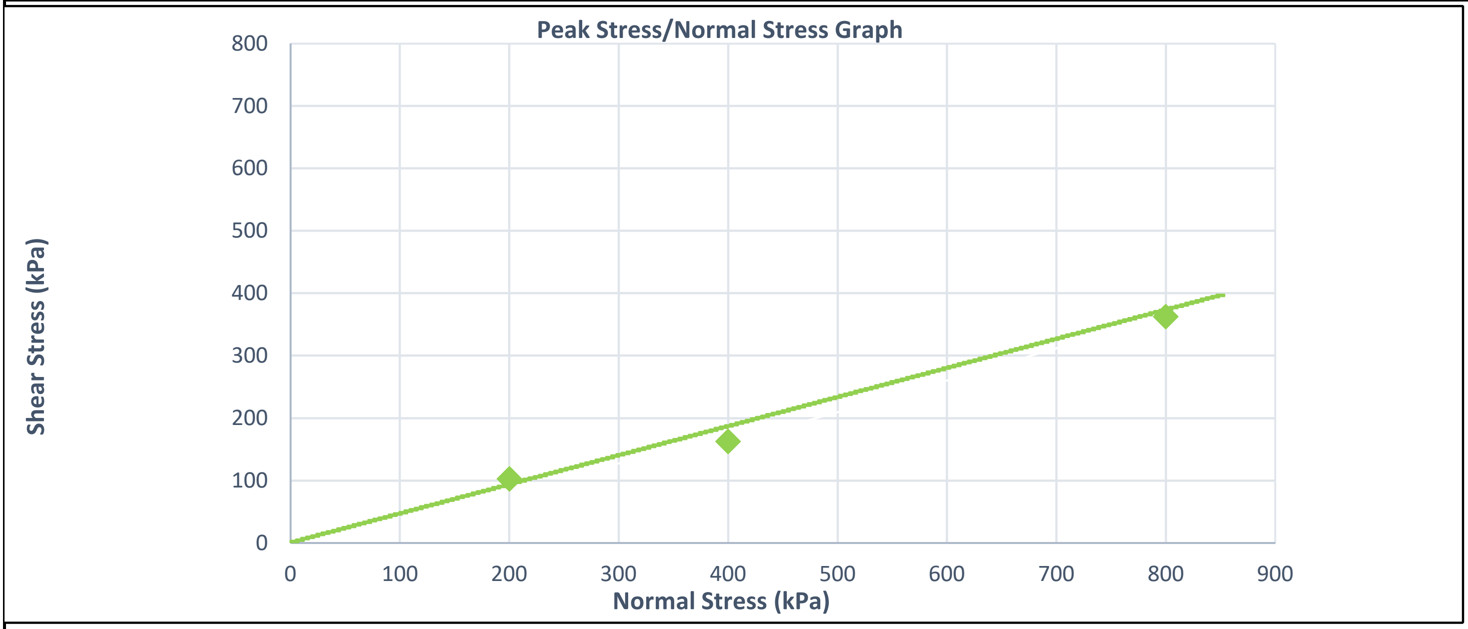
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5430**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-108**		**Page 1**

Borehole: **STX1903G** **Sample ID:** **Shear-108** **Depth From:** **106.21** **Depth To:** **106.38**

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	11/11/2019	Wet Density	2.19	2.18	2.20
Sampled By:	Cardno	Dry Density	2.09	2.07	2.10
Sampling Method:	AS 1289 1.2.1	Moisture (%)	5.1	5.1	4.9
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Siltstone	Peak Shear Stress (kPa)	103	163	362
Sample Type:	Core	Primary Consolidation (mm)	0.2	0.3	0.4
Lab Ref Number:	19-5430	Strain Rate (mm/min)	0.128	0.118	0.104



Effective Cohesion C' (kPa):	0.0
Effective Angle of Friction ϕ' (Degrees):	25.0
Failure Criteria:	Peak Shear Stress

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Direct Shear on Rock Report

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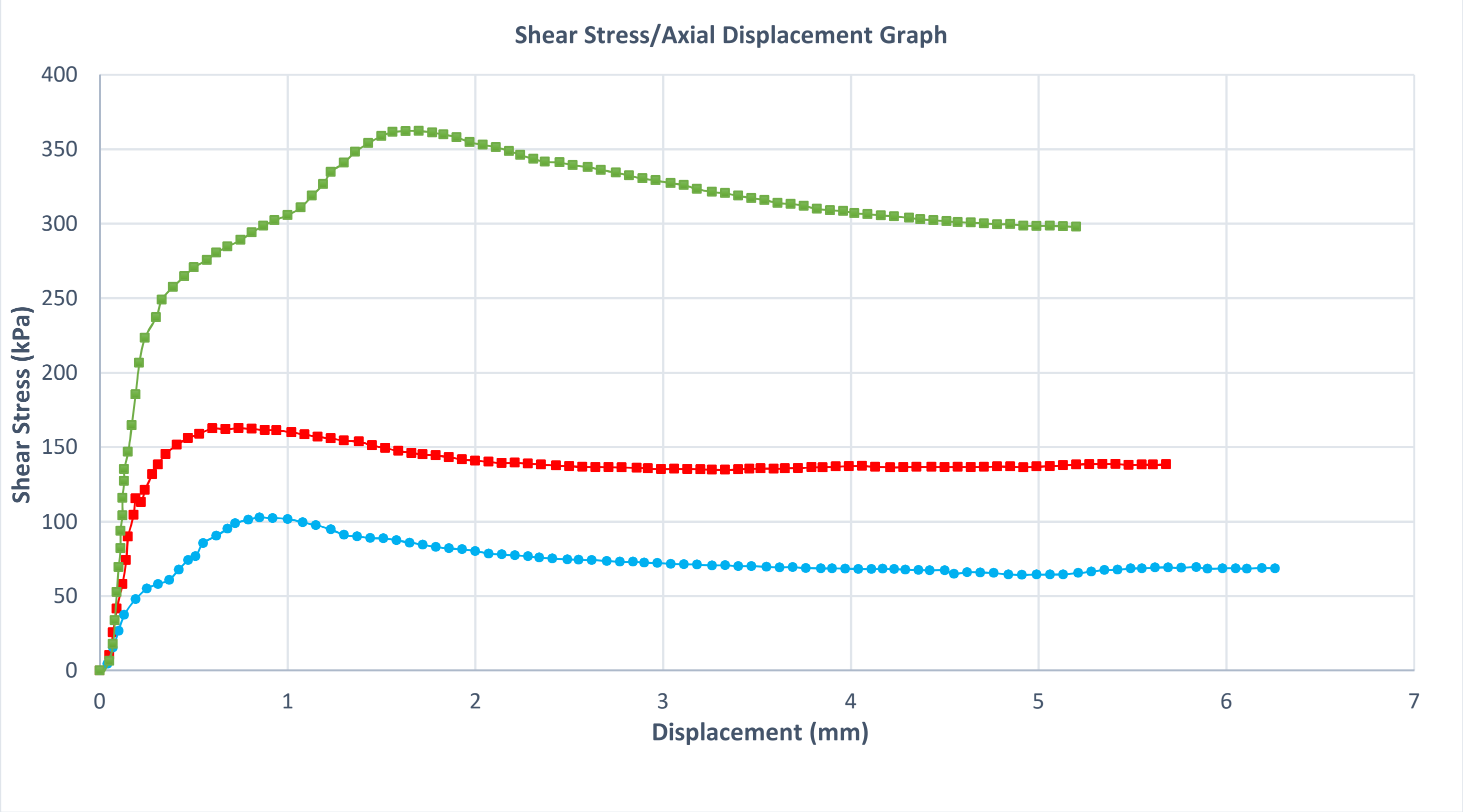
Address: **Level 17, 240 Queen Street, Brisbane, QLD**
Project Number: **M30863**
Project Name: **CQ Coal Styx Basin Geotechnical Investigation**
Location: **STX1903G**

Report Number: **19-5430**
Report Date: **12/11/2019**
Order Number: **-**
Test Method **AS 1289.6.2.2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	103	0.85	49
2	400	163	0.74	46
3	800	362	1.70	56

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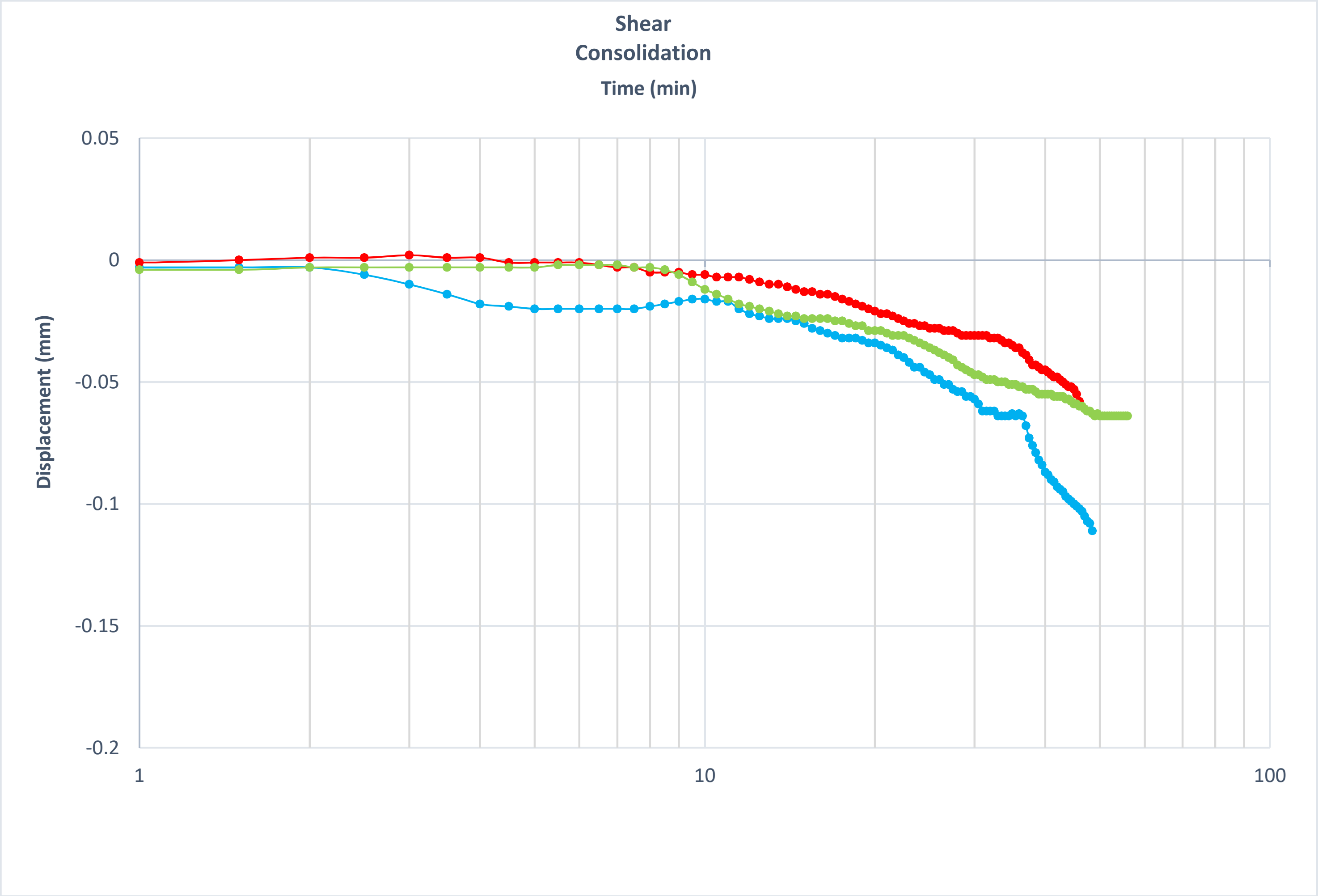
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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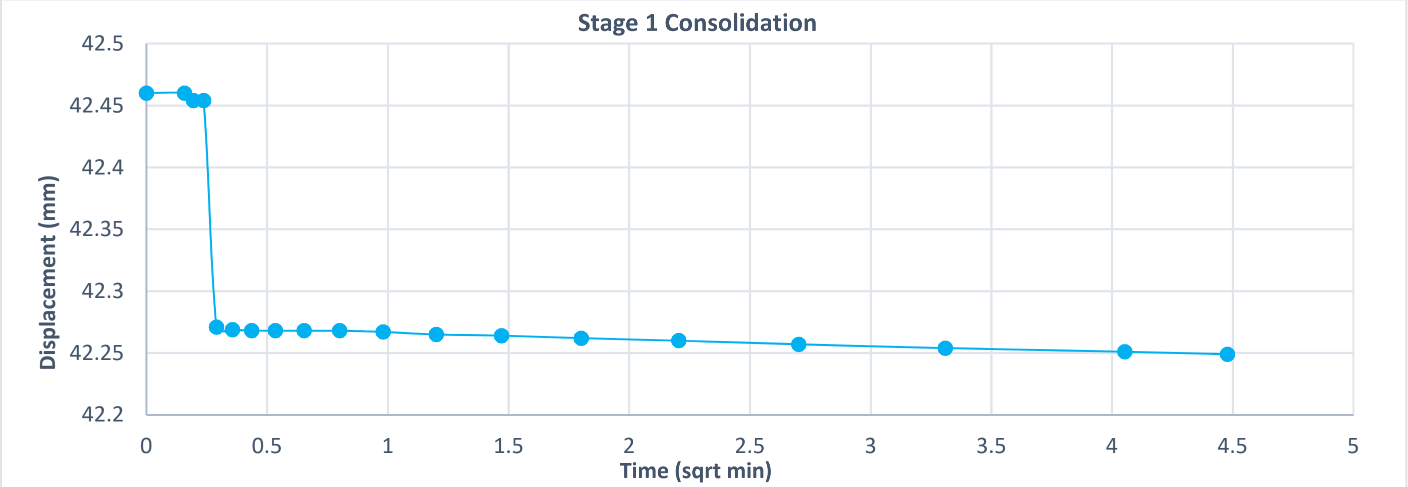
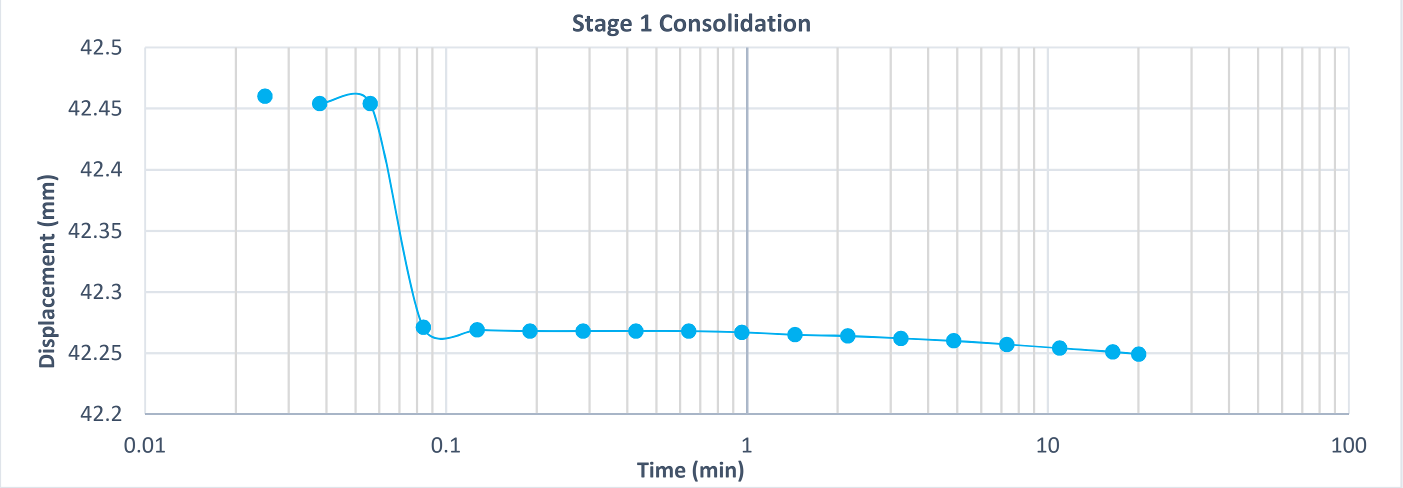
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





Sample/s supplied by Cardno Note: Graph not to scale

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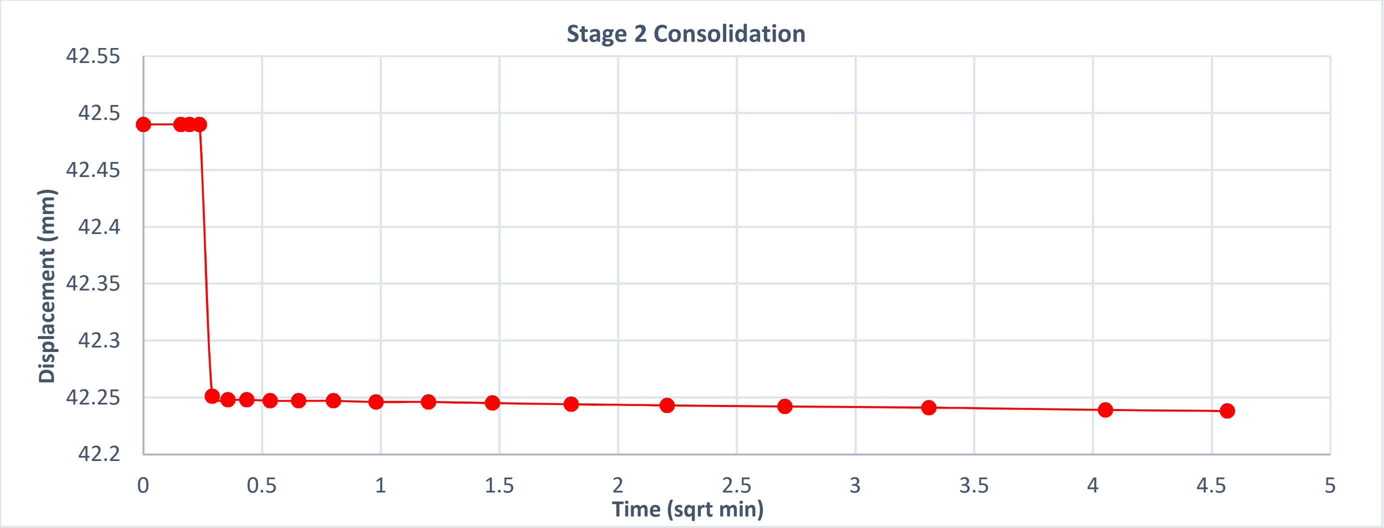
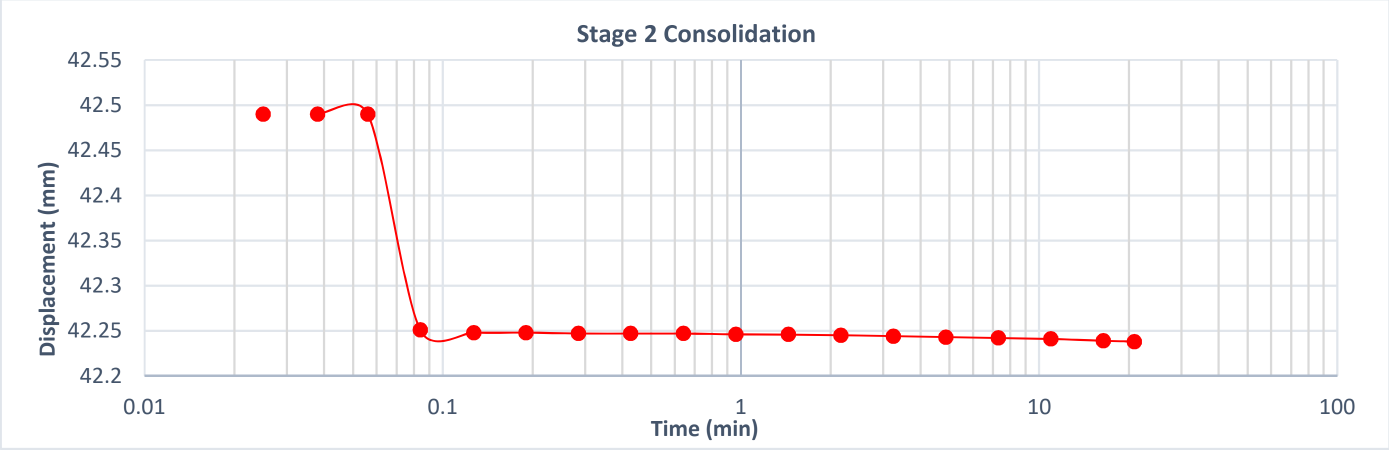
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5430**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 5**





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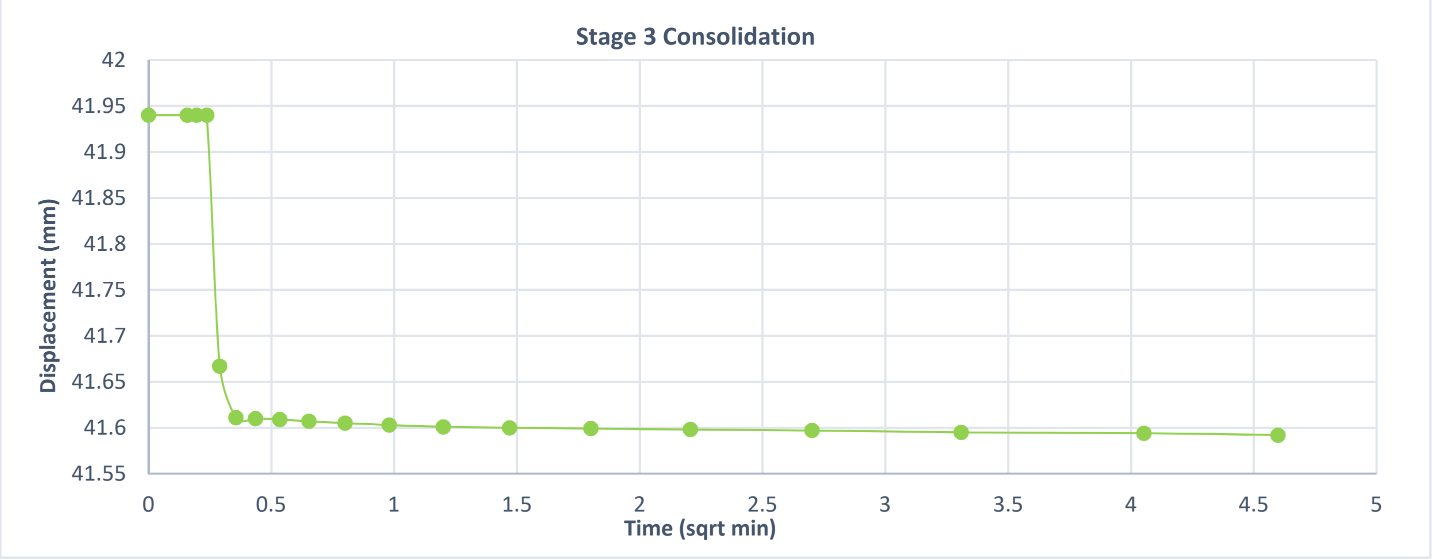
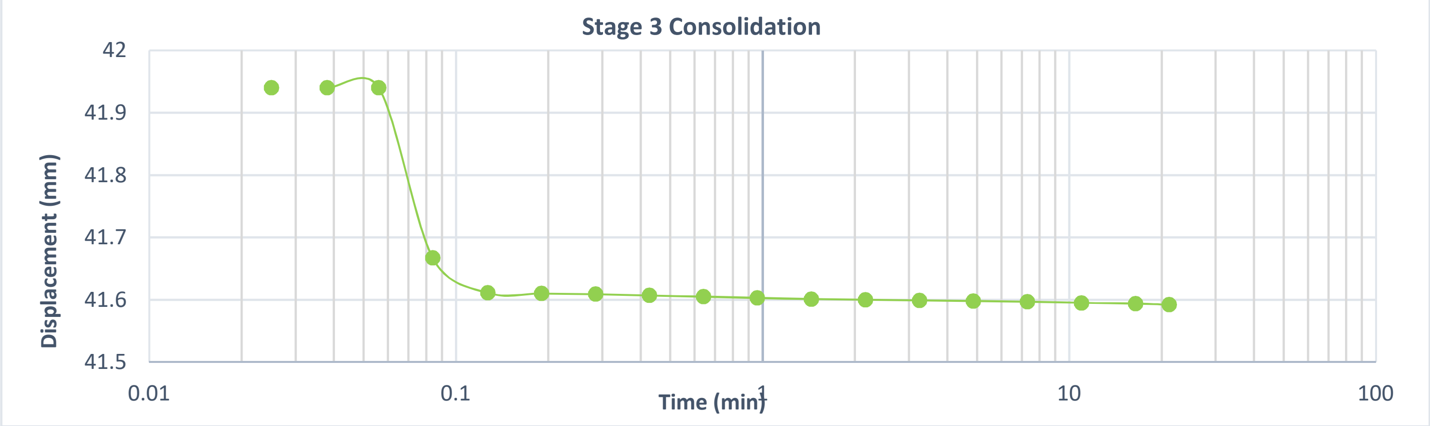
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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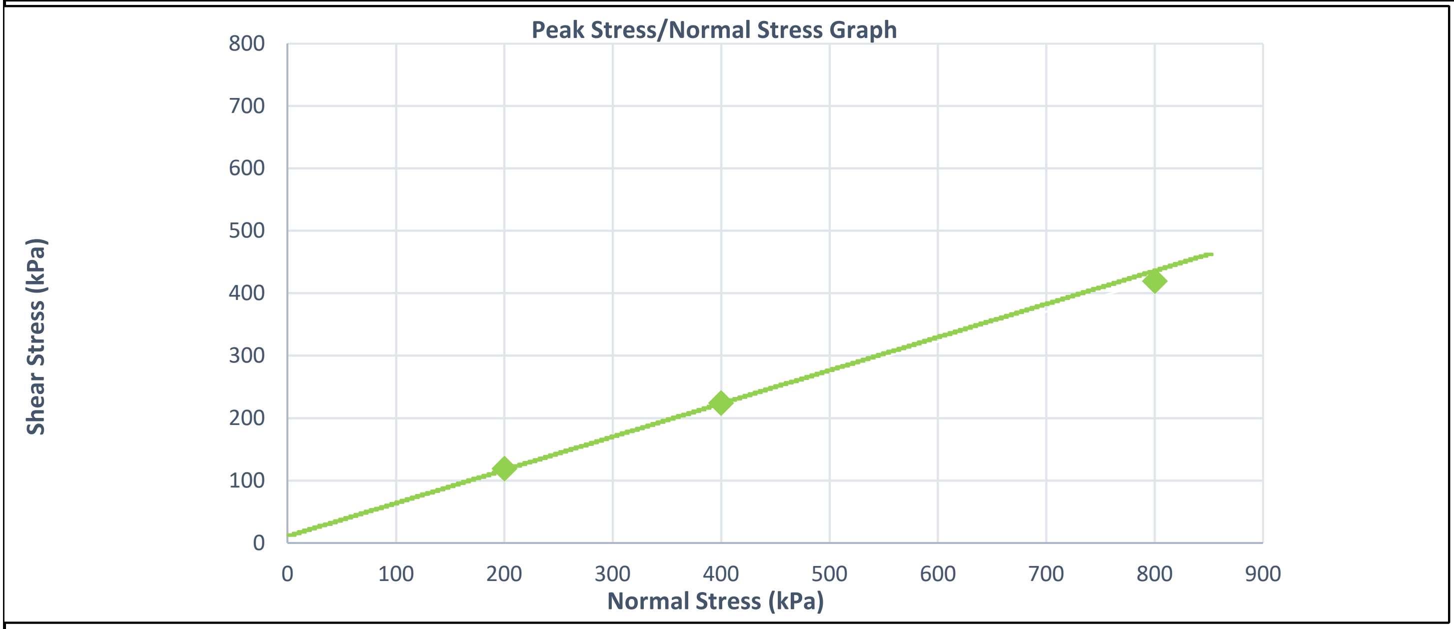
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5434**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G** **Shear-112**		**Page 1**

Borehole: **STX1903G** **Sample ID:** **Shear-112** **Depth From:** **111.64** **Depth To:** **111.81**

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	11/11/2019	Wet Density	2.35	2.43	2.31
Sampled By:	Cardno	Dry Density	2.30	2.37	2.27
Sampling Method:	AS 1289 1.2.1	Moisture (%)	2.2	2.3	2.0
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Carbonaceous Siltstone	Peak Shear Stress (kPa)	119	224	419
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.1	0.2
Lab Ref Number:	19-5434	Strain Rate (mm/min)	0.124	0.106	0.094



Effective Cohesion C' (kPa):	10.0
Effective Angle of Friction ϕ' (Degrees):	28.0
Failure Criteria:	Peak Shear Stress

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Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**

Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	119	6.74	53
2	400	224	4.53	51
3	800	419	5.27	62

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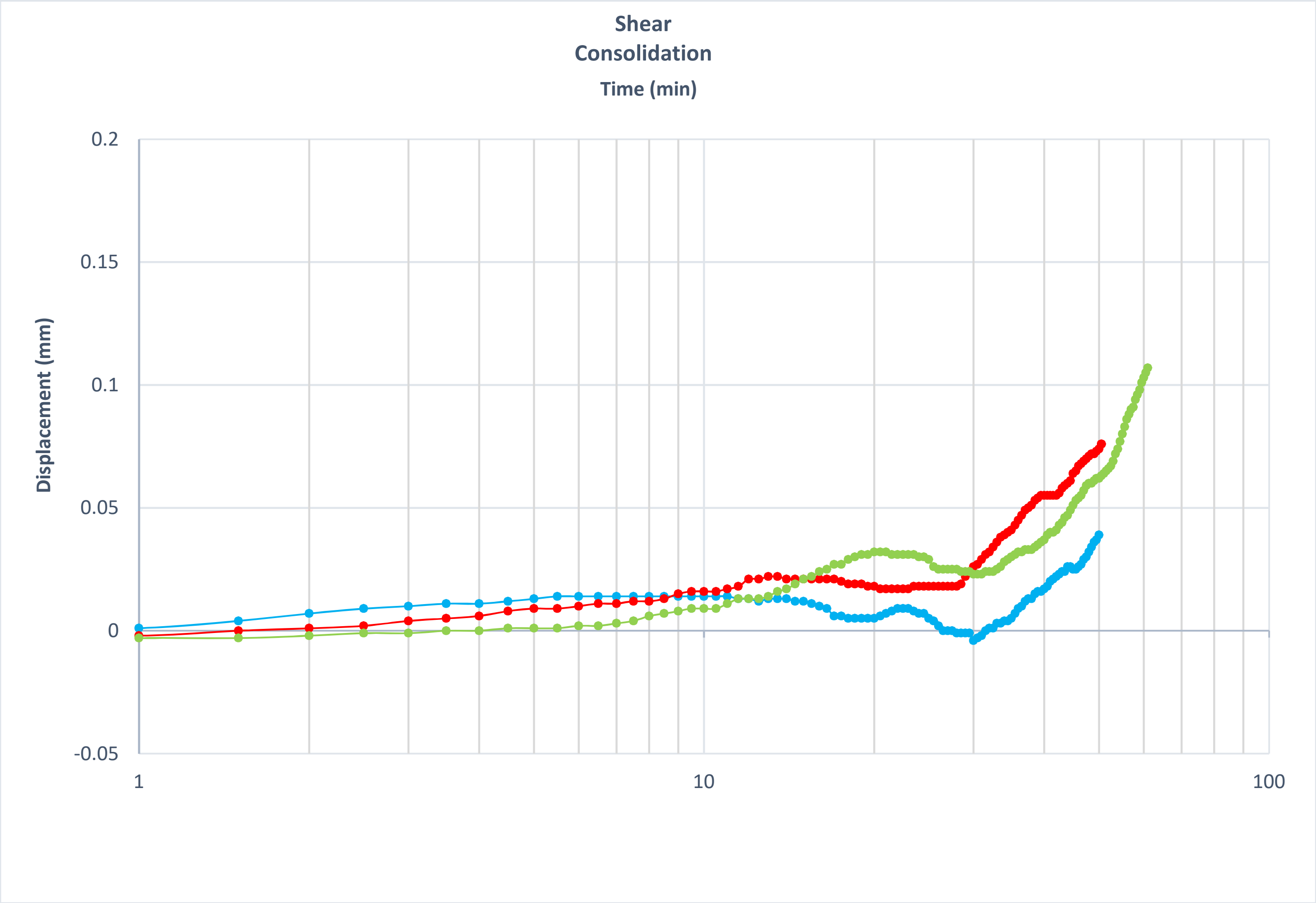
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 3**



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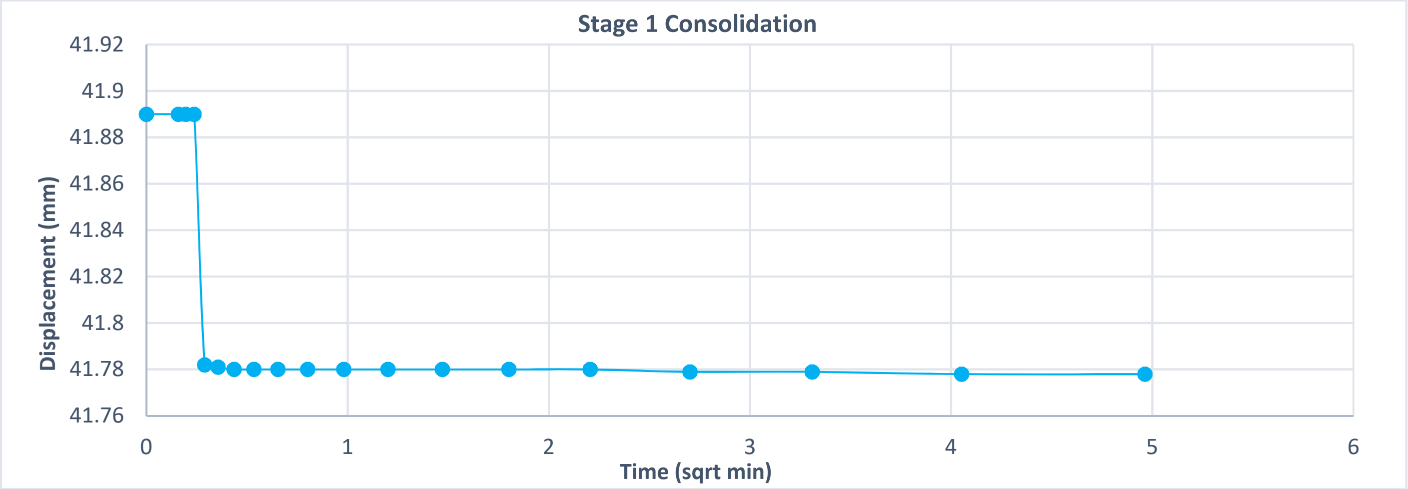
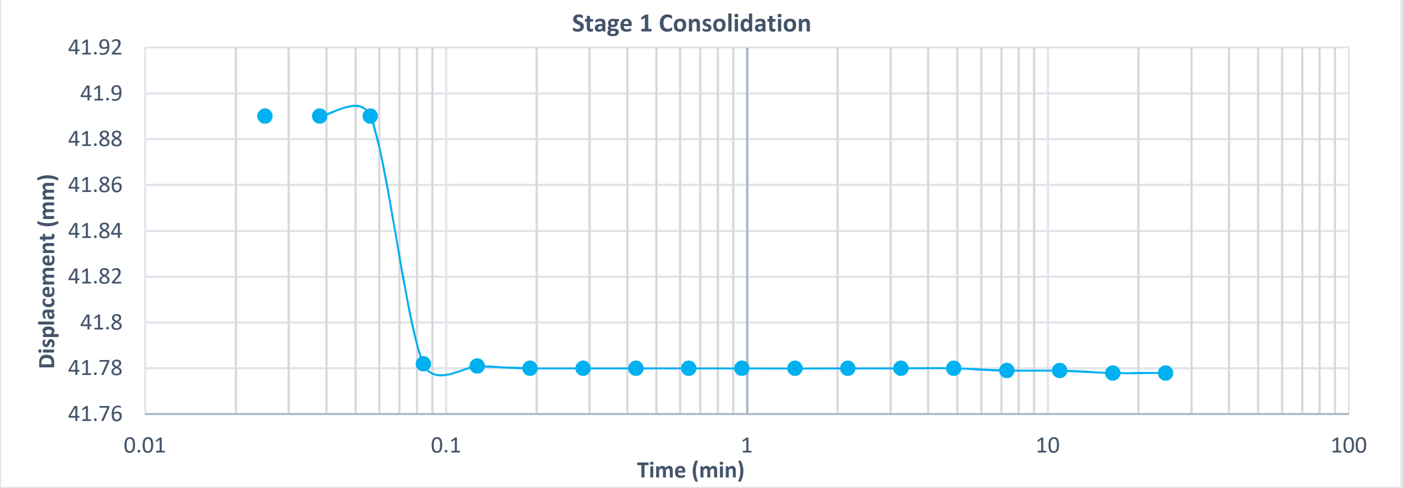
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 4**





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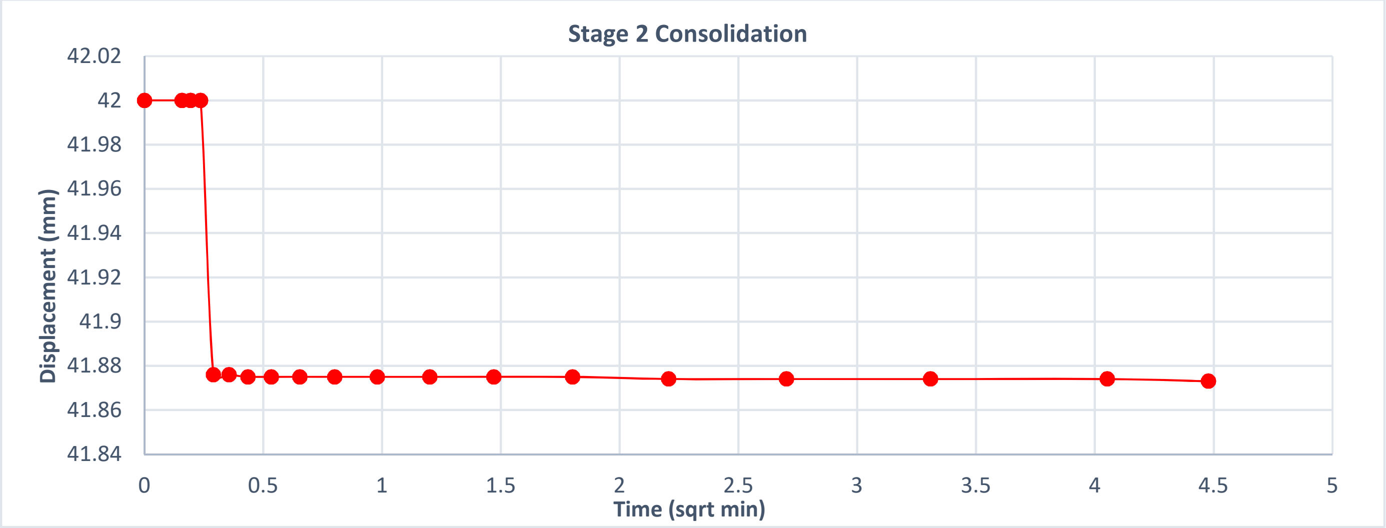
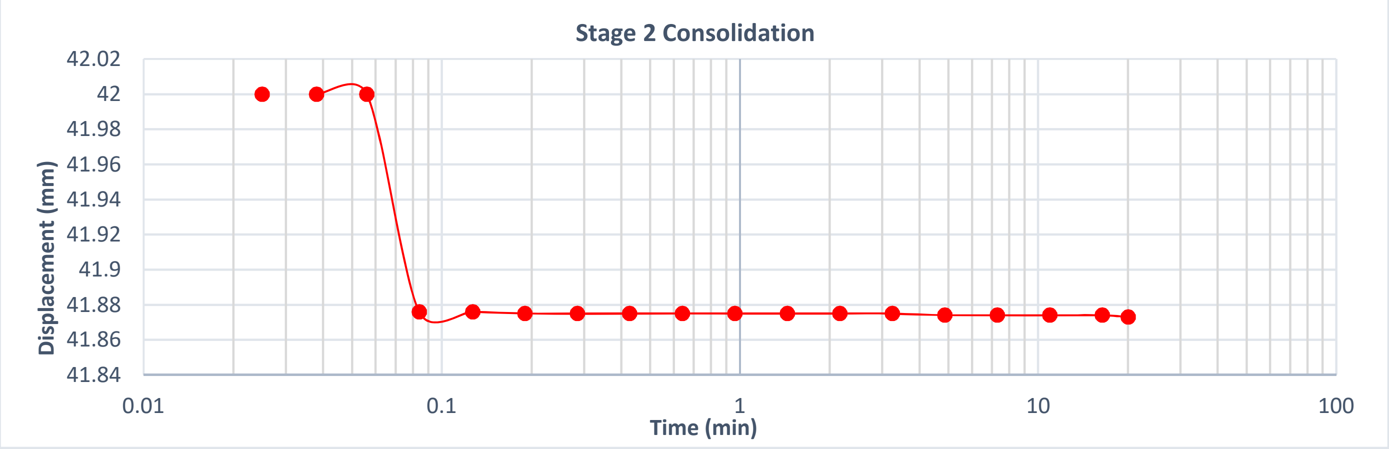
Location:	**STX1903G**		**Page 5**





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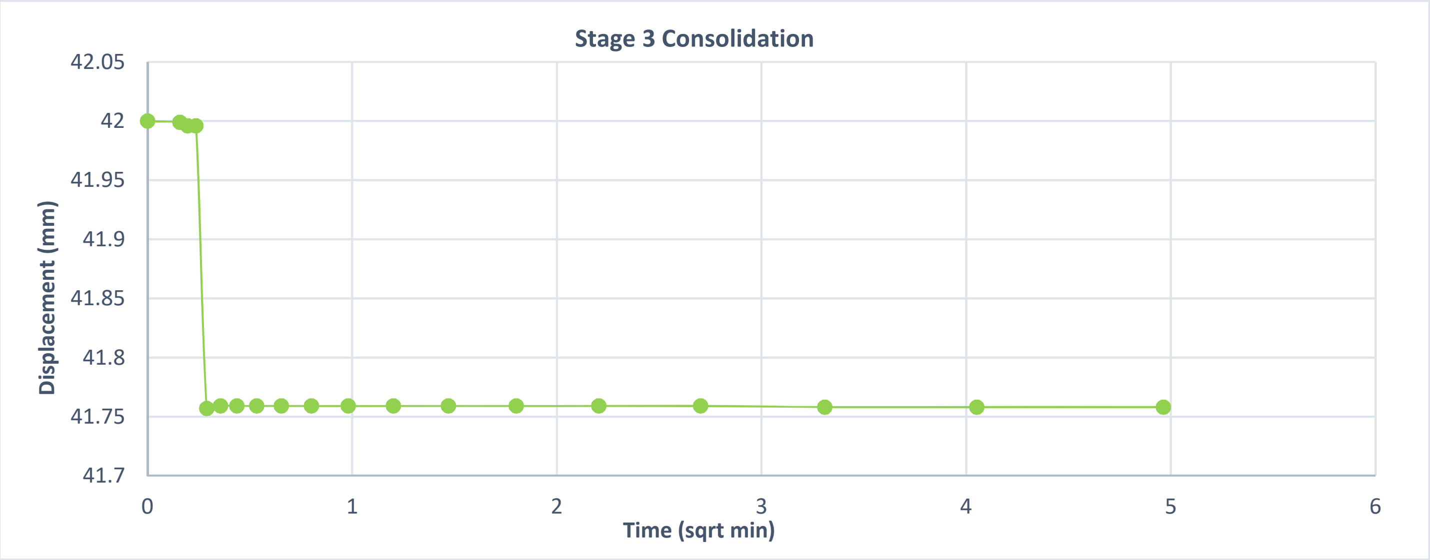
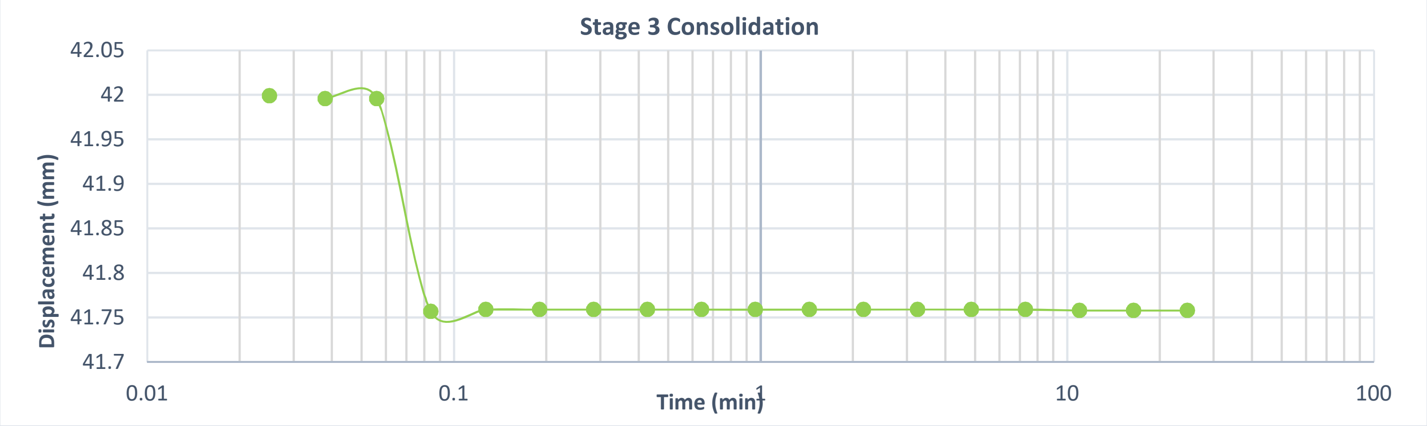
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**12/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 6**





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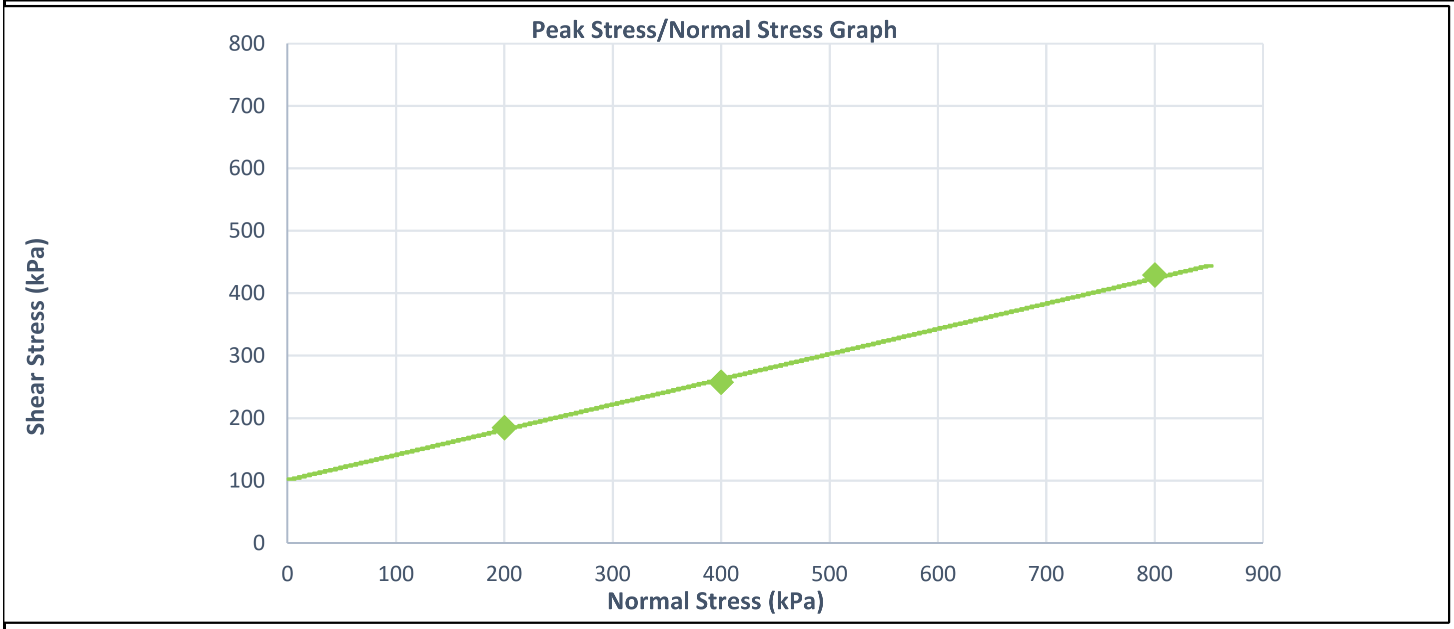
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5441A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	-
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G Shear-119**		**Page 1**

Borehole: STX1903G Sample ID: Shear-119 Depth From: 124.68 Depth To: 124.9

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	12/11/2019	Wet Density	2.33	2.42	2.39
Sampled By:	Cardno	Dry Density	2.27	2.36	2.33
Sampling Method:	AS 1289 1.2.1	Moisture (%)	2.8	2.6	2.8
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Interlaminated Sandstone and Siltstone	Peak Shear Stress (kPa)	184	257	429
Sample Type:	Core	Primary Consolidation (mm)	0.3	0.2	0.4
Lab Ref Number:	19-5441A	Strain Rate (mm/min)	0.114	0.110	0.098



Effective Cohesion C' (kPa):	100.0
Effective Angle of Friction ϕ' (Degrees):	22.0
Failure Criteria:	Peak Shear Stress

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Direct Shear on Rock Report

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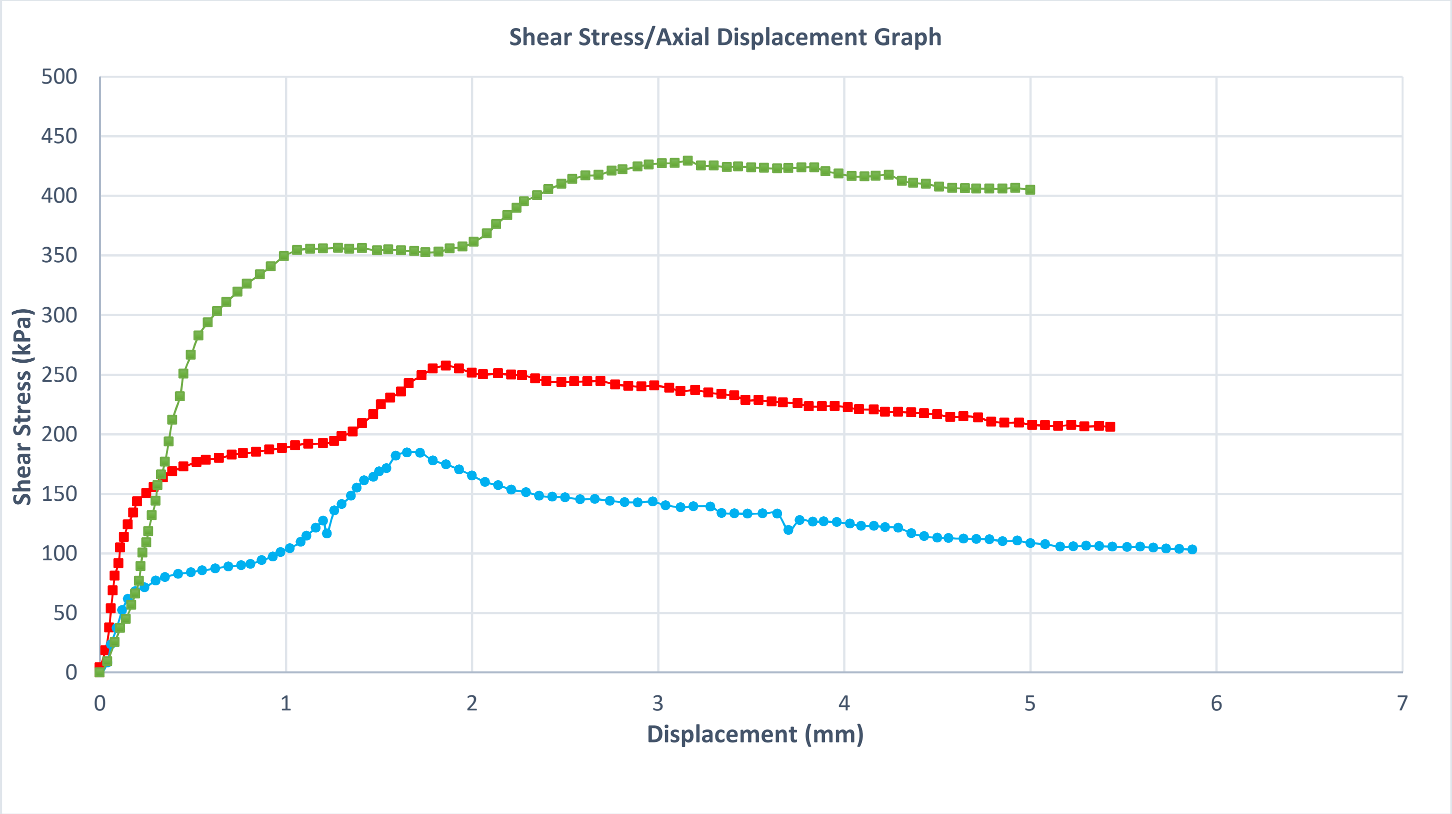
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1903G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	184	1.65	54
2	400	257	1.86	53
3	800	429	3.16	60

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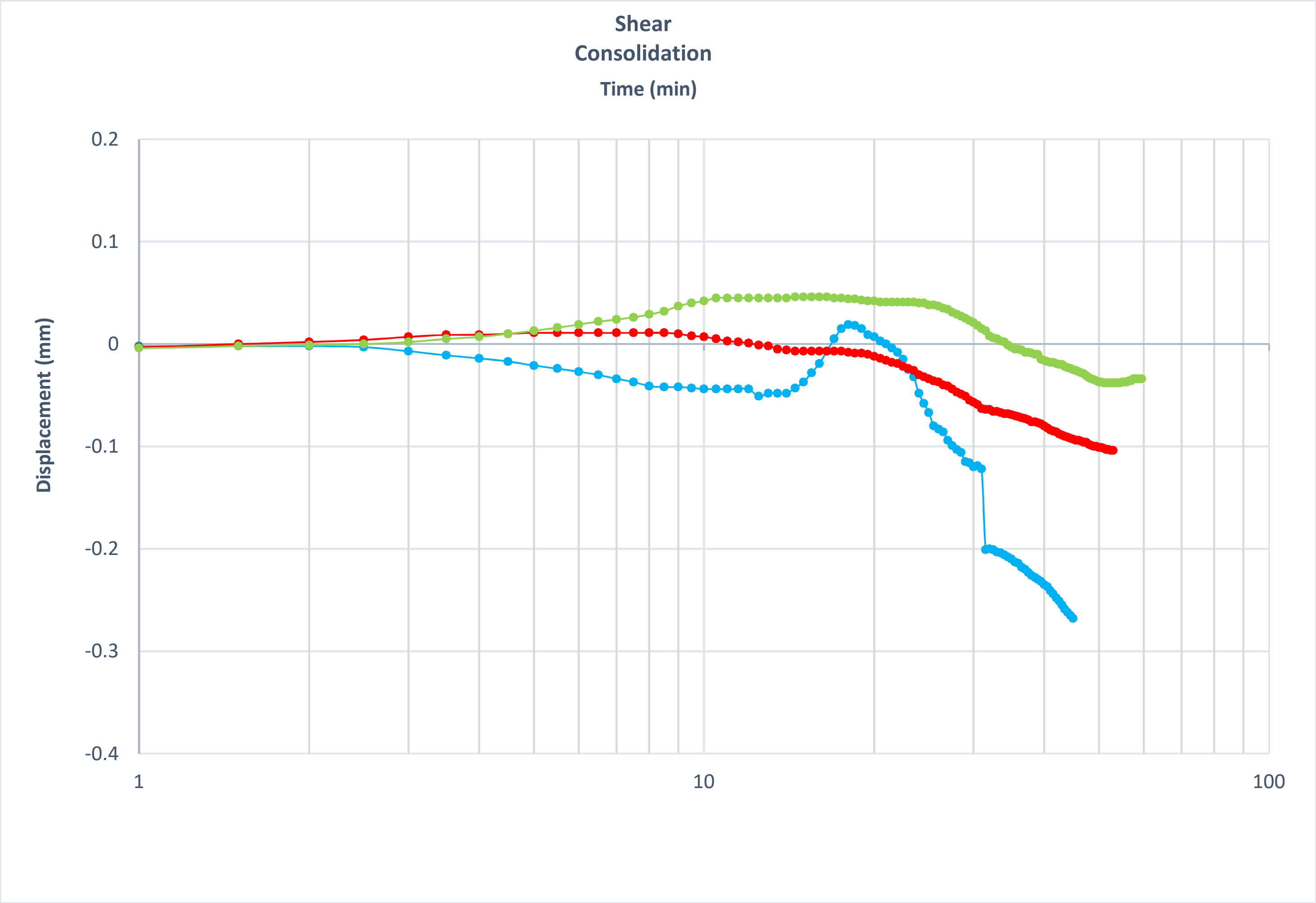
Location:	**STX1903G**		**Page 3**



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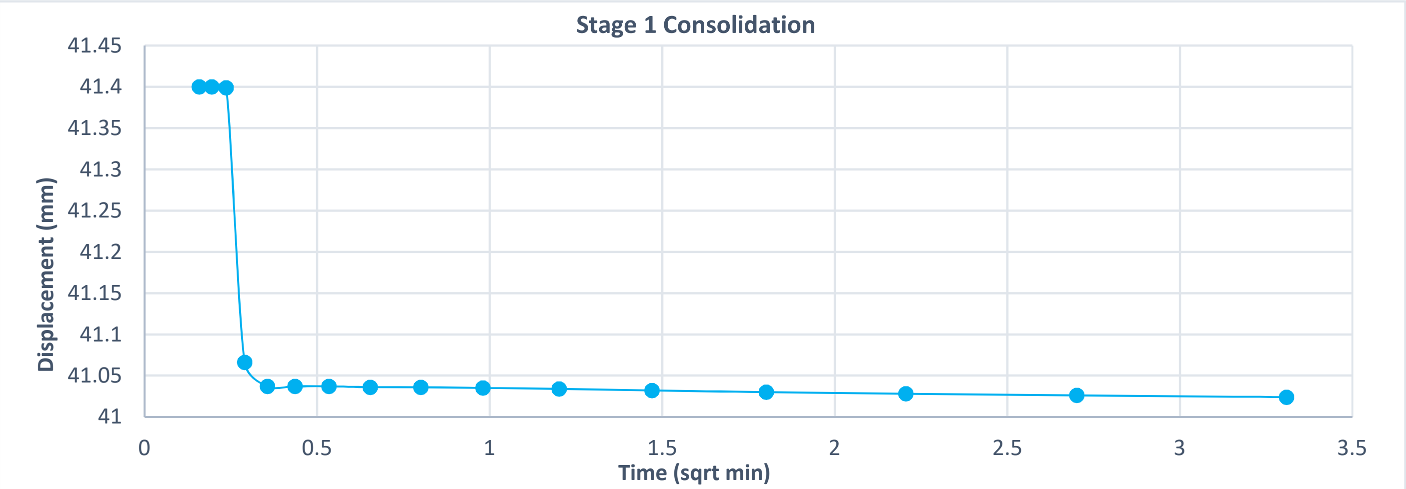
Location:	**STX1903G**		**Page 4**



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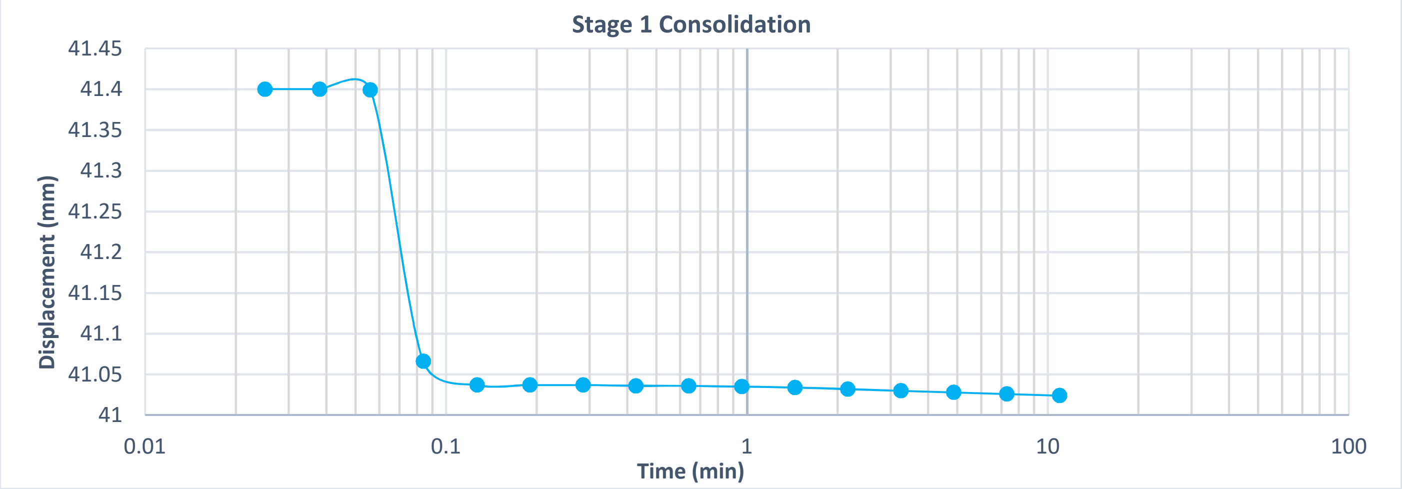

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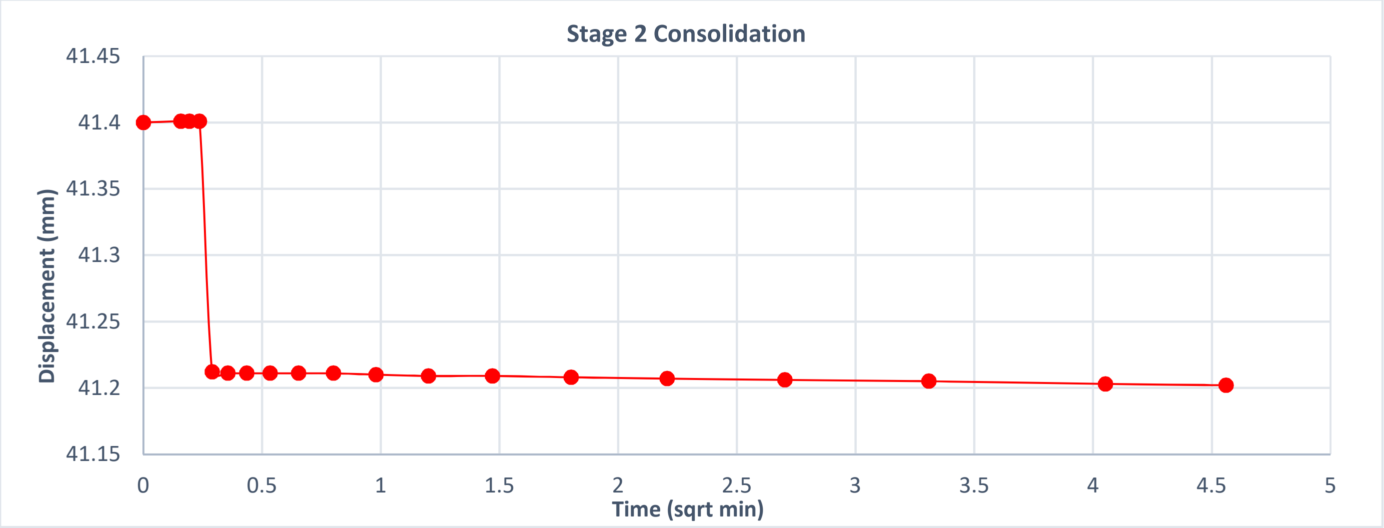

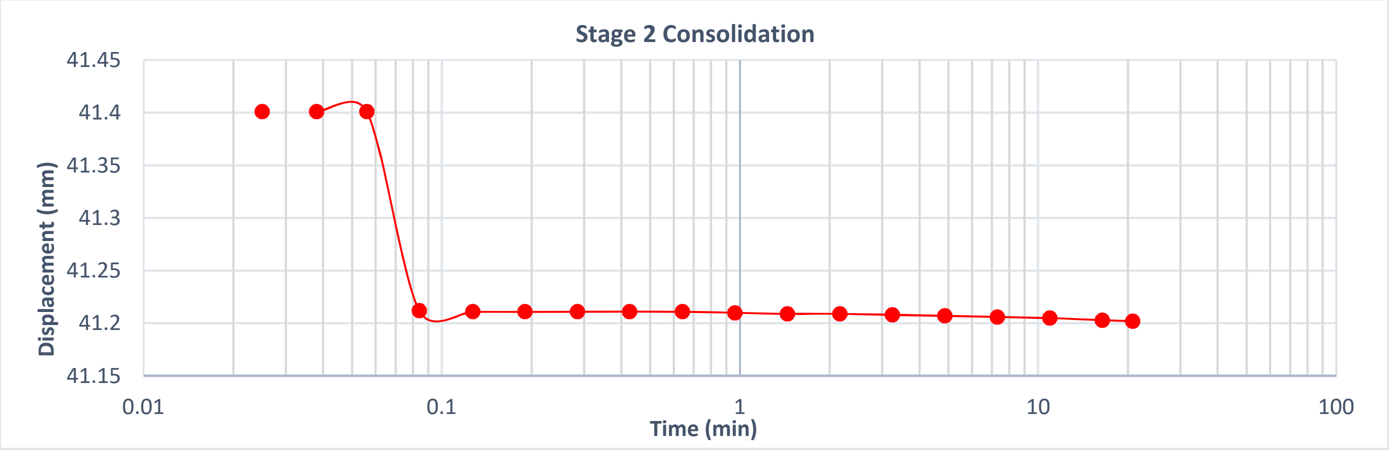

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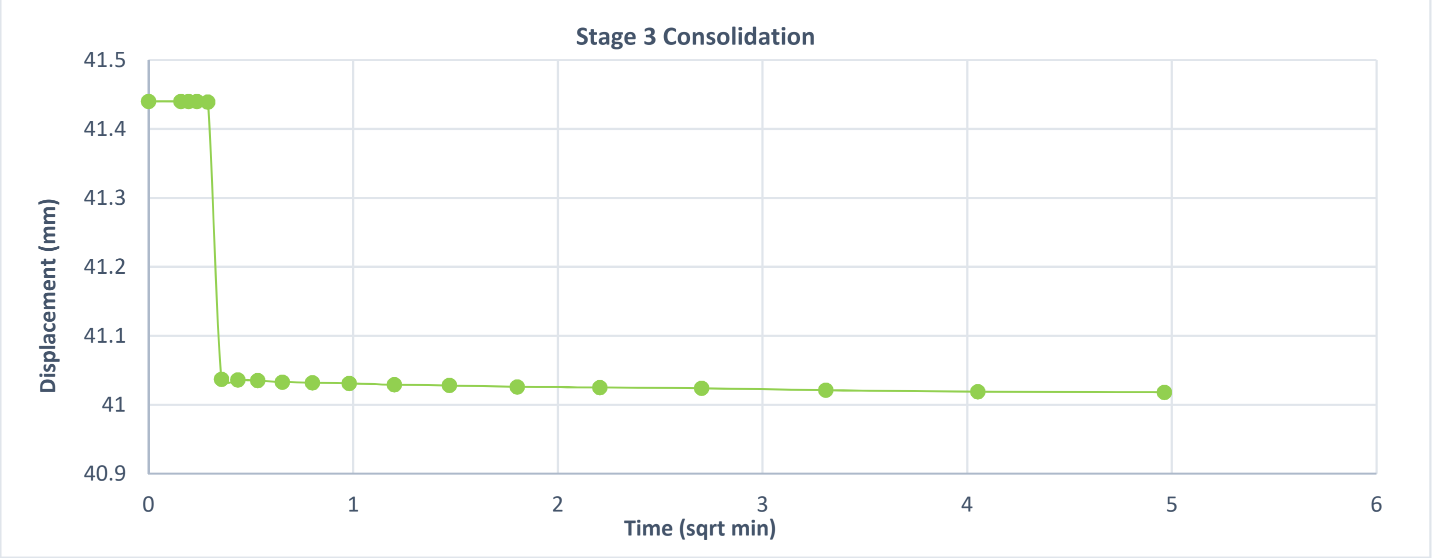

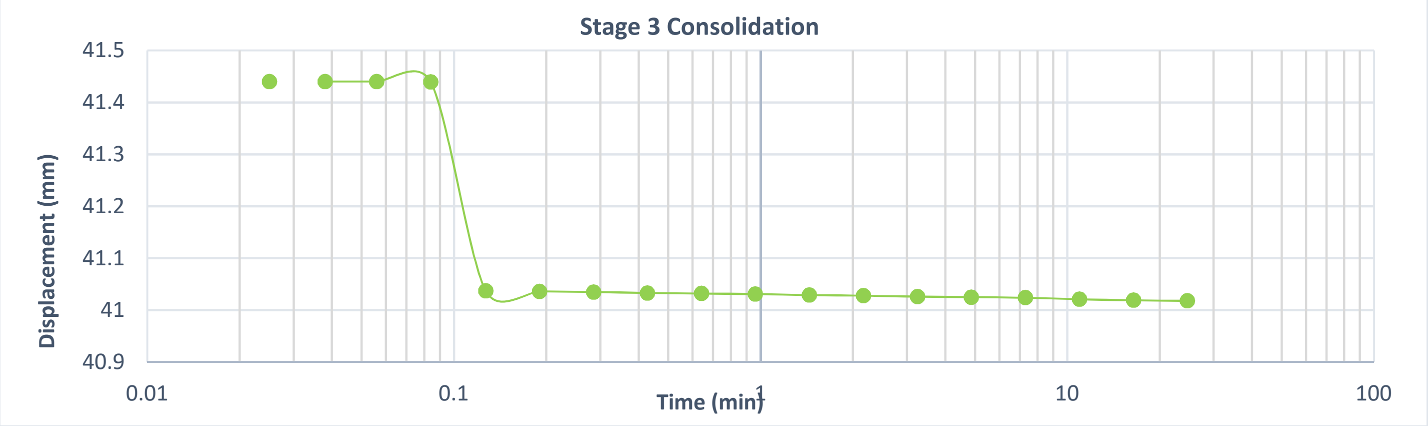

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REPORT ON POINT LOAD STRENGTH INDEX

Sheet 1 of 6 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	Refer below
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	21-Oct-19
TEST PROCEDURE:	AS4133.4.1 (2007)	**CHECKED BY:**	AW	**CHECK DATE:**	22-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5329A	STX1903G	PL-7	27.19	27.30	Diametral	60	0.90	0.27	LOW
19-5329B	STX1903G	PL-7	27.19	27.30	Axial	31	1.00	0.41	MEDIUM
19-5330A	STX1903G	PL-8	26.84	26.96	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5330B	STX1903G	PL-8	26.84	26.96	Axial	33	0.40	0.16	LOW
19-5332A	STX1903G	pl-10	28.01	28.11	Diametral	61	0.60	0.18	LOW
19-5332B	STX1903G	pl-10	28.01	28.11	Axial	32	1.30	0.53	MEDIUM
19-5333A	STX1903G	pl-11	28.55	28.65	Diametral	61	0.80	0.24	LOW
19-5333B	STX1903G	pl-11	28.55	28.65	Axial	32	1.20	0.48	MEDIUM
19-5334A	STX1903G	pl-12	29.25	29.34	Diametral	61	0.70	0.21	LOW
19-5334B	STX1903G	pl-12	29.25	29.34	Axial	-	-	-	-
19-5336A	STX1903G	pl-14	30.00	30.07	Diametral	61	6.00	1.77	HIGH
19-5336B	STX1903G	pl-14	30.00	30.07	Axial	-	-	-	-
19-5337A	STX1903G	pl-15	30.07	30.17	Diametral	61	0.60	0.18	LOW
19-5337B	STX1903G	pl-15	30.07	30.17	Axial	31	1.00	0.41	MEDIUM
19-5338A	STX1903G	pl-17	31.21	31.35	Diametral	61	0.80	0.24	LOW
19-5338B	STX1903G	pl-17	31.21	31.35	Axial	31	0.90	0.37	MEDIUM
19-5340A	STX1903G	pl-18	32.30	32.41	Diametral	61	0.60	0.18	LOW
19-5340B	STX1903G	pl-18	32.30	32.41	Axial	32	0.80	0.32	MEDIUM
19-5341A	STX1903G	pl-19	32.54	32.67	Diametral	61	0.50	0.15	LOW
19-5341B	STX1903G	pl-19	32.54	32.67	Axial	31	0.60	0.24	LOW
19-5342A	STX1903G	pl-20	32.88	33.02	Diametral	61	0.20	0.06	VERY LOW
19-5342B	STX1903G	pl-20	32.88	33.02	Axial	32	0.80	0.32	MEDIUM
19-5344A	STX1903G	pl-22	33.27	33.46	Diametral	61	0.70	0.21	LOW
19-5344B	STX1903G	pl-22	33.27	33.46	Axial	32	0.90	0.36	MEDIUM
19-5347A	STX1903G	pl-25	36.23	36.40	Diametral	61	0.50	0.15	LOW
19-5347B	STX1903G	pl-25	36.23	36.40	Axial	31	1.20	0.50	MEDIUM
19-5350A	STX1903G	pl-27	36.96	37.17	Diametral	61	0.60	0.18	LOW
19-5350B	STX1903G	pl-27	36.96	37.17	Axial	32	2.30	0.93	MEDIUM
19-5351A	STX1903G	pl-28	37.65	37.76	Diametral	61	1.00	0.30	LOW
19-5351B	STX1903G	pl-28	37.65	37.76	Axial	32	1.60	0.65	MEDIUM

Notes: Moisture contents of each specimen was not determined.

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Authorised Signatory

A. J. Williams

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REPORT ON POINT LOAD STRENGTH INDEX

Sheet 2 of 6 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 21-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) **CHECKED BY:** AW **CHECK DATE:** 22-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5351A	STX1903G	pl-29	38.20	38.37	Diametral	61	1.00	0.30	LOW
19-5351B	STX1903G	pl-29	38.20	38.37	Axial	32	1.60	0.65	MEDIUM
19-5354A	STX1903G	pl-32	39.91	40.02	Diametral	61	5.20	1.53	HIGH
19-5354B	STX1903G	pl-32	39.91	40.02	Axial	31	8.90	3.64	VERY HIGH
19-5355A	STX1903G	pl-33	40.04	40.14	Diametral	61	0.60	0.18	LOW
19-5355B	STX1903G	pl-33	40.04	40.14	Axial	31	1.40	0.57	MEDIUM
19-5357A	STX1903G	pl-35	41.66	41.78	Diametral	61	0.90	0.26	LOW
19-5357B	STX1903G	pl-35	41.66	41.78	Axial	32	1.30	0.53	MEDIUM
19-5358A	STX1903G	pl-36	42.60	42.73	Diametral	61	0.50	0.15	LOW
19-5358B	STX1903G	pl-36	42.60	42.73	Axial	31	1.30	0.53	MEDIUM
19-5361A	STX1903G	pl-39	43.97	44.09	Diametral	61	0.60	0.18	LOW
19-5361B	STX1903G	pl-39	43.97	44.09	Axial	31	3.70	1.52	HIGH
19-5362A	STX1903G	pl-40	45.22	45.38	Diametral	61	2.80	0.82	MEDIUM
19-5362B	STX1903G	pl-40	45.22	45.38	Axial	31	4.80	1.99	HIGH
19-5363A	STX1903G	pl-41	46.57	46.68	Diametral	61	1.00	0.29	LOW
19-5363B	STX1903G	pl-41	46.57	46.68	Axial	31	1.30	0.53	MEDIUM
19-5365A	STX1903G	pl-43	48.01	48.14	Diametral	61	1.90	0.56	MEDIUM
19-5365B	STX1903G	pl-43	48.01	48.14	Axial	31	2.00	0.83	MEDIUM
19-5368A	STX1903G	pl-46	49.22	49.32	Diametral	61	0.20	0.06	VERY LOW
19-5368B	STX1903G	pl-46	49.22	49.32	Axial	32	1.80	0.72	MEDIUM
19-5369A	STX1903G	pl-47	49.75	49.87	Diametral	61	0.90	0.26	LOW
19-5369B	STX1903G	pl-47	49.75	49.87	Axial	32	3.00	1.22	HIGH
19-5370A	STX1903G	pl-48	50.25	50.37	Diametral	61	0.80	0.23	LOW
19-5370B	STX1903G	pl-48	50.25	50.37	Axial	32	1.40	0.57	MEDIUM
19-5372A	STX1903G	pl-50	51.17	51.27	Diametral	61	1.60	0.47	MEDIUM
19-5372B	STX1903G	pl-50	51.17	51.27	Axial	32	1.60	0.65	MEDIUM
19-5375A	STX1903G	pl-53	54.05	54.17	Diametral	61	0.70	0.21	LOW
19-5375B	STX1903G	pl-53	54.05	54.17	Axial	31	1.50	0.62	MEDIUM
19-5376A	STX1903G	pl-54	55.05	55.18	Diametral	61	3.50	1.03	HIGH
19-5376B	STX1903G	pl-54	55.05	55.18	Axial	31	5.10	2.13	HIGH

Notes: Moisture contents of each specimen was not determined.

NATA

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Authorised Signatory

A. J. Williams

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REPORT ON POINT LOAD STRENGTH INDEX

Sheet 3 of 6 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 21-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) **CHECKED BY:** AW **CHECK DATE:** 22-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5377A	STX1903G	pl-55	55.81	55.91	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5377B	STX1903G	pl-55	55.81	55.91	Axial	31	0.20	0.08	VERY LOW
19-5378A	STX1903G	pl-56	56.20	56.74	Diametral	61	4.60	1.35	HIGH
19-5378B	STX1903G	pl-56	56.20	56.74	Axial	31	5.50	2.27	HIGH
19-5381A	STX1903G	pl-59	59.20	59.37	Diametral	61	1.00	0.29	LOW
19-5381B	STX1903G	pl-59	59.20	59.37	Axial	32	2.20	0.89	MEDIUM
19-5382A	STX1903G	pl-60	59.70	59.87	Diametral	61	0.60	0.18	LOW
19-5382B	STX1903G	pl-60	59.70	59.87	Axial	31	0.80	0.33	MEDIUM
19-5383A	STX1903G	pl-61	60.15	60.25	Diametral	61	0.40	0.12	LOW
19-5383B	STX1903G	pl-61	60.15	60.25	Axial	31	0.50	0.21	LOW
19-5384A	STX1903G	pl-62	60.48	60.60	Diametral	61	0.01	0.00	EXTREMELY LOW
19-5384B	STX1903G	pl-62	60.48	60.60	Axial	32	0.60	0.24	LOW
19-5385A	STX1903G	pl-63	61.25	61.40	Diametral	61	0.70	0.21	LOW
19-5385B	STX1903G	pl-63	61.25	61.40	Axial	31	1.80	0.75	MEDIUM
19-5386A	STX1903G	pl-64	62.06	62.17	Diametral	61	0.70	0.21	LOW
19-5386B	STX1903G	pl-64	62.06	62.17	Axial	31	0.80	0.33	MEDIUM
19-5388A	STX1903G	pl-66	62.73	62.84	Diametral	61	0.40	0.12	LOW
19-5388B	STX1903G	pl-66	62.73	62.84	Axial	32	0.70	0.28	LOW
19-5390A	STX1903G	pl-68	64.34	64.56	Diametral	61	1.10	0.32	MEDIUM
19-5390B	STX1903G	pl-68	64.34	64.56	Axial	31	3.30	1.34	HIGH
19-5391A	STX1903G	pl-69	65.26	65.34	Diametral	61	2.20	0.65	MEDIUM
19-5391B	STX1903G	pl-69	65.26	65.34	Axial	31	2.70	1.11	HIGH
19-5392A	STX1903G	pl-70	66.20	66.29	Diametral	61	1.10	0.32	MEDIUM
19-5392B	STX1903G	pl-70	66.20	66.29	Axial	31	5.80	2.37	HIGH
19-5393A	STX1903G	pl-71	67.20	67.30	Diametral	61	0.30	0.09	VERY LOW
19-5393B	STX1903G	pl-71	67.20	67.30	Axial	33	3.40	1.34	HIGH
19-5394A	STX1903G	pl-73	67.83	67.97	Diametral	61	0.20	0.06	VERY LOW
19-5394B	STX1903G	pl-73	67.83	67.97	Axial	31	2.00	0.82	MEDIUM
19-5395A	STX1903G	pl-72	68.95	69.08	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5395B	STX1903G	pl-72	68.95	69.08	Axial	33	1.50	0.59	MEDIUM

Notes: Moisture contents of each specimen was not determined.

NATA

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Authorised Signatory

A. J. Williams

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REPORT ON POINT LOAD STRENGTH INDEX

Sheet 4 of 6 | Mackay Laboratory

CLIENT: Central Queensland Coal | **JOB NO.:** M30863 | **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin geotechnical Investigation | **SAMPLED BY:** Cardno | **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin | **TESTED BY:** MS | **TEST DATE:** 21-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) | **CHECKED BY:** AW | **CHECK DATE:** 22-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5397A	STX1903G	pl-75	70.05	70.14	Diametral	61	0.70	0.21	LOW
19-5397B	STX1903G	pl-75	70.05	70.14	Axial	32	0.30	0.12	LOW
19-5398A	STX1903G	pl-76	71.60	71.70	Diametral	61	0.20	0.06	VERY LOW
19-5398B	STX1903G	pl-76	71.60	71.70	Axial	32	0.70	0.28	LOW
19-5400A	STX1903G	pl-78	72.81	72.93	Diametral	61	0.05	0.01	EXTREMELY LOW
19-5400B	STX1903G	pl-78	72.81	72.93	Axial	33	0.50	0.20	LOW
19-5401A	STX1903G	pl-79	74.03	74.18	Diametral	61	1.00	0.29	LOW
19-5401B	STX1903G	pl-79	74.03	74.18	Axial	33	1.30	0.51	MEDIUM
19-5402A	STX1903G	pl-80	74.18	74.29	Diametral	61	1.00	0.29	LOW
19-5402B	STX1903G	pl-80	74.18	74.29	Axial	33	0.50	0.20	LOW
19-5403A	STX1903G	pl-81	75.07	75.20	Diametral	61	0.20	0.06	VERY LOW
19-5403B	STX1903G	pl-81	75.07	75.20	Axial	32	0.20	0.08	VERY LOW
19-5406A	STX1903G	pl-84	77.82	77.91	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5406B	STX1903G	pl-84	77.82	77.91	Axial	32	0.40	0.16	LOW
19-5407A	STX1903G	pl-85	76.68	76.83	Diametral	61	5.60	1.64	HIGH
19-5407B	STX1903G	pl-85	76.68	76.83	Axial	31	6.90	2.81	HIGH
19-5408A	STX1903G	pl-86	76.26	76.39	Diametral	61	1.00	0.29	LOW
19-5408B	STX1903G	pl-86	76.26	76.39	Axial	33	4.40	1.73	HIGH
19-5411A	STX1903G	pl-89	81.76	81.90	Diametral	61	0.40	0.12	LOW
19-5411B	STX1903G	pl-89	81.76	81.90	Axial	33	0.30	0.12	LOW
19-5414A	STX1903G	pl-92	82.72	82.84	Diametral	61	1.00	0.29	LOW
19-5414B	STX1903G	pl-92	82.72	82.84	Axial	31	1.70	0.69	MEDIUM
19-5415A	STX1903G	pl-93	83.39	83.48	Diametral	61	0.50	0.15	LOW
19-5415B	STX1903G	pl-93	83.39	83.48	Axial	31	1.10	0.45	MEDIUM
19-5416A	STX1903G	pl-94	83.90	84.01	Diametral	61	0.30	0.09	VERY LOW
19-5416B	STX1903G	pl-94	83.90	84.01	Axial	31	0.90	0.37	MEDIUM
19-5417A	STX1903G	pl-95	87.75	87.90	Diametral	61	0.80	0.24	LOW
19-5417B	STX1903G	pl-95	87.75	87.90	Axial	31	0.70	0.29	LOW
19-5418A	STX1903G	pl-96	88.60	88.72	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5418B	STX1903G	pl-96	88.60	88.72	Axial	32	0.40	0.16	LOW

Notes: Moisture contents of each specimen was not determined.

NATA

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Authorised Signatory

A. J. Williams

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REPORT ON POINT LOAD STRENGTH INDEX

Sheet 5 of 6 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 21-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) **CHECKED BY:** AW **CHECK DATE:** 22-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5419A	STX1903G	pl-97	88.72	88.82	Diametral	61	1.10	0.32	MEDIUM
19-5419B	STX1903G	pl-97	88.72	88.82	Axial	32	3.80	1.53	HIGH
19-5421A	STX1903G	pl-99	90.11	90.24	Diametral	61	1.90	0.56	MEDIUM
19-5421B	STX1903G	pl-99	90.11	90.24	Axial	31	5.40	2.24	HIGH
19-5423A	STX1903G	pl-101	91.88	92.00	Diametral	61	5.20	1.53	HIGH
19-5423B	STX1903G	pl-101	91.88	92.00	Axial	32	12.40	4.97	VERY HIGH
19-5424A	STX1903G	pl-102	95.28	95.40	Diametral	61	0.03	0.01	EXTREMELY LOW
19-5424B	STX1903G	pl-102	95.28	95.40	Axial	32	0.80	0.32	MEDIUM
19-5426A	STX1903G	pl-104	95.81	95.92	Diametral	61	0.50	0.15	LOW
19-5426B	STX1903G	pl-104	95.81	95.92	Axial	32	2.20	0.88	MEDIUM
19-5427A	STX1903G	pl-105	99.69	99.82	Diametral	61	7.50	2.21	HIGH
19-5427B	STX1903G	pl-105	99.69	99.82	Axial	33	4.90	1.92	HIGH
19-5429A	STX1903G	pl-106	100.41	100.54	Diametral	61	0.90	0.26	LOW
19-5429B	STX1903G	pl-106	100.41	100.54	Axial	32	3.40	1.36	HIGH
19-5432A	STX1903G	pl-110	107.36	107.47	Diametral	61	0.50	0.15	LOW
19-5432B	STX1903G	pl-110	107.36	107.47	Axial	32	1.70	0.68	MEDIUM
19-5435A	STX1903G	pl-113	114.08	114.22	Diametral	61	0.20	0.06	VERY LOW
19-5435B	STX1903G	pl-113	114.08	114.22	Axial	32	1.60	0.65	MEDIUM
19-5436A	STX1903G	pl-114	118.84	118.98	Diametral	61	0.02	0.01	EXTREMELY LOW
19-5436B	STX1903G	pl-114	118.84	118.98	Axial	33	0.40	0.16	LOW
19-5437A	STX1903G	pl-115	119.54	119.68	Diametral	61	2.10	0.62	MEDIUM
19-5437B	STX1903G	pl-115	119.54	119.68	Axial	32	5.10	2.04	HIGH
19-5439A	STX1903G	pl-117	120.39	120.47	Diametral	61	0.01	0.00	EXTREMELY LOW
19-5439B	STX1903G	pl-117	120.39	120.47	Axial	31	0.01	0.00	EXTREMELY LOW
19-5442A	STX1903G	pl-120	131.16	131.29	Diametral	61	0.08	0.02	EXTREMELY LOW
19-5442B	STX1903G	pl-120	131.16	131.29	Axial	33	1.40	0.55	MEDIUM
19-5444A	STX1903G	pl-122	132.18	132.30	Diametral	61	0.01	0.00	EXTREMELY LOW
19-5444B	STX1903G	pl-122	132.18	132.30	Axial	32	4.30	1.71	HIGH
19-5445A	STX1903G	pl-123	129.19	130.01	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5445B	STX1903G	pl-123	129.19	130.01	Axial	32	1.40	0.56	MEDIUM

Notes: Moisture contents of each specimen was not determined.

NATA

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A. J. Williams

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REPORT ON POINT LOAD STRENGTH INDEX

Sheet 6 of 6 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 21-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) **CHECKED BY:** AW **CHECK DATE:** 22-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5446A	STX1903G	pl-124	132.80	132.92	Diametral	61	3.90	1.15	HIGH
19-5446B	STX1903G	pl-124	132.80	132.92	Axial	32	6.90	2.79	HIGH
19-5448A	STX1903G	pl-126	133.89	134.01	Diametral	61	2.60	0.76	MEDIUM
19-5448B	STX1903G	pl-126	133.89	134.01	Axial	31	7.40	3.01	VERY HIGH
19-5449A	STX1903G	pl-127	134.87	135.40	Diametral	61	8.30	2.43	HIGH
19-5449B	STX1903G	pl-127	134.87	135.40	Axial	31	10.30	4.25	VERY HIGH
19-5450A	STX1903G	pl-128	145.00	145.45	Diametral	61	1.60	0.47	MEDIUM
19-5450B	STX1903G	pl-128	145.00	145.45	Axial	32	0.90	0.36	MEDIUM
19-5452A	STX1903G	pl-130	146.20	146.32	Diametral	60	0.60	0.18	LOW
19-5452B	STX1903G	pl-130	146.20	146.32	Axial	32	1.80	0.72	MEDIUM
19-5453A	STX1903G	pl-131	144.32	144.45	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5453B	STX1903G	pl-131	144.32	144.45	Axial	32	2.20	0.88	MEDIUM
19-5454A	STX1903G	pl-132	147.15	147.28	Diametral	61	1.60	0.47	MEDIUM
19-5454B	STX1903G	pl-132	147.15	147.28	Axial	32	2.50	1.01	HIGH

Notes: Moisture contents of each specimen was not determined.

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REPORT ON SLAKE DURABILITY INDEX OF ROCK

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** SG **TEST DATE:** 23-Oct-19
TEST PROCEDURE: AS 4133.3.4 (2009) **CHECKED BY:** AW **CHECK DATE:** 24-Oct-19

Lab Ref No	Borehole	Client Ref	Corrected Depth From (m)	Corrected Depth To (m)	Slake Durability Index (First Cycle) %	Slake Durability Index (Second Cycle) %	Appearance of Fragments Retained in the drum	Appearance of Fragments Passing the drum
19-5326A	STX1903G	slk-4	21.62	21.86	0.0	0.0	Rock lumps completely broken down, many small angular particles present	Large quantities of angular, flaky material present
19-5343A	STX1903G	slk-21	33.02	33.24	63.1	15.6	Rock lumps completely broken down, many small angular particles present	Large quantities of angular, flaky material present
19-5349C	STX1903G	slk-27	36.96	37.17	91.9	69.9	Lumps slightly broken down, angular particles present	Gritty material present
19--5404A	STX1903G	slk-82	74.9	75.07	95.6	85.2	Lumps slightly broken down, angular particles present	Gritty material present
19-5431A	STX1903G	slk-109	106.38	106.57	98.9	96.6	Rock lumps still intact	Fine silt

Temperature of slaking fluid: 23 °C
Slaking fluid used: Potable

Variations from standard: Nil

Accredited No.	910
Certificate No.	19-5326A
Date of Issue	24-Oct-19

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Authorised Signatory

A. J. Williams

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Quality of Materials Report

Client :	**Central Queensland Coal**	Report Number:	**M30863 - 1**
Address :	**Level 17, 240 Queen Street, Brisbane, QLD, 4001**	Report Date :	**2/12/2019**
Project Name :	**Geotechnical Investigation**	Order Number :	
Project Number :	**M30863**	Test Method :	**AS1289.3.6.1**
Location:	**CQ Coal Styx Basin , Queensland**		**Page 1 of 1**

Sample Number :	19-5507
Sampling Method :	Sampled by Client
Sampled By :	Cardno
Date Sampled :	10/10/2019
Date Tested :	29/11/2019
Material Type :	CLAY
Material Source :	Styx Basin
Remarks :	

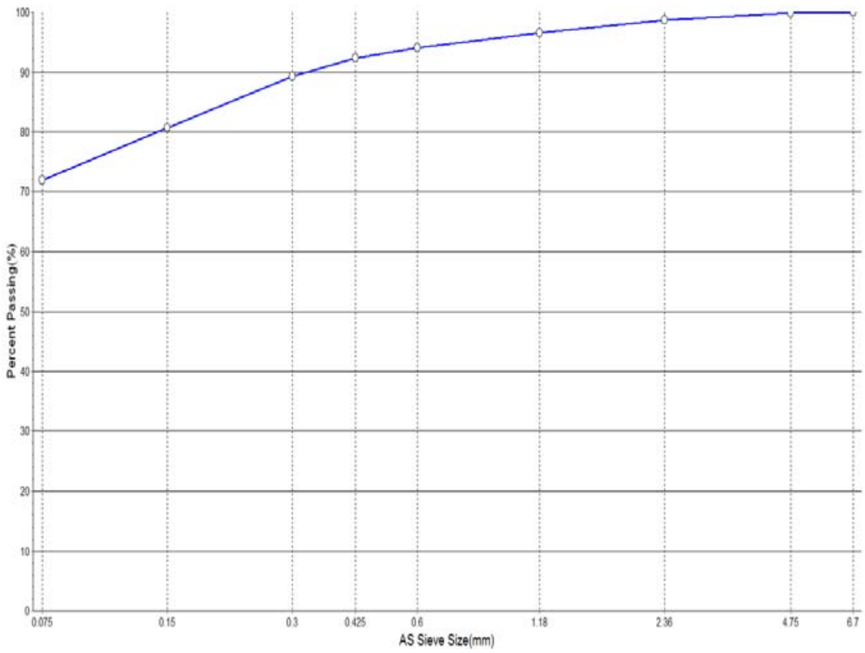
SAMPLE LOCATION

Borehole: STX1904G 1

Depth: 2.22-2.57m

Test Number :	
Lot Number :	
Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0		
16.0		
13.2		
9.5		
6.7	**100**	
4.75	**100**	
2.36	**99**	
1.18	**97**	
0.600	**94**	
0.425	**92**	
0.300	**89**	
0.150	**81**	
0.075	**72**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1, 3.2.1,3.3.1 & 3.4.1**	**35**	Shrinkage Comments :	**Some Curling Occured**
Plastic Limit (%) :			**11**	Mould Length (mm) :	**250**
Plasticity Index (%) :			**24**	Sample History	**Oven Dried**
Linear Shrinkage (%) :			**10**		
Soil Description :					

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Quality of Materials Report

Client : **Central Queensland Coal**
Address : **Level 17, 240 Queen Street, Brisbane, QLD, 4001**
Project Name : **Geotechnical Investigation**
Project Number : **M30863**
Location: **CQ Coal Styx Basin , Queensland**

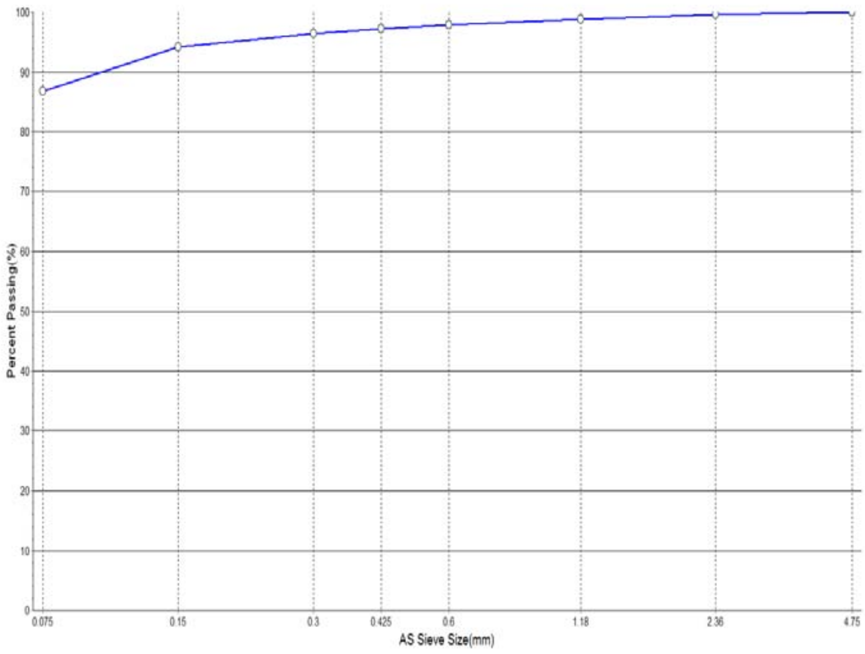
Report Number: **M30863 - 2**
Report Date : **2/12/2019**
Order Number :
Test Method : **AS1289.3.6.1**
Page 1 of 1

Sample Number : 19-5508
Sampling Method : Sanpled by Client
Sampled By : Cardno
Date Sampled : 10/10/2019
Date Tested : 29/11/2019
Material Type : CLAY
Material Source : Styx Basin
Remarks :

SAMPLE LOCATION
Borehole: STX1904G 2
Depth: 3.70-3.89m

Test Number :
Lot Number :
Specification Number :

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0		
16.0		
13.2		
9.5		
6.7		
4.75	**100**	
2.36	**100**	
1.18	**99**	
0.600	**98**	
0.425	**97**	
0.300	**96**	
0.150	**94**	
0.075	**87**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1, 3.2.1,3.3.1 & 3.4.1**	**60**	Shrinkage Comments :	**Some Curling Occured**
Plastic Limit (%) :			**21**	Mould Length (mm) :	**250**
Plasticity Index (%) :			**39**	Sample History	**Oven Dried**
Linear Shrinkage (%) :			**13.5**		
Soil Description :					

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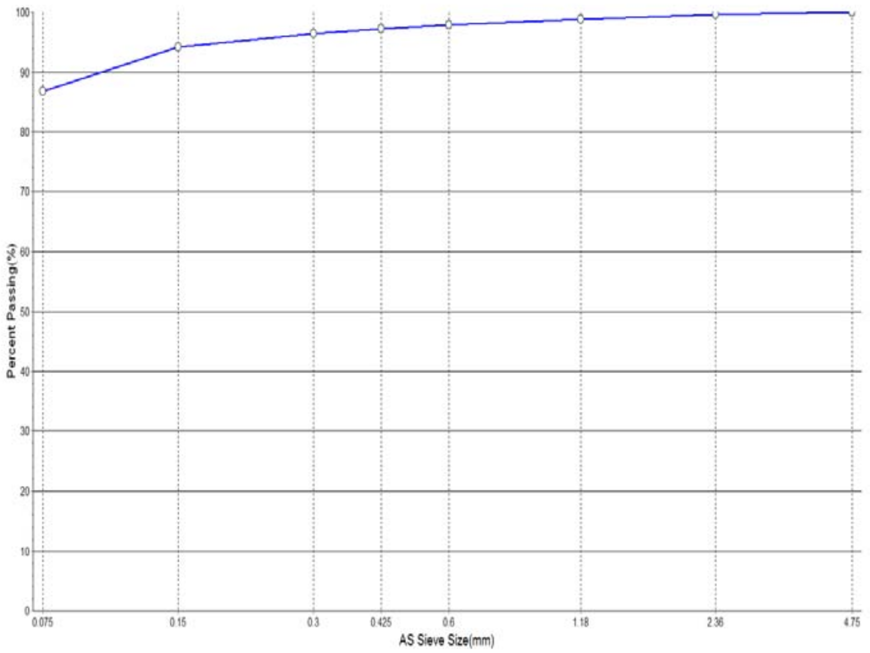
Address :	**Level 17, 240 Queen Street, Brisbane, QLD, 4001**	Report Date :	**2/12/2019**
Project Name :	**Geotechnical Investigation**	Order Number :	
Project Number :	**M30863**	Test Method :	**AS1289.3.6.1**
Location:	**CQ Coal Styx Basin , Queensland**	**Page 1 of 1**	

Sample Number :	19-5508	SAMPLE LOCATION	
Sampling Method :	Sanpled by Client	**Borehole: STX1904G 2**	
Sampled By :	Cardno	**Depth: 3.70-3.89m**	
Date Sampled :	10/10/2019		
Date Tested :	29/11/2019		
Material Type :	CLAY	Test Number :	
Material Source :	Styx Basin	Lot Number :	
Remarks :		Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0		
16.0		
13.2		
9.5		
6.7		
4.75	**100**	
2.36	**100**	
1.18	**99**	
0.600	**98**	
0.425	**97**	
0.300	**96**	
0.150	**94**	
0.075	**87**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1, 3.2.1,3.3.1 & 3.4.1**	**60**	Shrinkage Comments :	**Some Curling Occured**
Plastic Limit (%) :			**21**	Mould Length (mm) :	**250**
Plasticity Index (%) :			**39**	Sample History	**Oven Dried**
Linear Shrinkage (%) :			**13.5**		
Soil Description :					

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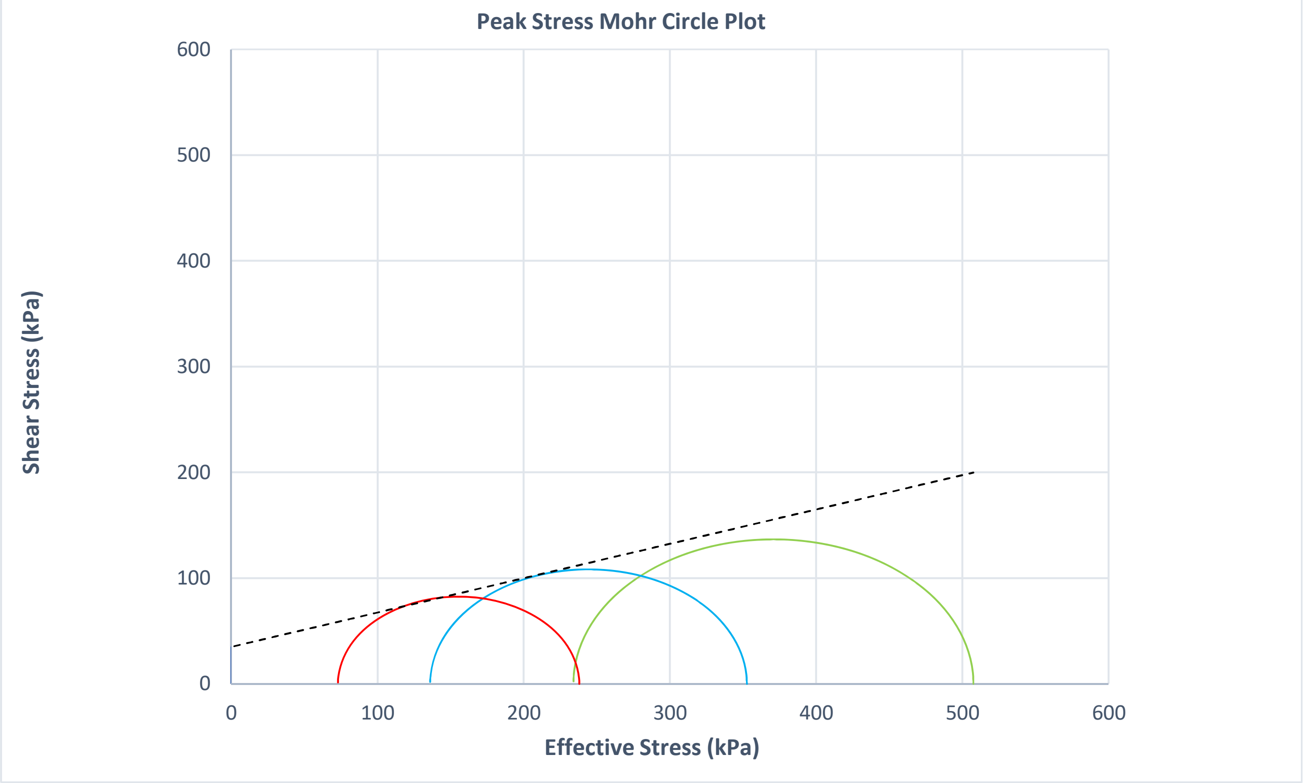
Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5507A**
Address:	**Level 17, 240 Queen Street, Brisbane, Q**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G, Depth 2.22-2.37m**		**Page 1**

Date Sampled:	2/09/2019	Sample Number:	19-5507A
Date Tested:	19/11/2019	Material Description:	Brown Clay
Sampled By:	Sampled by Client	Initial Wet Density:	2.10 t/m^3
Initial Sample Height:	204.2 mm	Initial Dry Density:	1.87 t/m^3
Initial Sample Diameter:	101.8 mm	L/D Ratio:	2.0 :1
Initial Moisture:	12.0 %	Skempton's B Response:	0.95 %
Final Moisture:	14.8 %	Sample Type:	Core
Sampling Method:	As Received		
Moisture Method:	AS 1289.2.1.1	Strain Rate %/min:	0.050 0.050 0.050



Effective Cohesion C' (kPa):	35.0
Effective Angle of Friction ϕ' (Degrees):	18.0
Failure Criteria:	Peak Deviator Stress

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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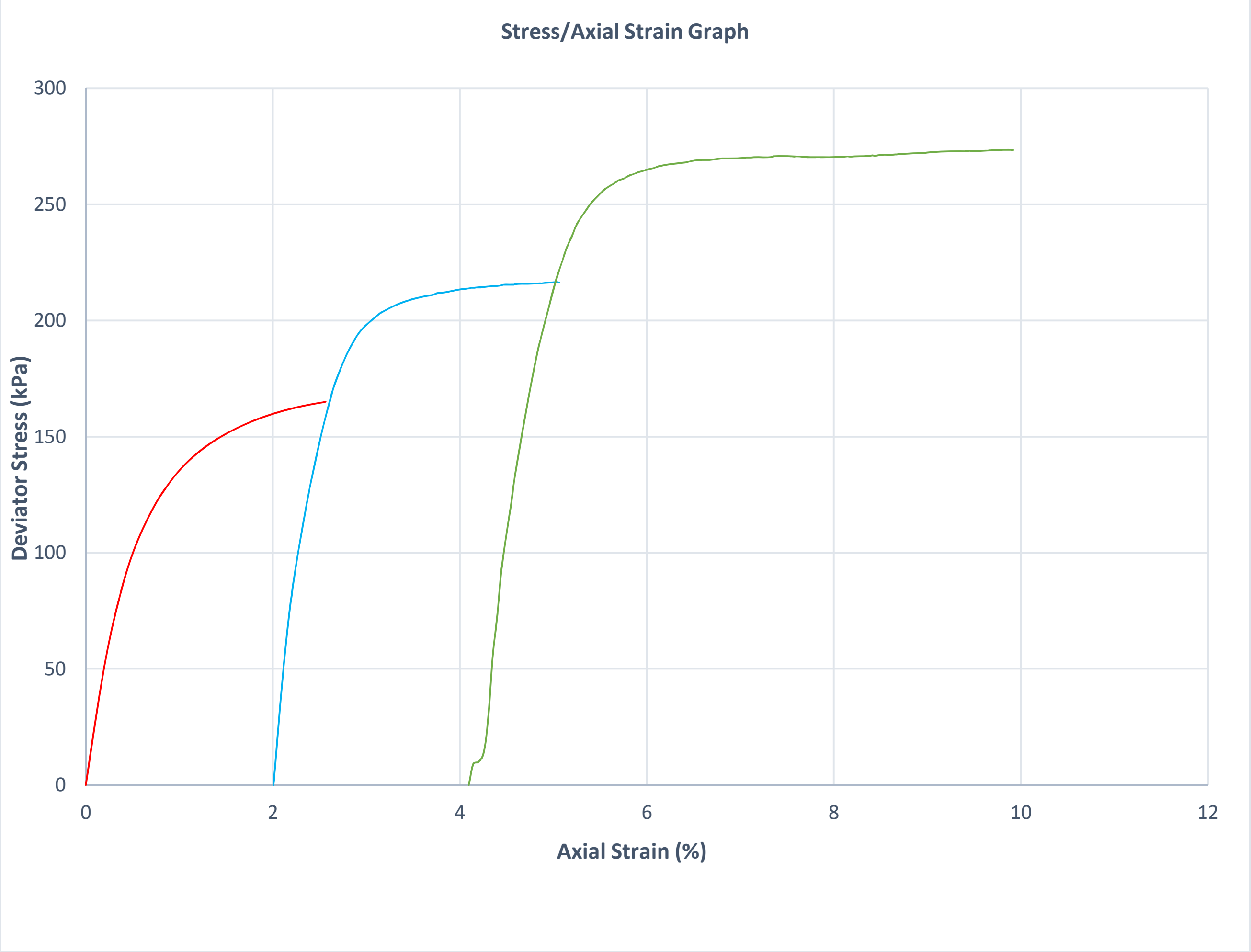
Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5507A**
Address:	**Level 17, 240 Queen Street, Brisbane, Q**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G, Depth 2.22-2.37m**		**Page 2**



Failure Details

Cell Pressure (kPa)	Back Pressure (kPa)	Effictive Pressure (kPa)	Initial Pore Pressure (kPa)	Failure Pore Pressure (kPa)	Principal Effective Stress			Deviator Stress (kPa)	Strain (%)
					σ'1 (kPa)	σ'3 (kPa)	σ'1/σ'3		
1500	1400	100	1391	1427	238	73	3.261	165	2.56
1662	1460	202	1455	1526	353	136	2.593	217	5.03
1798	1401	397	1422	1562	507	234	2.169	273	9.86

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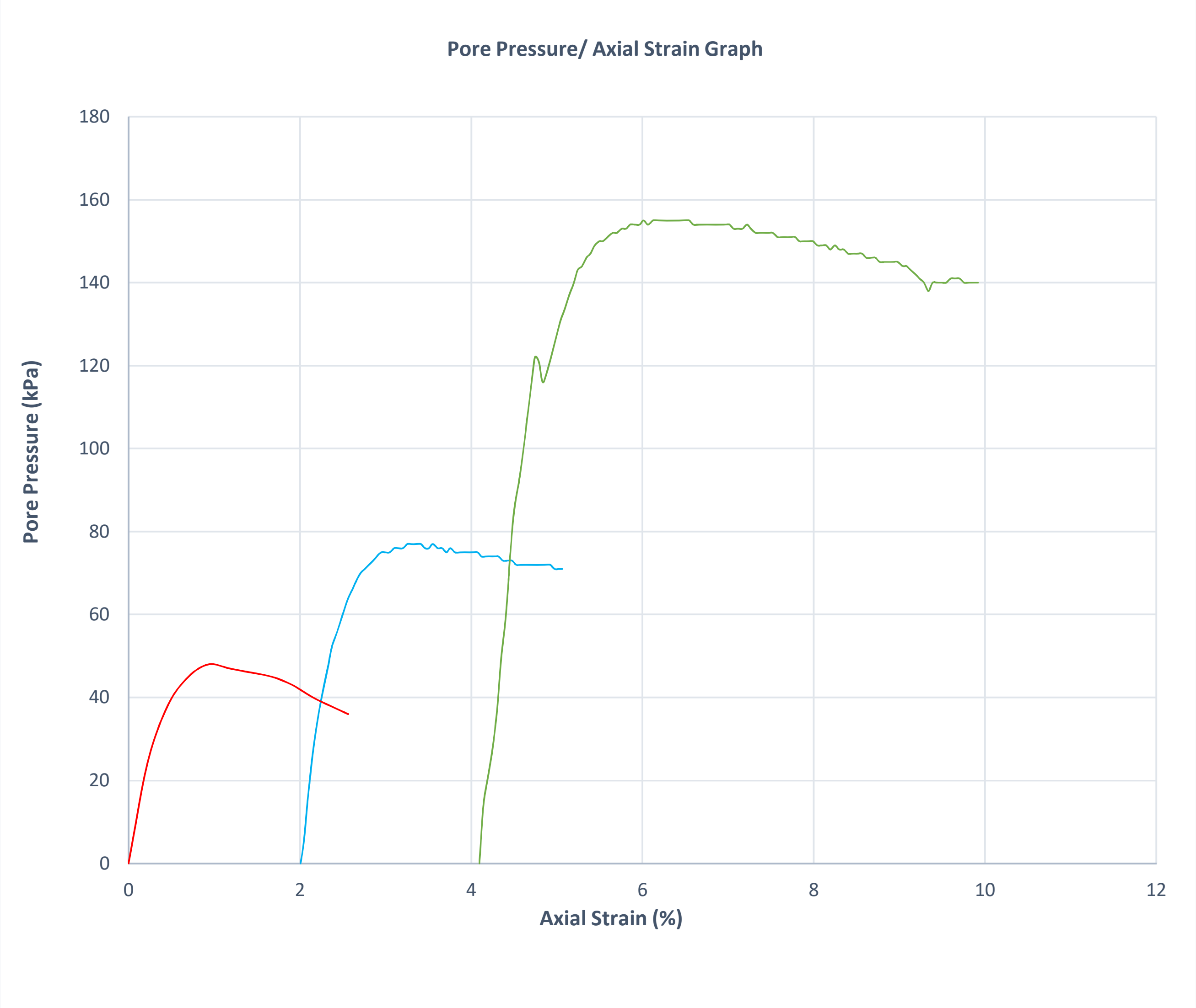
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G, Depth 2.22-2.37m**		**Page 3**



Sample/s supplied by	Client	Note:	Graph not to scale	Membrane Thickness:	0.3mm

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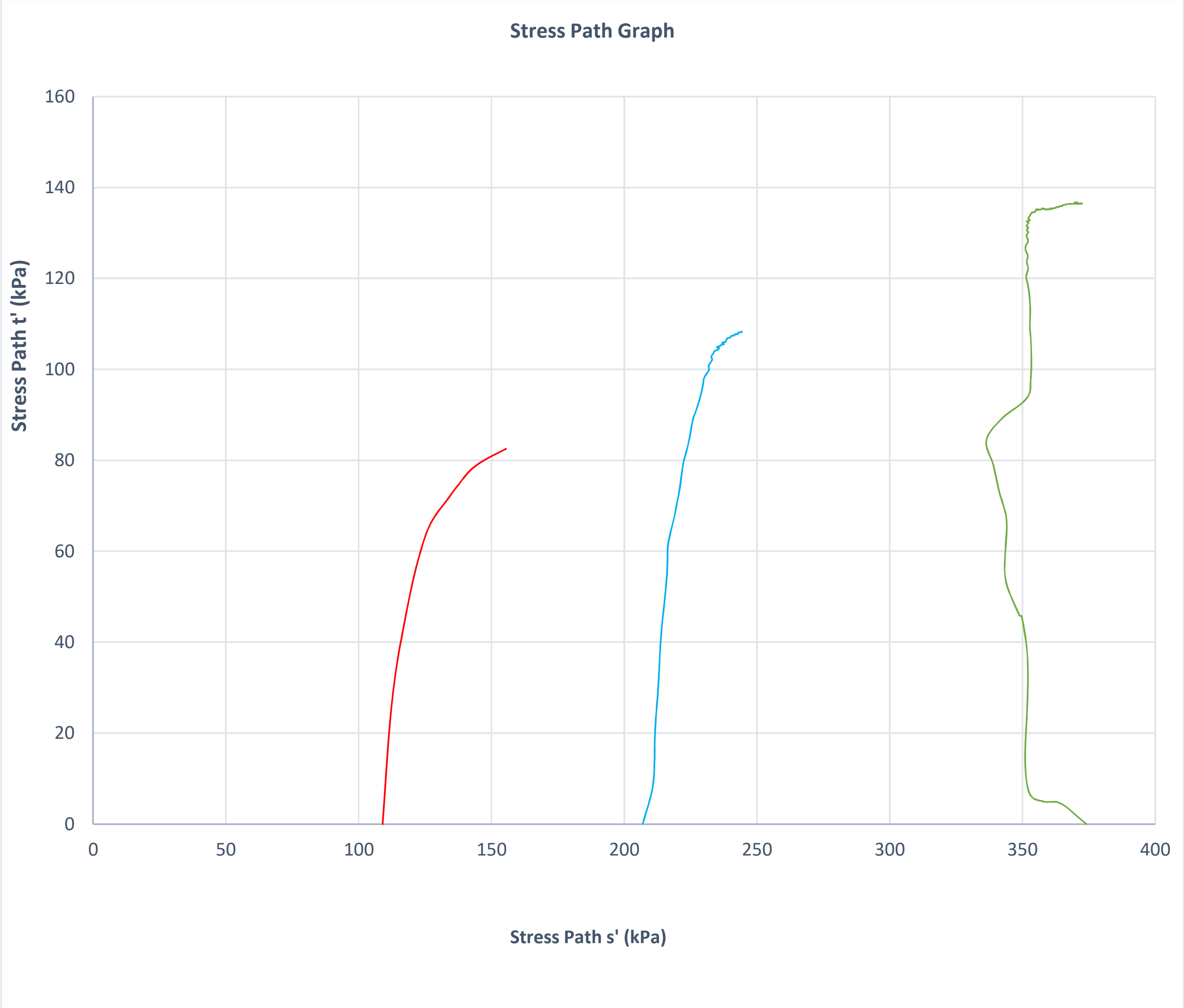
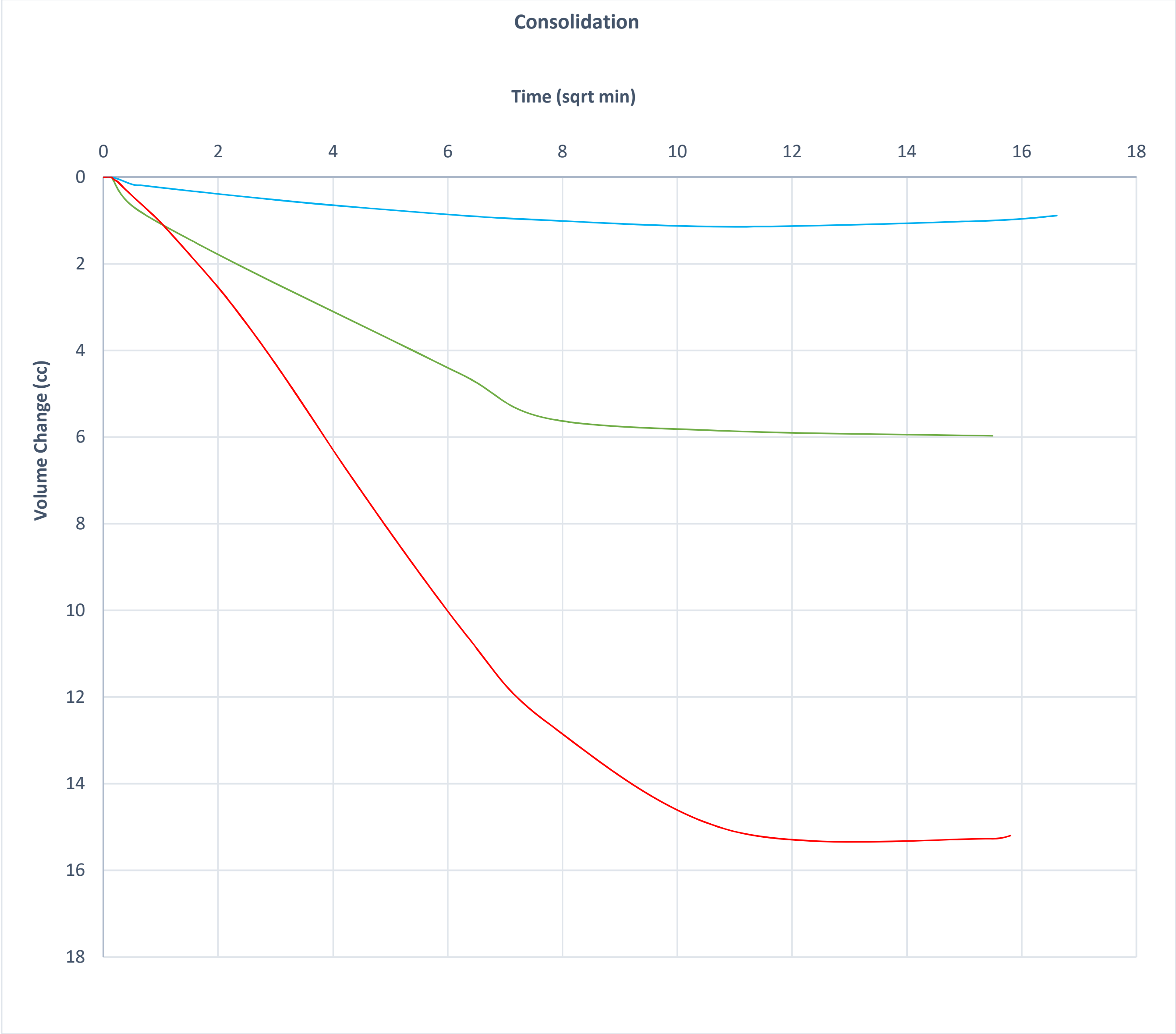
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G, Depth 2.22-2.37m**		**Page 4**



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5507A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G, Depth 2.22-2.37m**		**Page 5**



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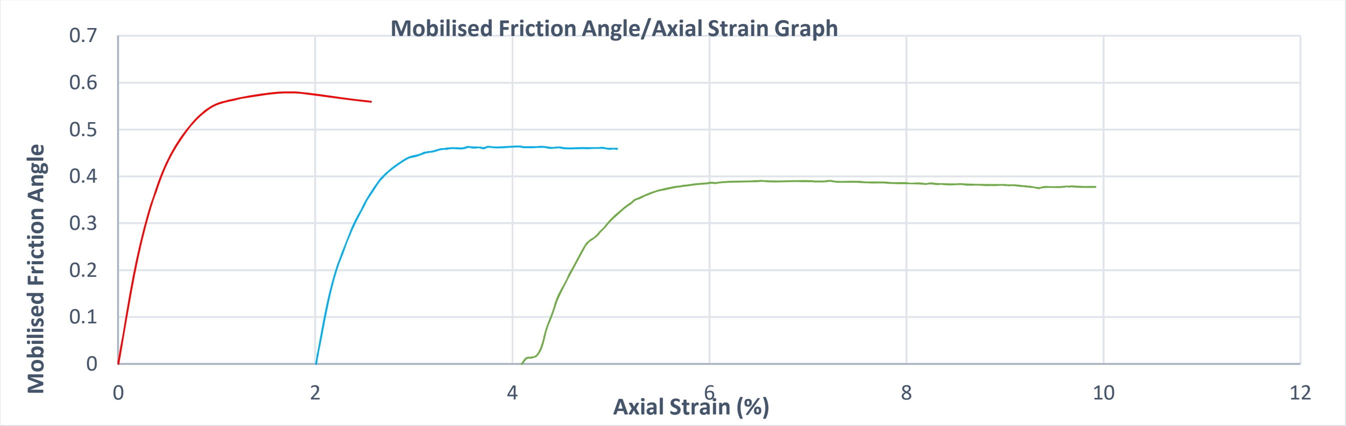
Location:	**Borehole: STX1904G, Depth 2.22-2.37m**		**Page 6**



Sample Before Test	Sample After Test
	

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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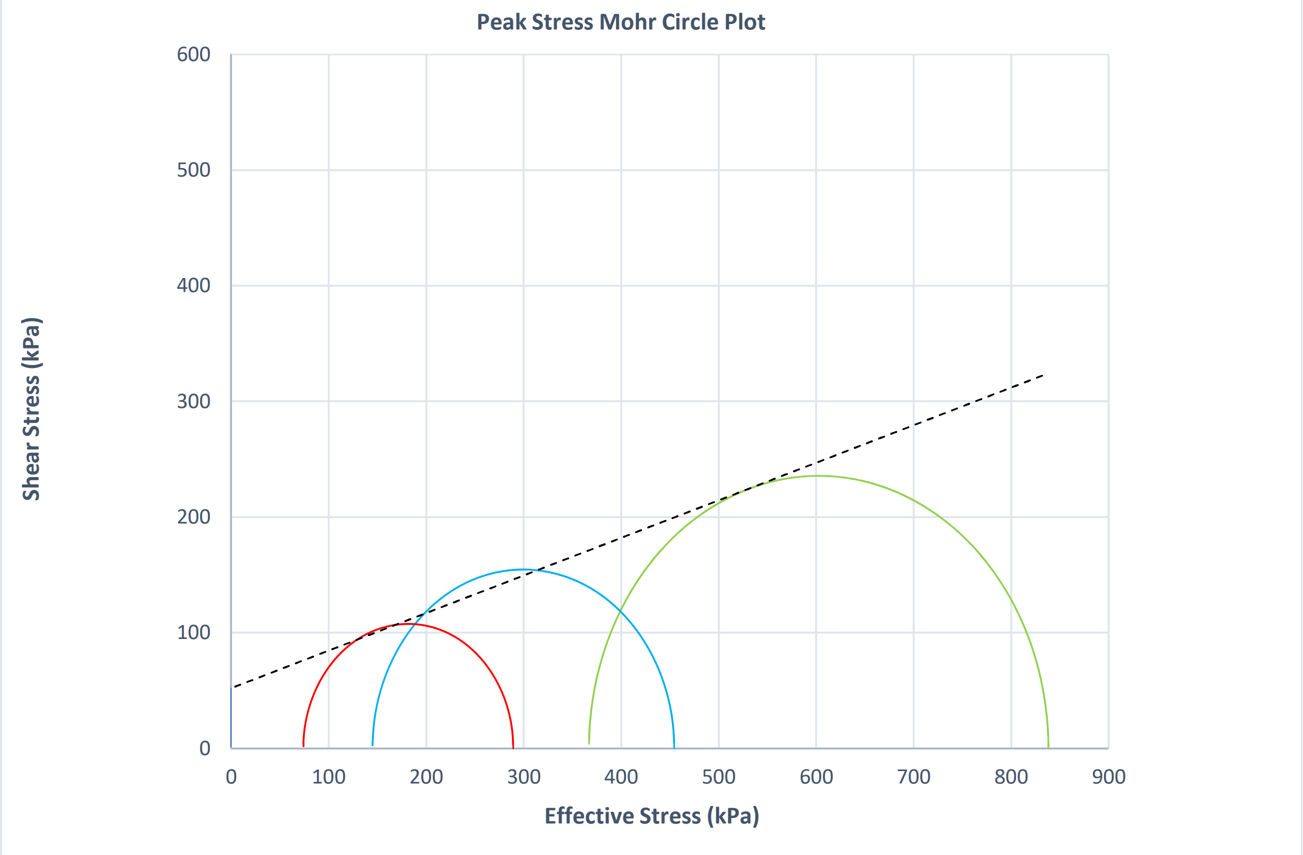
Address:	**Level 17, 240 Queen Street, Brisbane, Q**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investi**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G 2, Depth 3.70-3.89m**		**Page 1**

Date Sampled:	2/09/2019	Sample Number:	19-5508A		
Date Tested:	24/11/2019	Material Description:	Orange White Clay		
Sampled By:	Sampled by Client	Initial Wet Density:	2.01 t/m^3		
Initial Sample Height:	187.7 mm	Initial Dry Density:	1.74 t/m^3		
Initial Sample Diameter:	101.9 mm	L/D Ratio:	1.8 :1		
Initial Moisture:	15.4 %	Skempton's B Response:	0.95 %		
Final Moisture:	16.5 %	Sample Type:	Core		
Sampling Method:	As Received				
Moisture Method:	AS 1289.2.1.1	Strain Rate %/min:	0.050	0.031	0.046



Effective Cohesion C' (kPa):	52.0
Effective Angle of Friction ϕ' (Degrees):	18.0
Failure Criteria:	Peak Deviator Stress

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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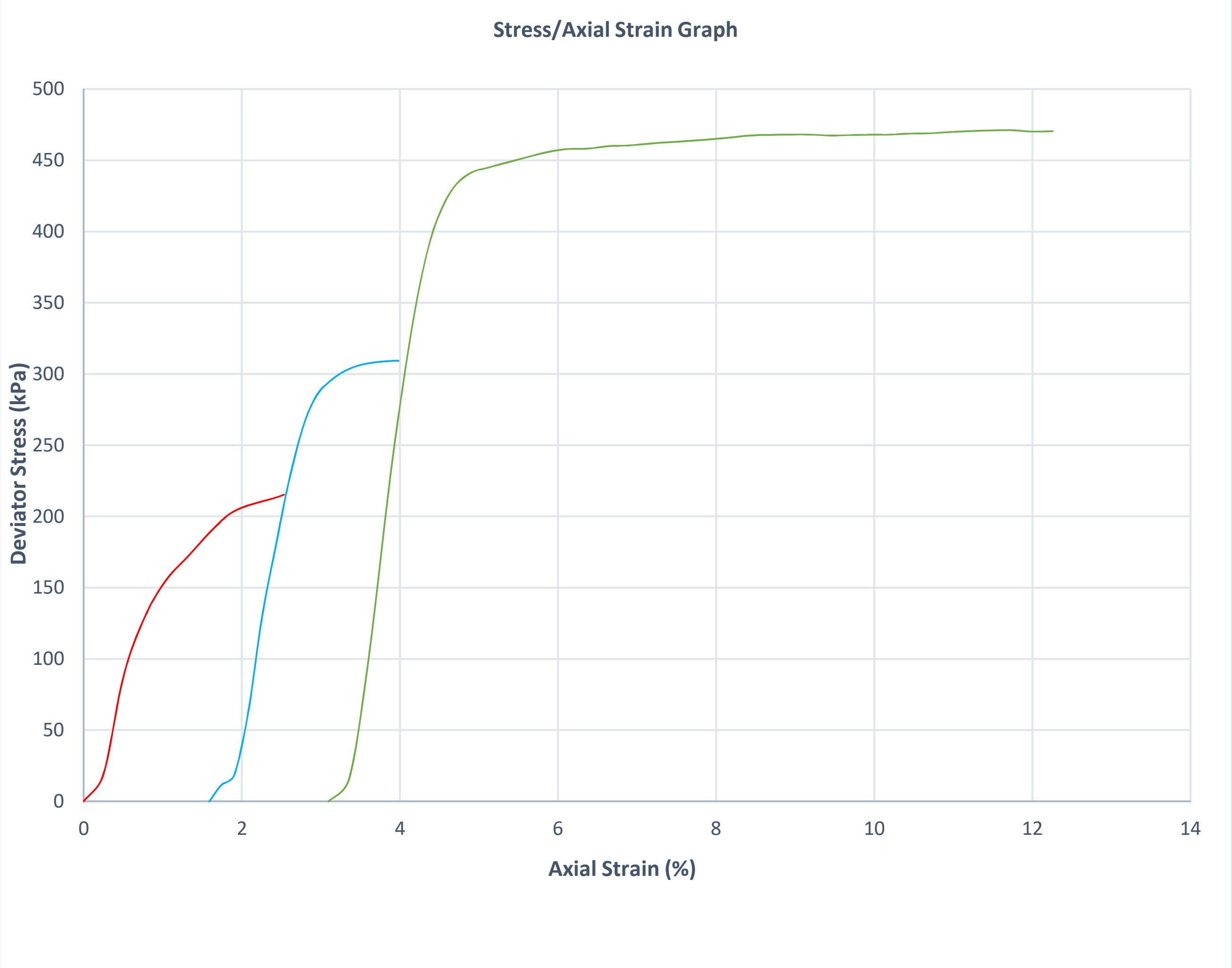
Location:	**Borehole: STX1904G 2, Depth 3.70-3.89m**		**Page 2**



Failure Details

Cell Pressure (kPa)	Back Pressure (kPa)	Effictive Pressure (kPa)	Initial Pore Pressure (kPa)	Failure Pore Pressure (kPa)	Principal Effective Stress			Deviator Stress (kPa)	Strain (%)
					σ'1 (kPa)	σ'3 (kPa)	σ'1/σ'3		
1300	1200	100	1195	1226	289	74	3.909	215	2.53
1500	1300	200	1284	1355	454	145	3.133	309	3.97
1850	1450	400	1435	1483	838	367	2.284	471	11.72

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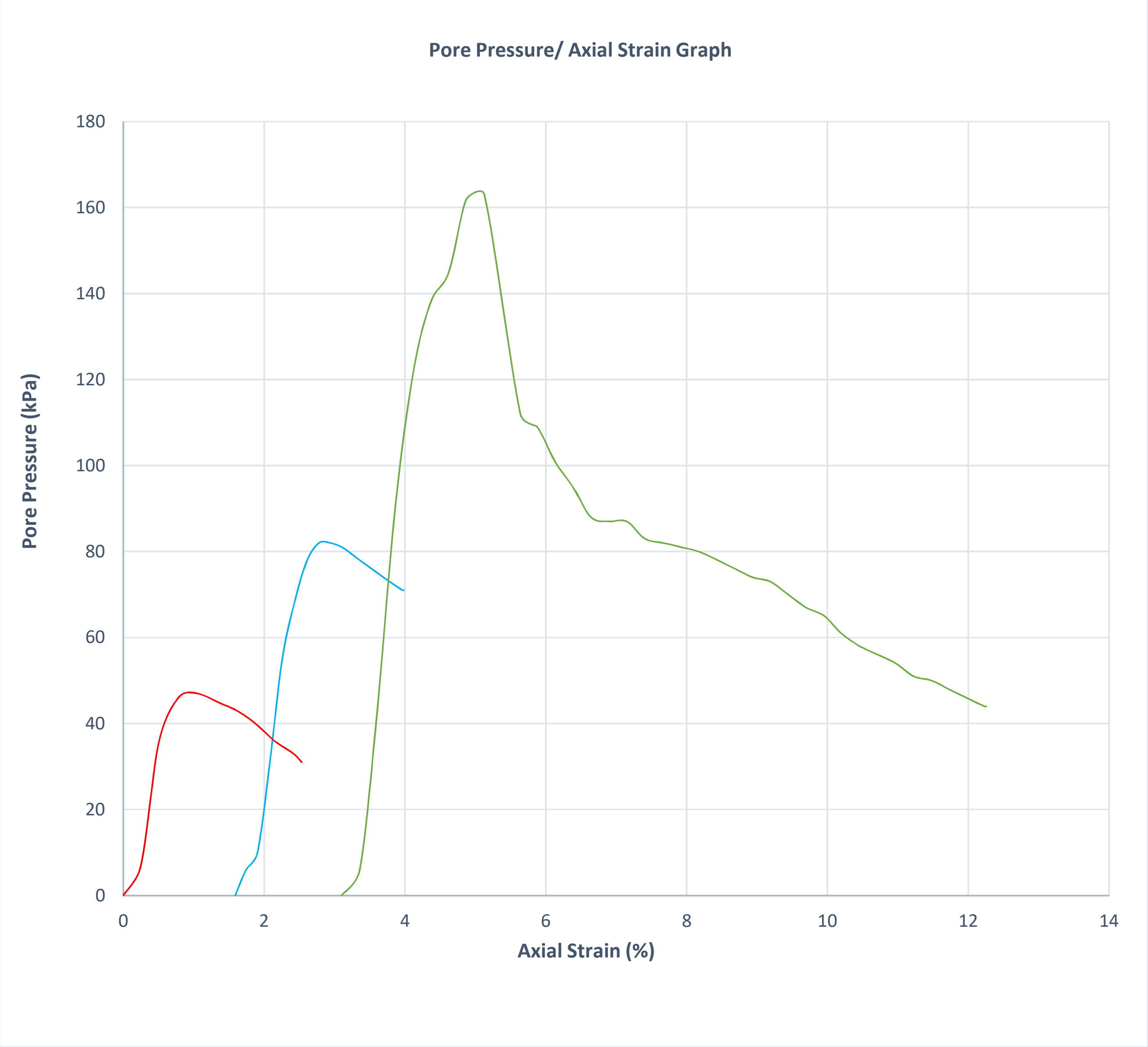
Location:	**Borehole: STX1904G 2, Depth 3.70-3.89m**		**Page 3**



Sample/s supplied by	Client	Note:	Graph not to scale	Membrane Thickness:	0.3mm

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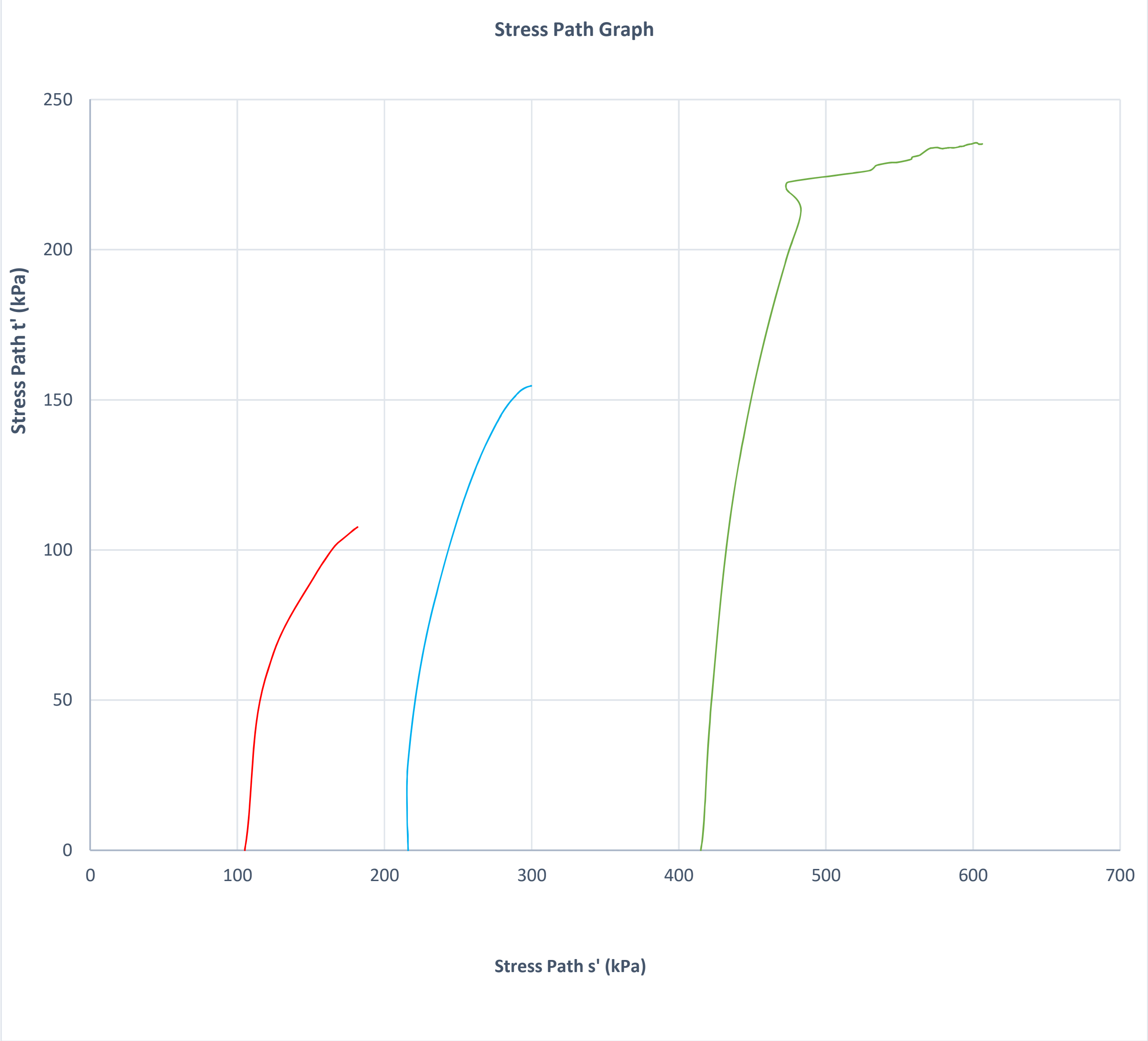

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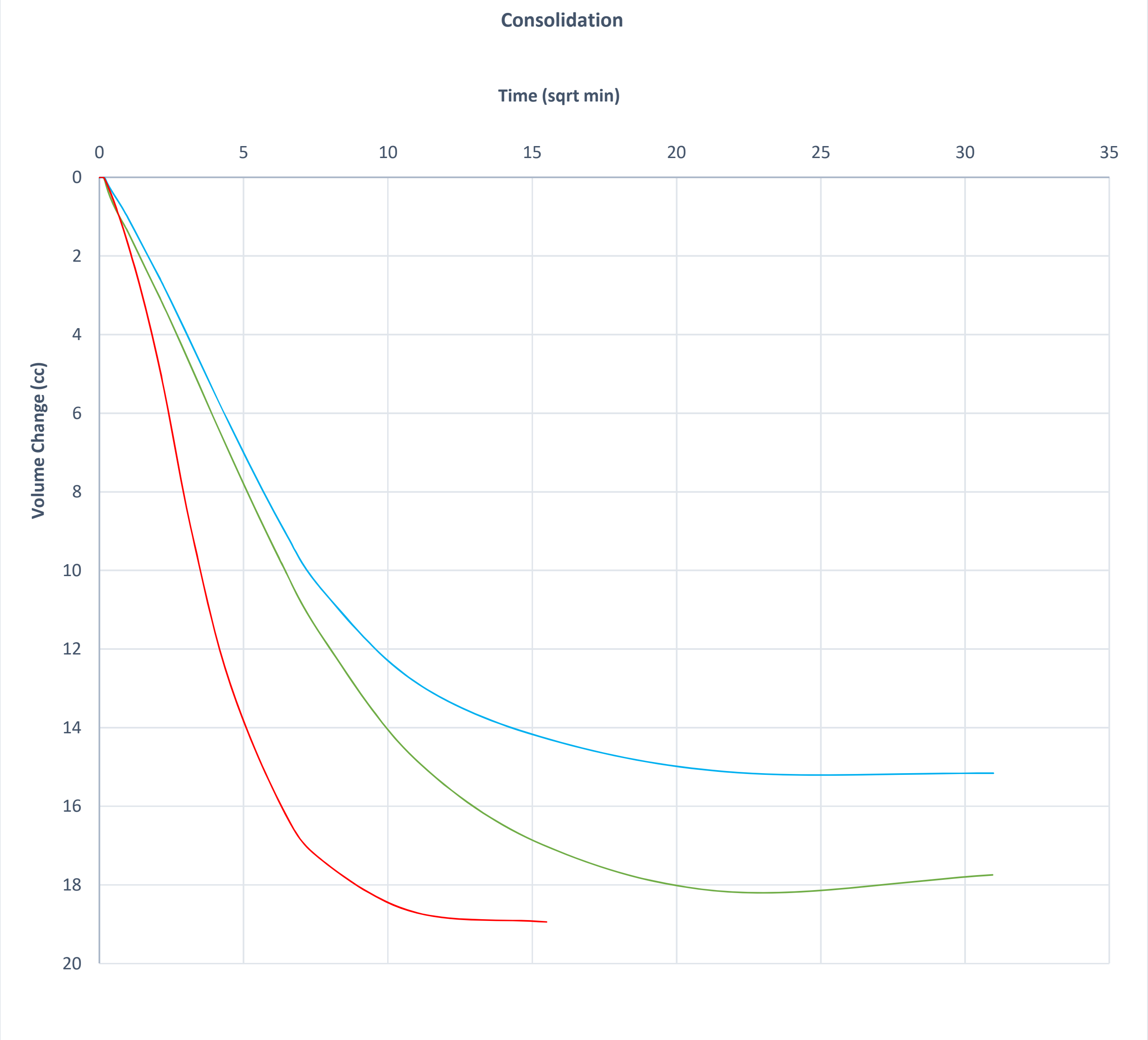
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G 2, Depth 3.70-3.89m**		**Page 5**



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

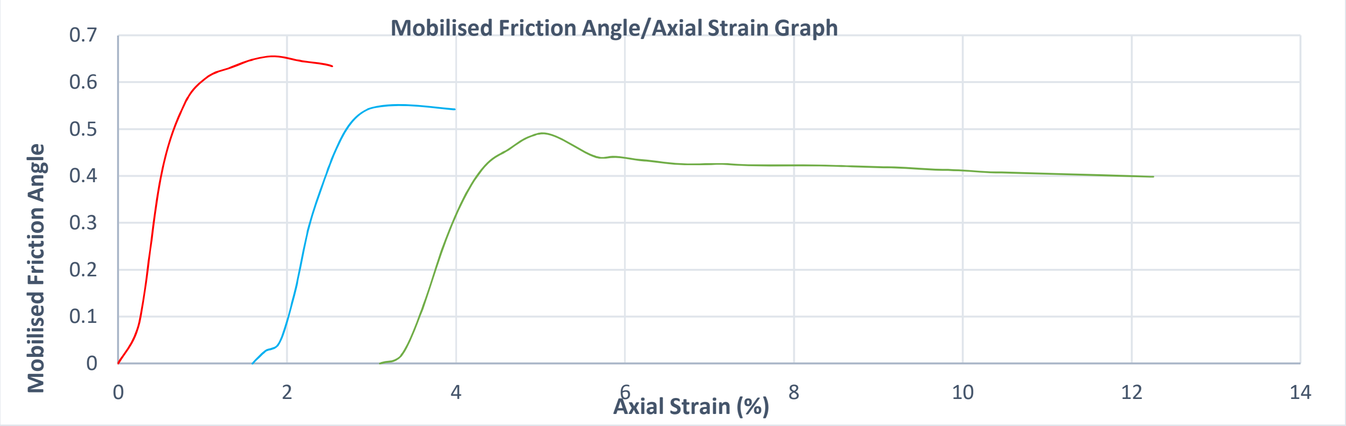
APPROVED SIGNATORY

D.Hoskins

Derren Hoskins - Lab Manager
NATA Accreditation Number
910 Mackay Laboratory

Consolidated Undrained Soil Triaxial Report

Client:	**Central Queensland Coal**	Report Number:	**19-5508A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**2/12/2019**
Project Number:	**M30863**	Client Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.4.2**
Location:	**Borehole: STX1904G 2, Depth 3.70-3.89m**		**Page 6**



Sample Before Test	Sample After Test
	

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 7

Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5490A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Carbonaceous Siltstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

Sample Details			
Borehole:	STX1904G	**Sample number:**	UCS-42
Depth from (m):	62.24	**Depth to (m):**	62.40

Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	124.5
Measurement:	Displacement Transducer	**Diameter (mm):**	60.8
		Moisture Content (%):	1.3
Rate of Loading (MPa/min):	8.48	**Mass of Sample (g):**	572.1
Time to Failure (min):	5.02	**Dry Density (t/m3):**	1.56
Test Duration (min):	5.36	**Wet Density (t/m3):**	1.58

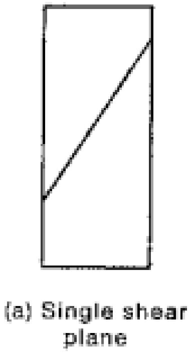
Intact Strength

	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	26.4	0.58
Stage 2	1.5	37.6	0.86
Stage 3	3	54.6	1.34

Residual Strength

	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1	3	40.2	
Residual Stress 2	1.5	27.6	
Residual Stress 3	0.75	18.2	
Residual Stress 4	0.5	13.1	
Residual Stress 5	0.25	8.9	

Dominant structural features with respect to core axis

Before Photo	**After Photo**	**Failure Diagram**
		

Comments: Testing was done at Room Temperature.

APPROVED SIGNATORY

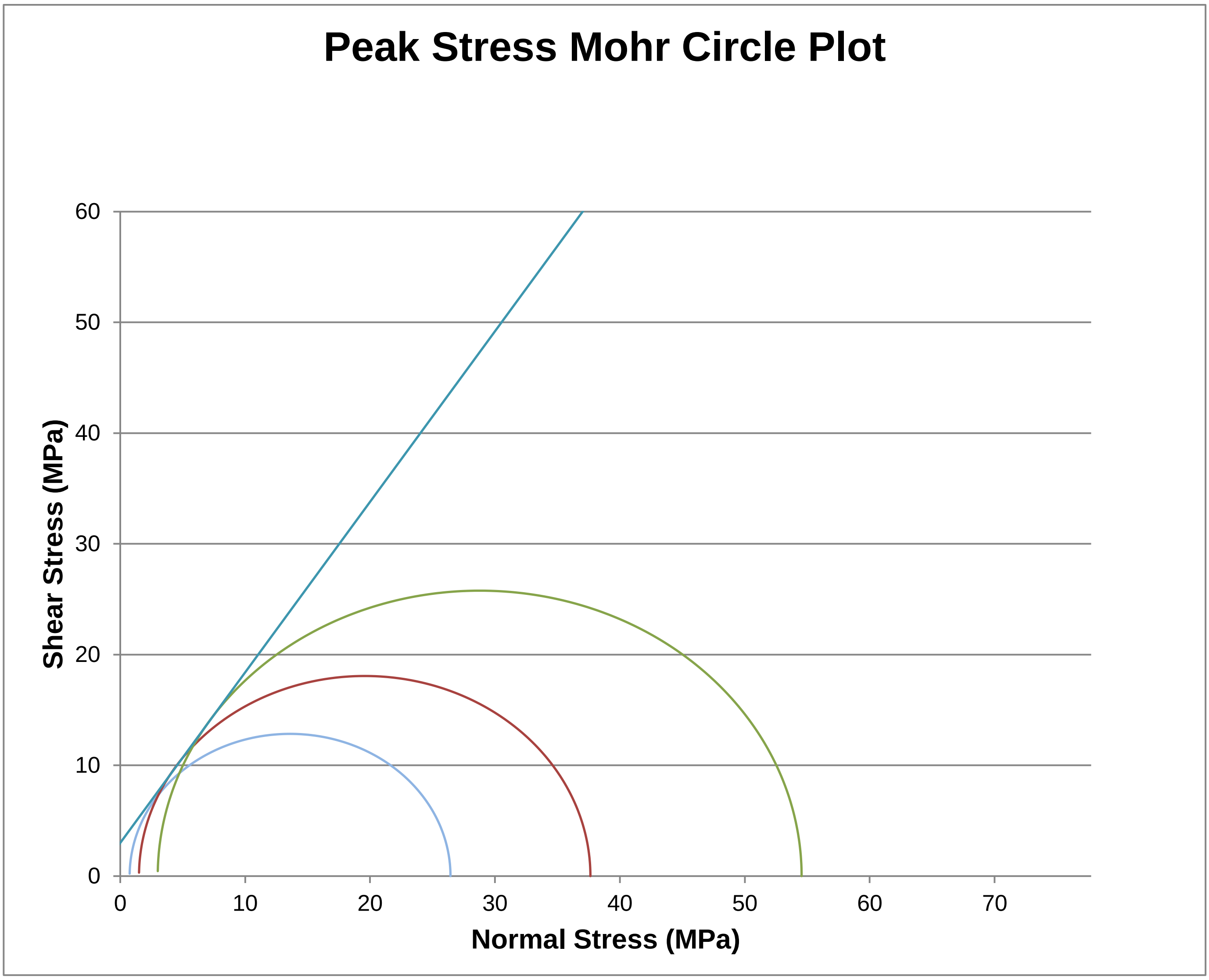
T Bradbury

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK



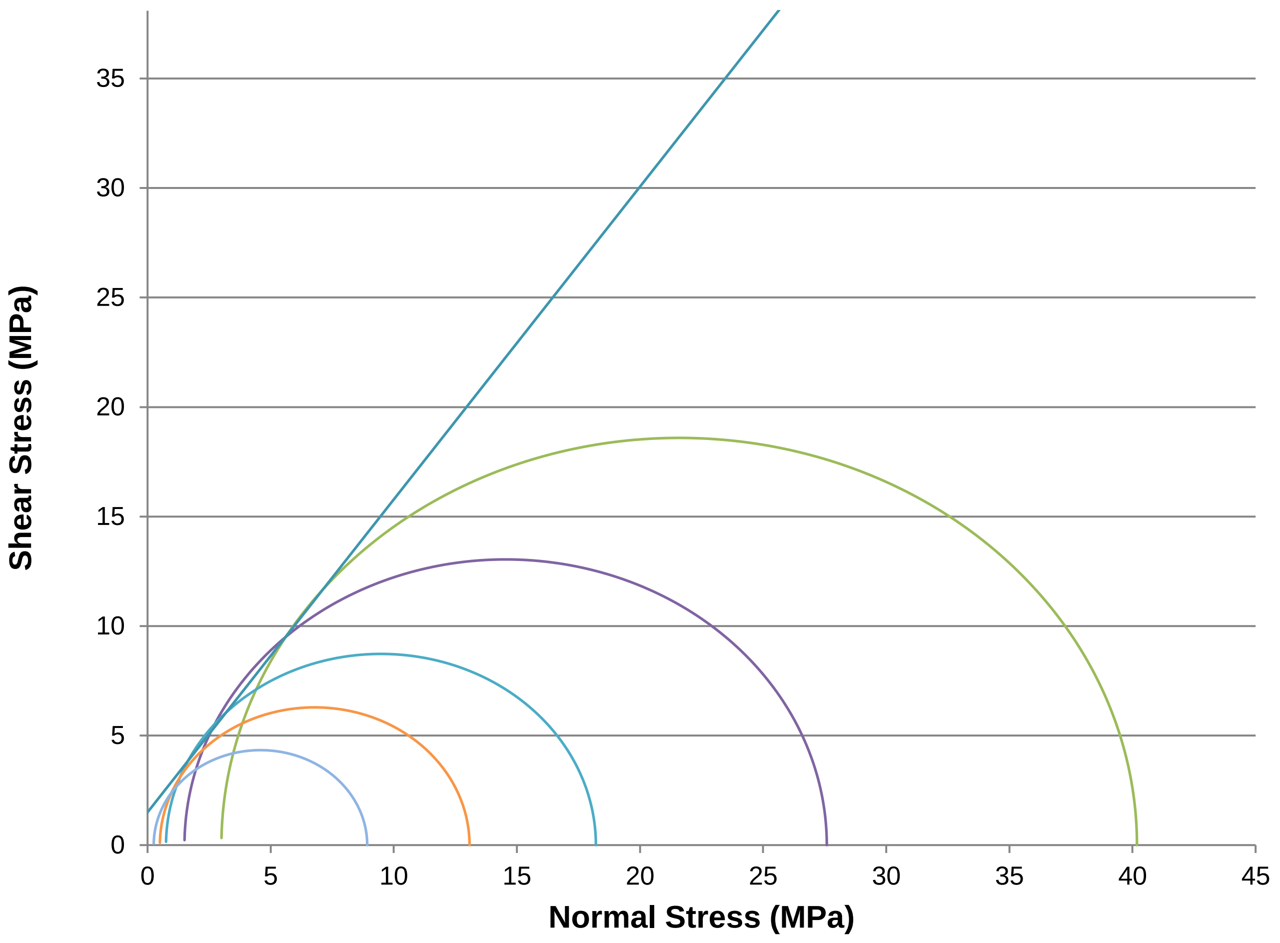
Estimated Peak Envelope	
Angle	57.0 °
Cohesion	3.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5490A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Residual Stress Mohr Circle Plot



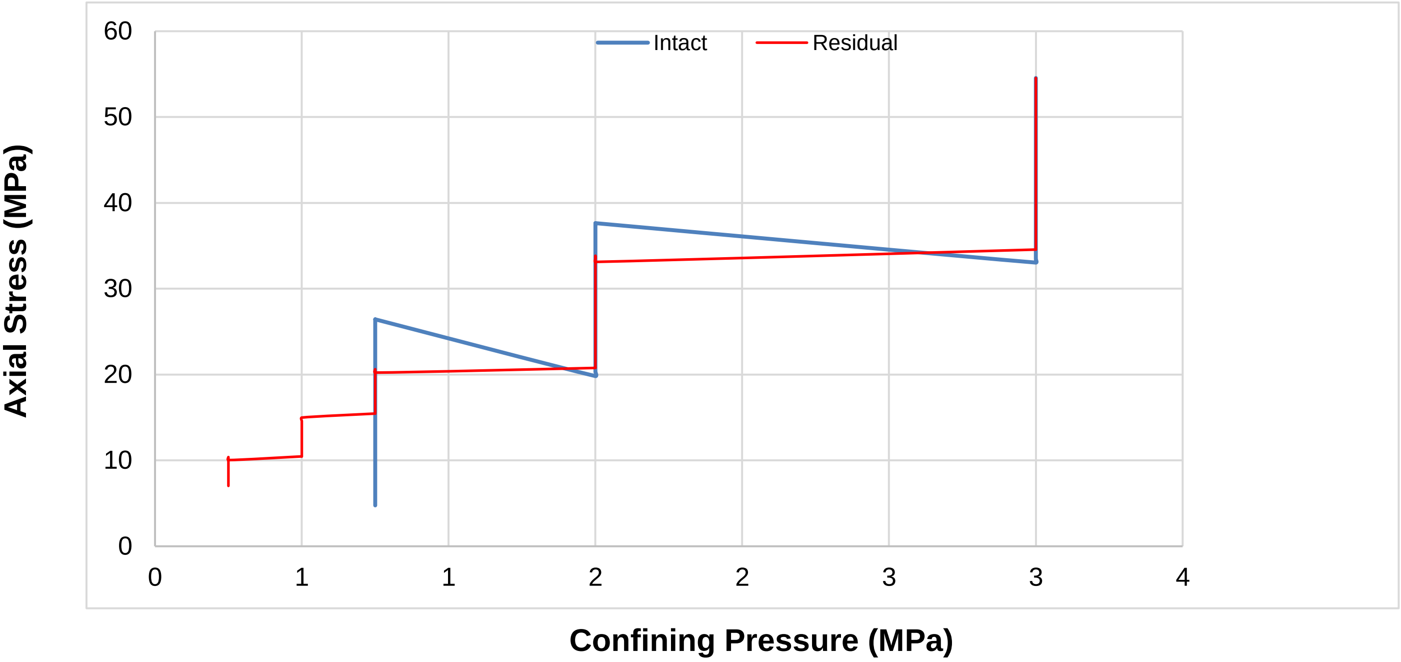
Estimated Residual Envelope	
Angle	55.0 °
Cohesion	1.5 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5490A

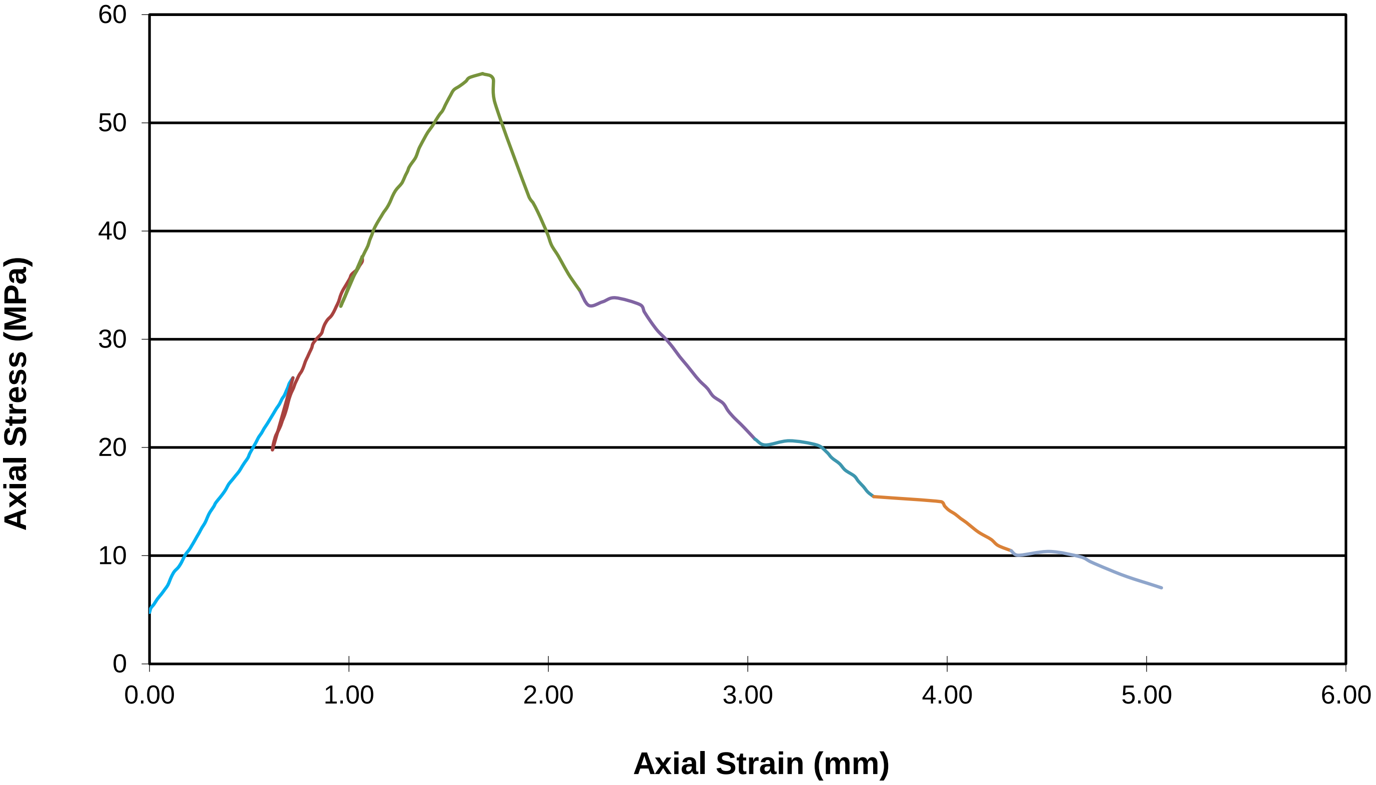
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5490A





CARDNO (QLD) PTY LTD

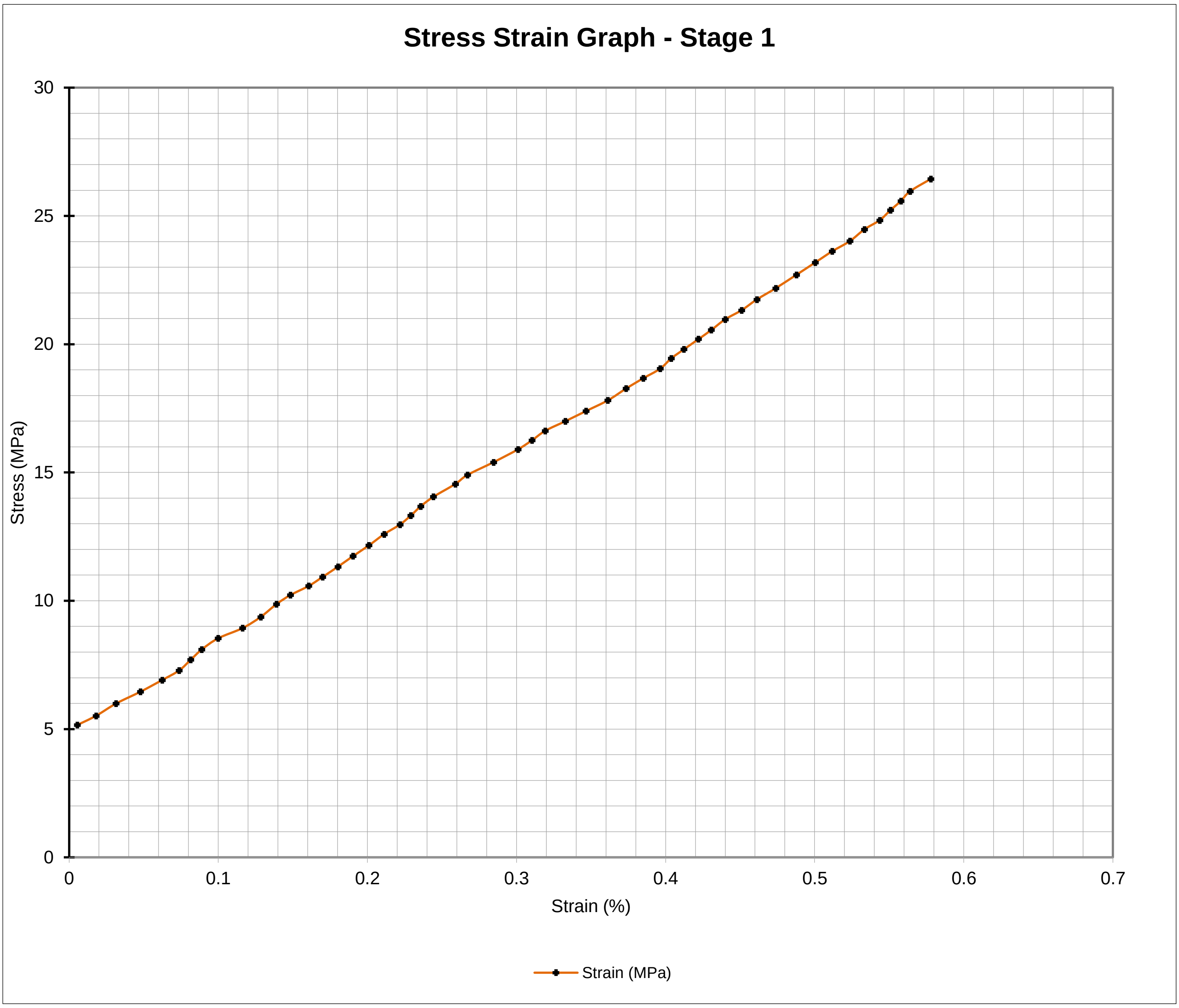
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5490A



CARDNO (QLD) PTY LTD

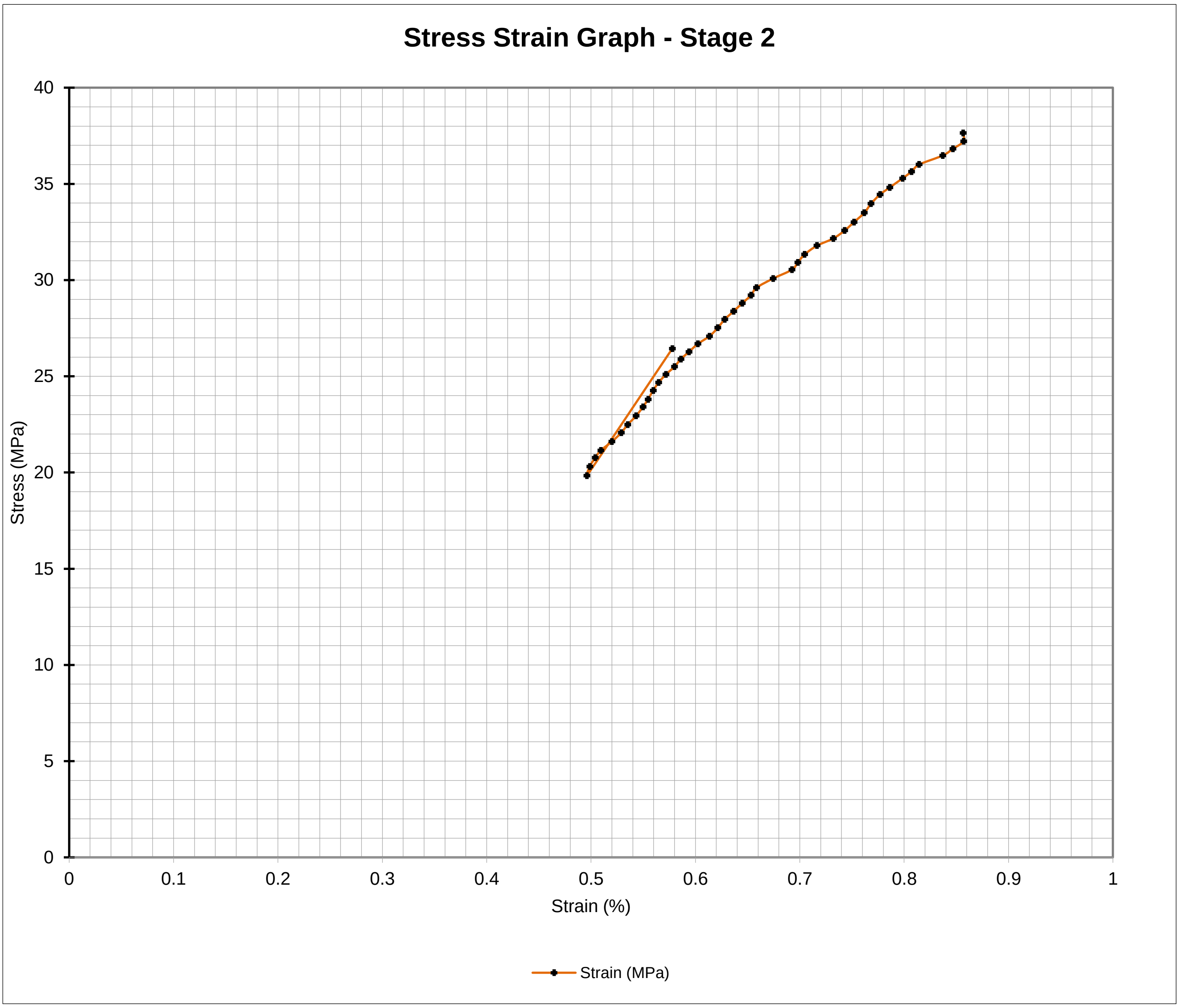
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

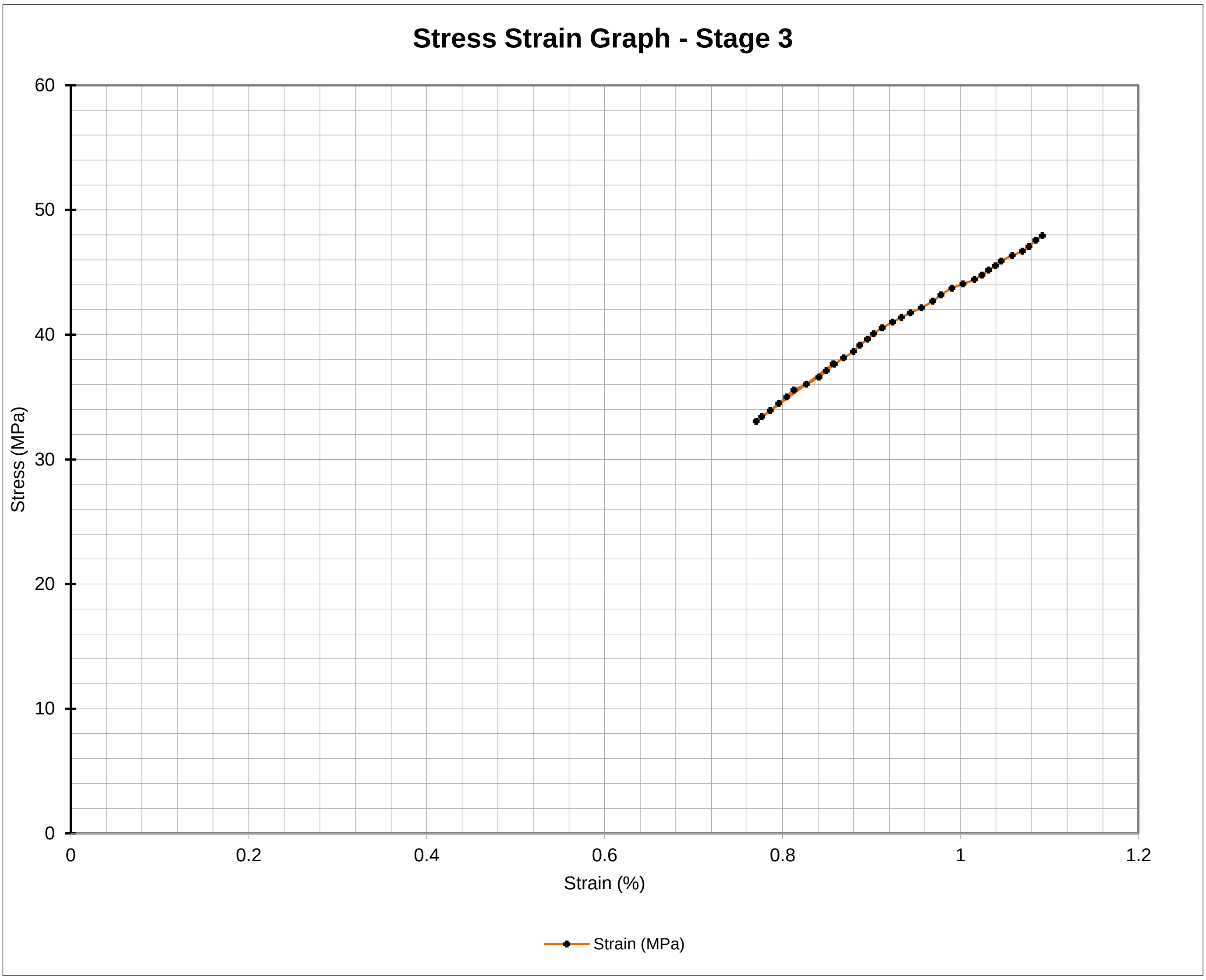
Sheet 6 of 7

Mackay Laboratory

LAB REF NO: 19-5490A



LAB REF NO: 19-5490A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

GEO-QF-GR 105 G
(07/17)

Sheet 1 of 7

Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5494A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Sandstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

		Sample Details			
		Borehole:	STX1904G	**Sample number:**	UCS-46
		Depth from (m):	70.58	**Depth to (m):**	70.78
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	123.2		
Measurement:	Displacement Transducer	**Diameter (mm):**	60.9		
		Moisture Content (%):	1.8		
Rate of Loading (MPa/min):	21.47	**Mass of Sample (g):**	899.6		
Time to Failure (min):	4.30	**Dry Density (t/m3):**	2.46		
Test Duration (min):	4.56	**Wet Density (t/m3):**	2.51		

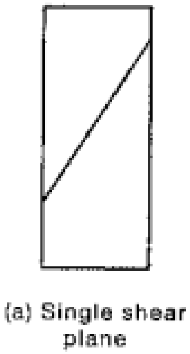
Intact Strength

	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	14.3	0.46
Stage 2	1.5	22.8	0.80
Stage 3	3	32.7	1.23

Residual Strength

	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1	3	29.9	
Residual Stress 2	1.5	26.7	
Residual Stress 3	0.75	23.5	
Residual Stress 4	0.5	17.6	
Residual Stress 5	0.25	13.5	

Dominant structural features with respect to core axis

Before Photo	**After Photo**	**Failure Diagram**
		

Comments: Testing was done at Room Temperature.
Had a natural crack along a lamination that was glued prior to test.

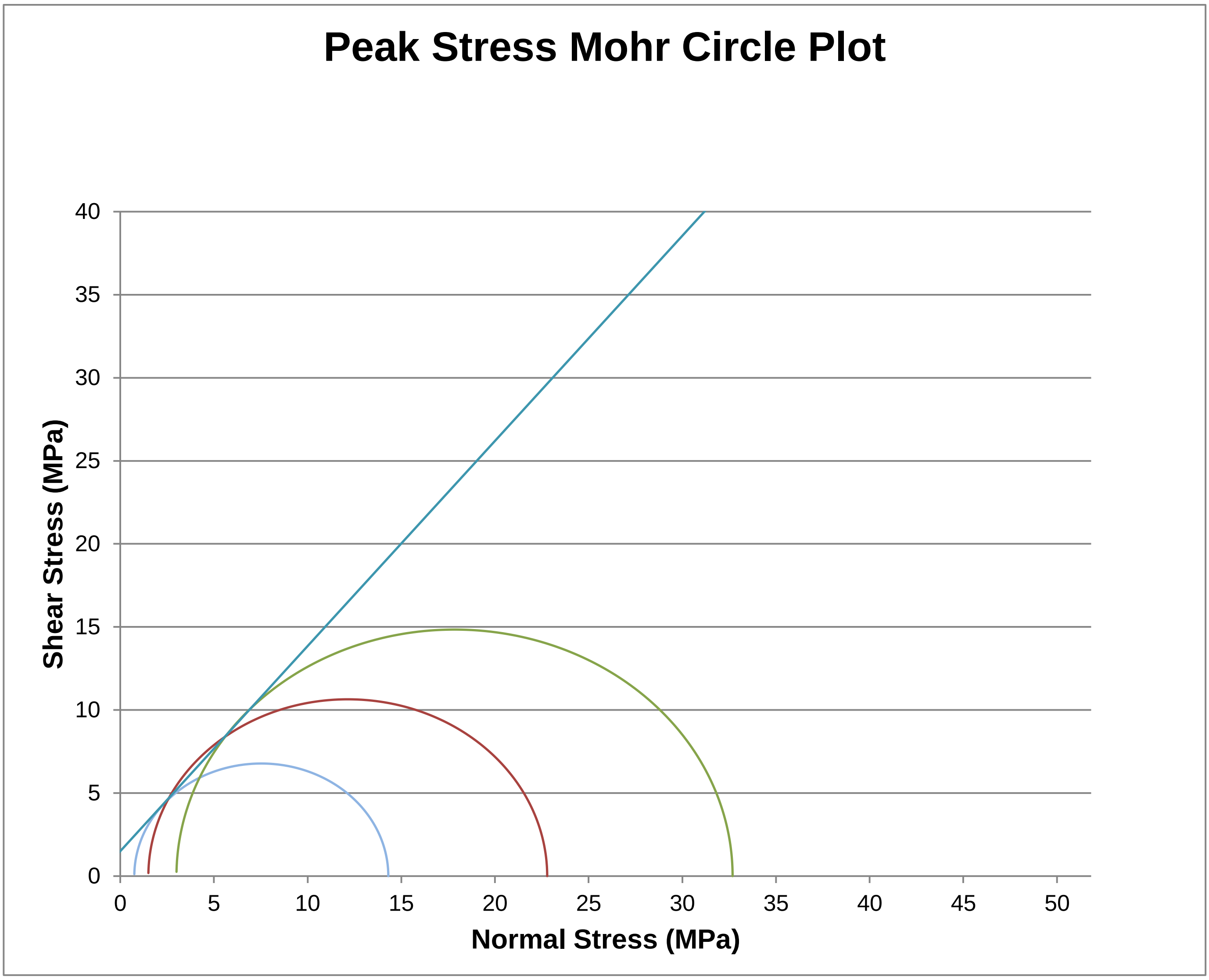
APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

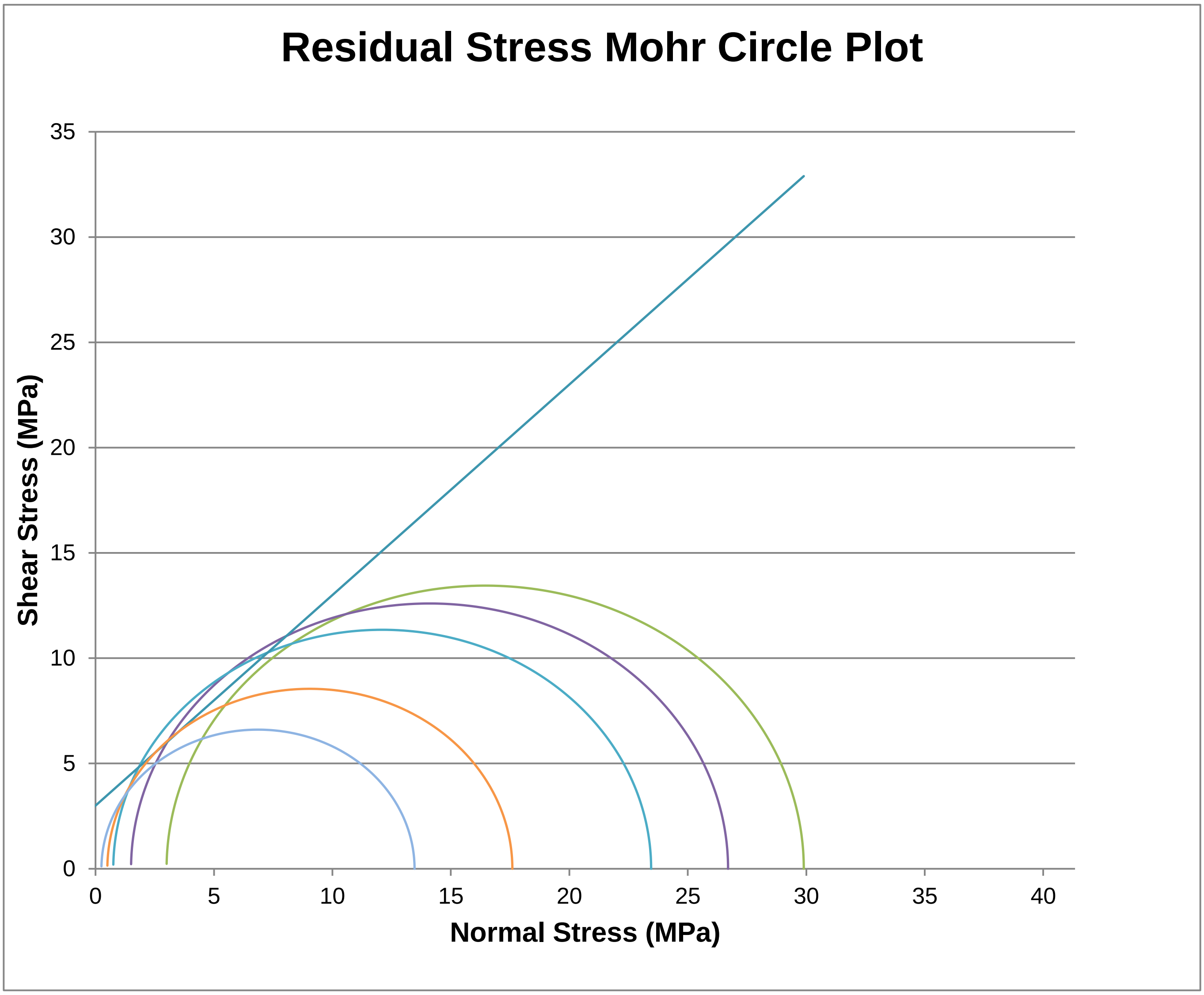


Estimated Peak Envelope	
Angle	51.0 °
Cohesion	1.5 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5494A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK



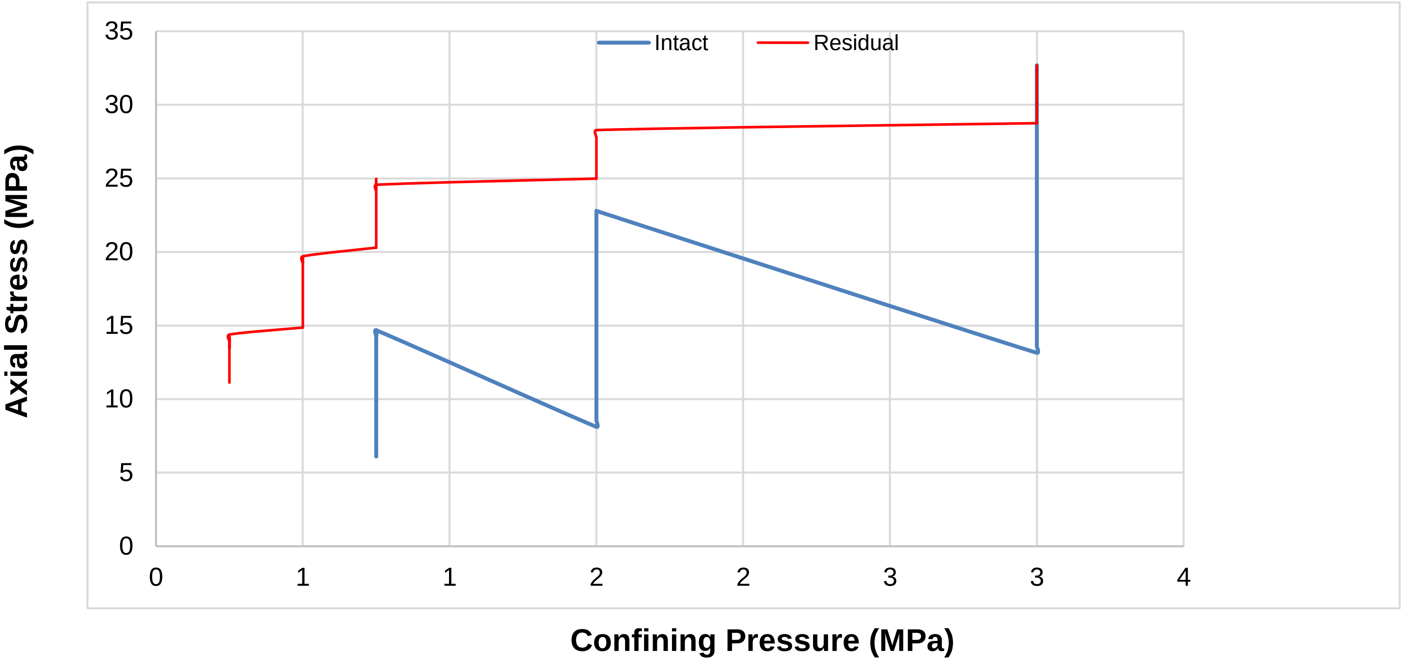
Estimated Residual Envelope	
Angle	45.0 °
Cohesion	3.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5494A

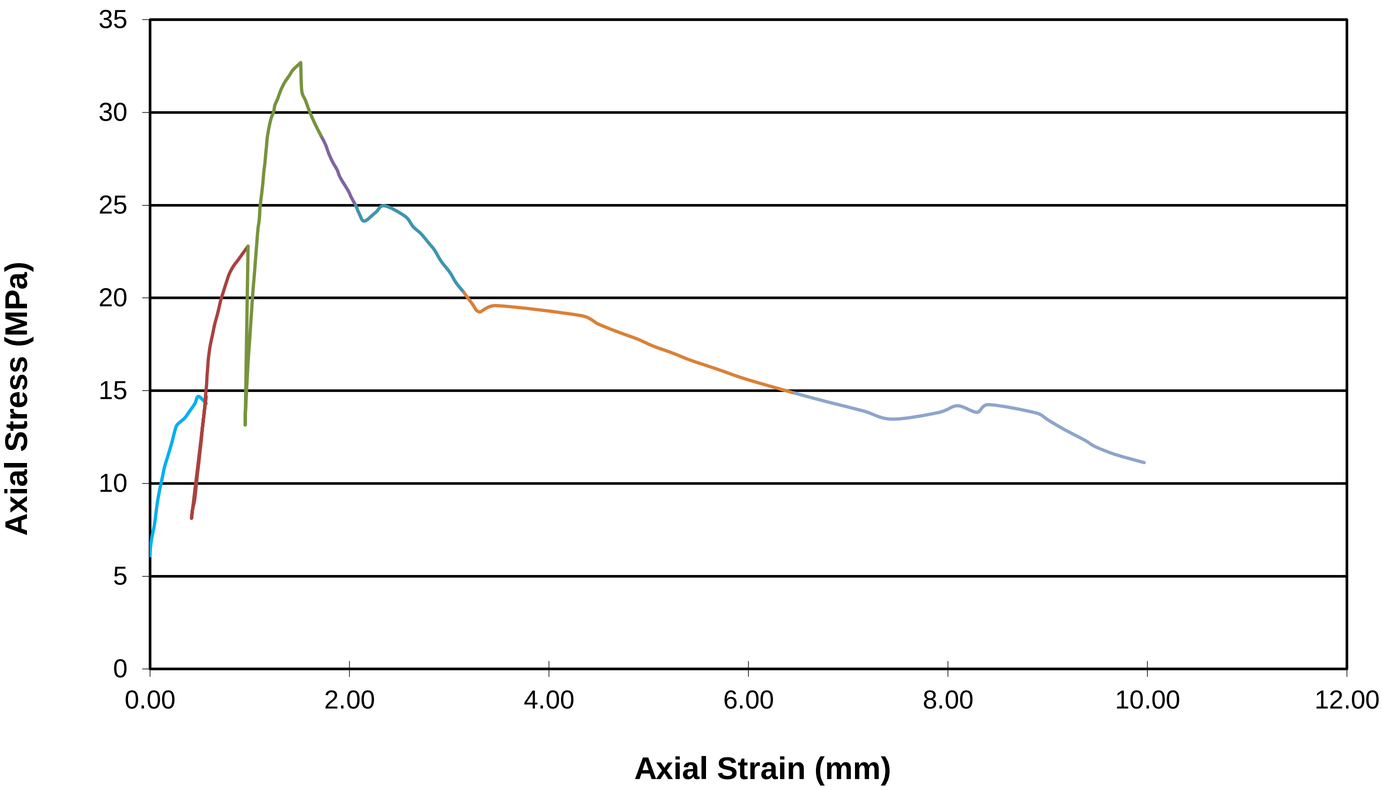
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5494A



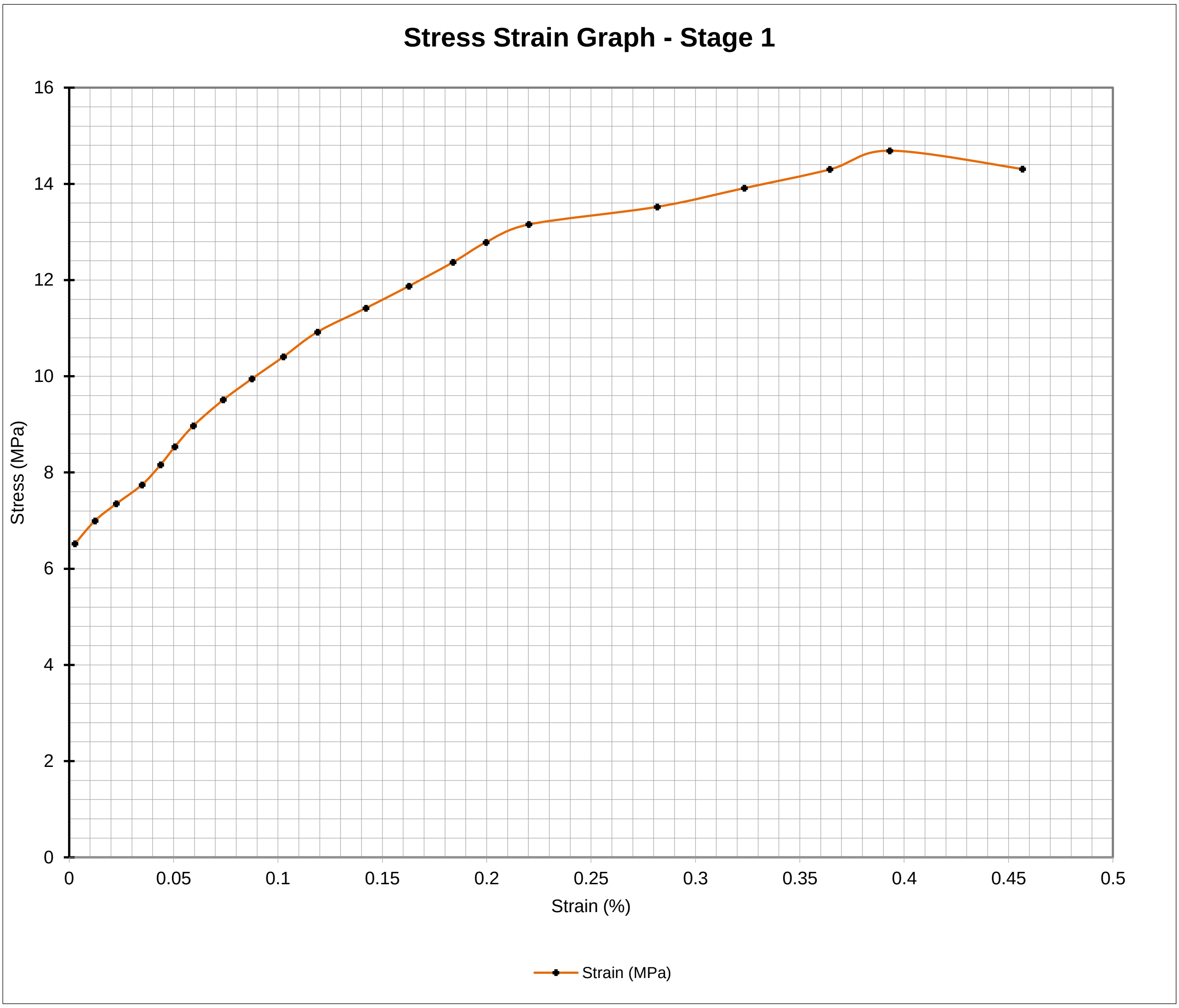


TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5494A



CARDNO (QLD) PTY LTD

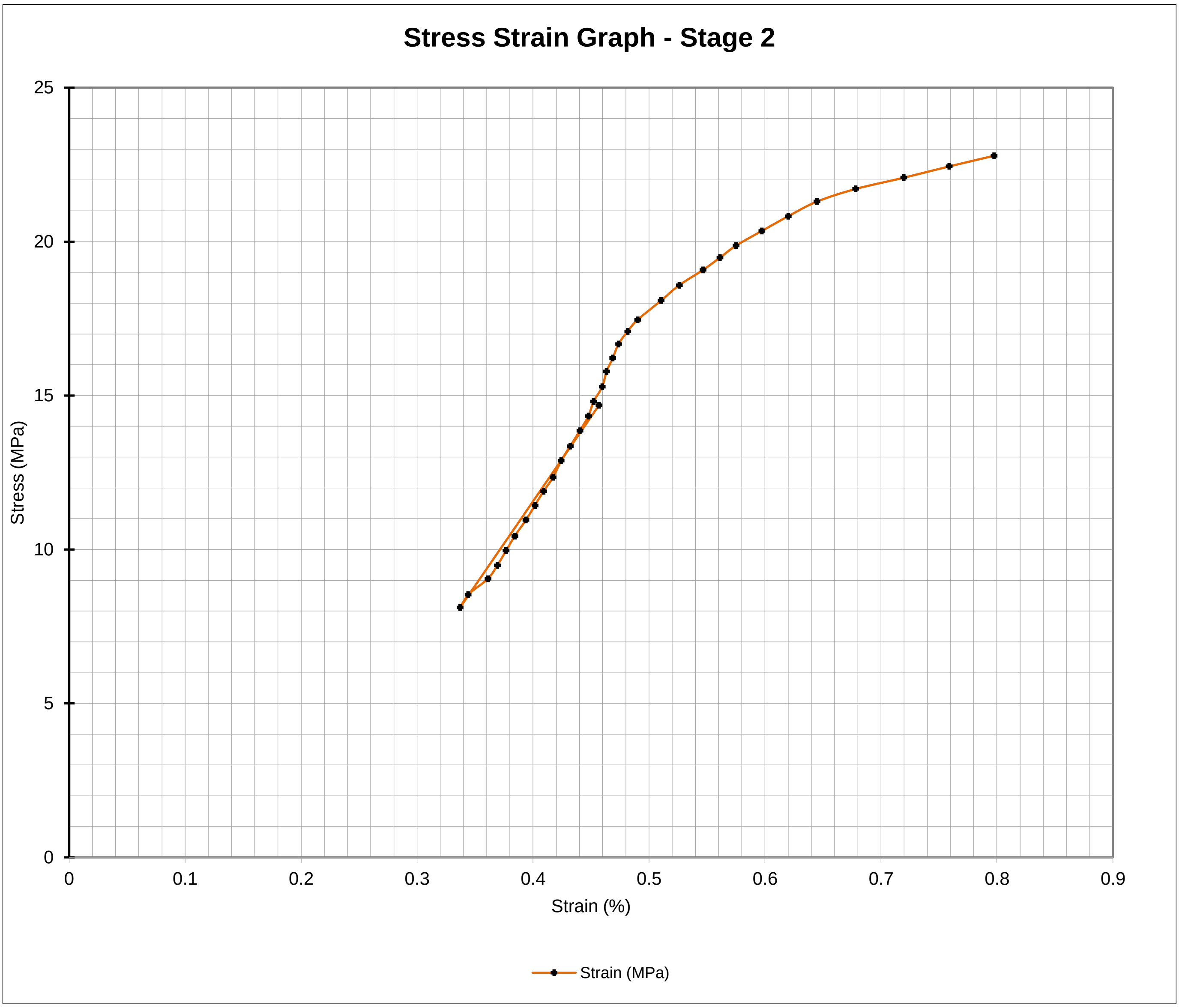
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 6 of 7

Mackay Laboratory

LAB REF NO: 19-5494A

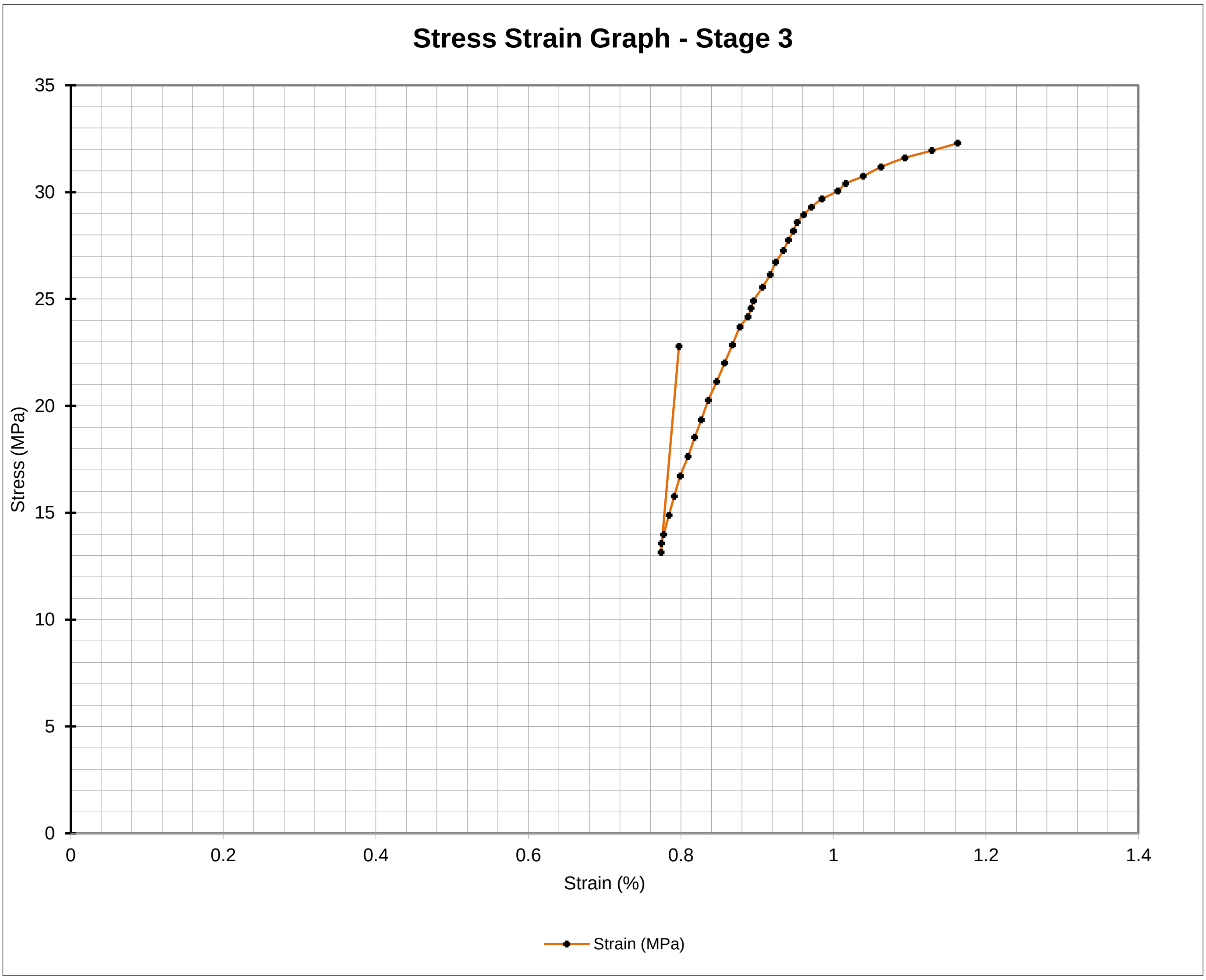


CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5494A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

GEO-QF-GR 105 G
(07/17)

Sheet 1 of 7

Mackay Laboratory

CLIENT: Central Queenssland Coal **JOB NO:** M30863 **LAB REF NO:** 19-5502A

ADDRESS: Level 17, 240 Queen Street, Brisbane, QLD 4000

PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Client **DATE:** 02-Sep-19

LOCATION: Styx Coal Mine **TESTED BY:** PM **DATE:** 07-Nov-19

MATERIAL: Interlaminated Sandstone/Siltstone **CHECKED BY:** DH **DATE:** 08-Nov-19

TEST PROCEDURES: **D7012-14 Method A; D4543** **CLIENT REF:** -

Seam: -

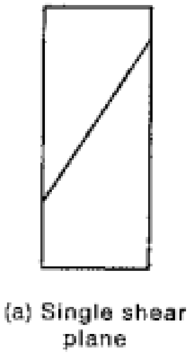
Sample Details			
Borehole:	STX1904G	**Sample number:**	UCS-54
Depth from (m):	92.98	**Depth to (m):**	93.21

Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	123.8
Measurement:	Displacement Transducer	**Diameter (mm):**	60.8
		Moisture Content (%):	2.6
Rate of Loading (MPa/min):	12.76	**Mass of Sample (g):**	890.3
Time to Failure (min):	5.45	**Dry Density (t/m3):**	2.41
Test Duration (min):	4.56	**Wet Density (t/m3):**	2.48

Intact Strength			
	Confining Pressure (MPa)	**Maximum Principal Stress (MPa):**	**Axial Strain (%)**
Stage 1	0.75	28.7	0.61
Stage 2	1.5	41.5	0.89
Stage 3	3	48.3	1.04

Residual Strength			
	Confining Pressure (MPa)	**Median Axial Stress (MPa)**	
Residual Stress 1	3	30.6	
Residual Stress 2	1.5	21.9	
Residual Stress 3	0.75	15.0	
Residual Stress 4	0.5	10.3	
Residual Stress 5	0.25	6.6	

Dominant structural features with respect to core axis

Before Photo	After Photo	Failure Diagram
		

Comments: Testing was done at Room Temperature.

NATA
WORLD RECOGNISED ACCREDITATION

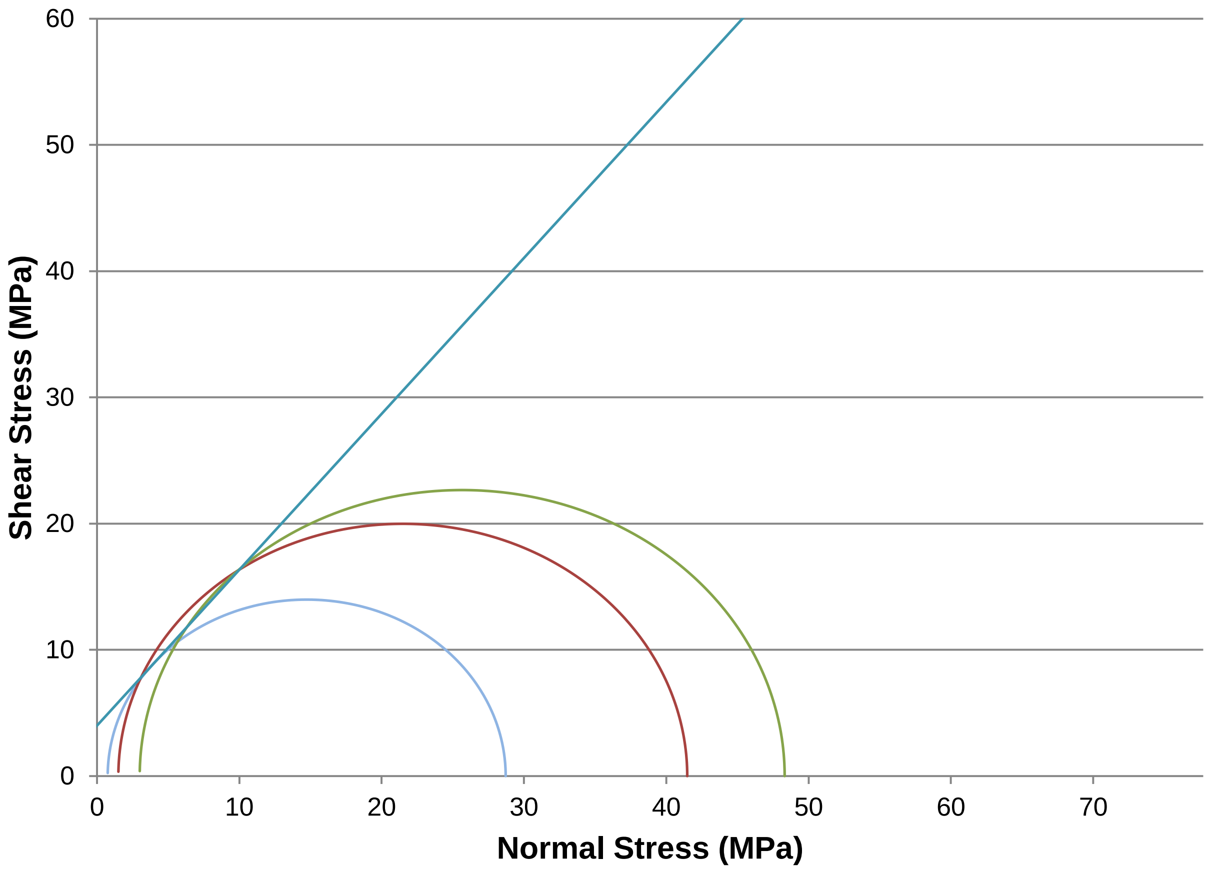
Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

TRIAXIAL PROPERTIES OF A ROCK

Peak Stress Mohr Circle Plot

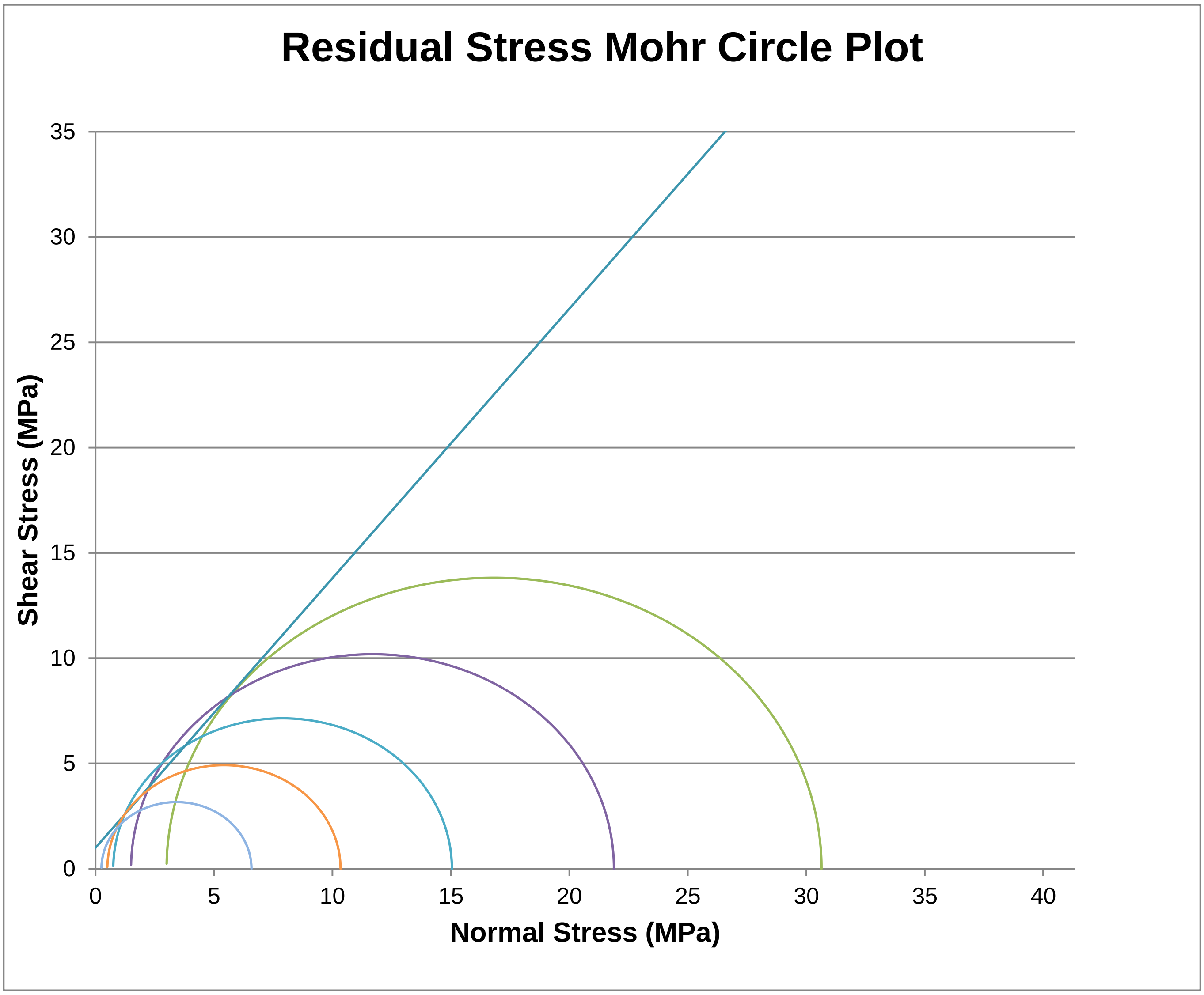


Estimated Peak Envelope	
Angle	51.0 °
Cohesion	4.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5502A

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK



Estimated Residual Envelope	
Angle	52.0 °
Cohesion	1.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5502A

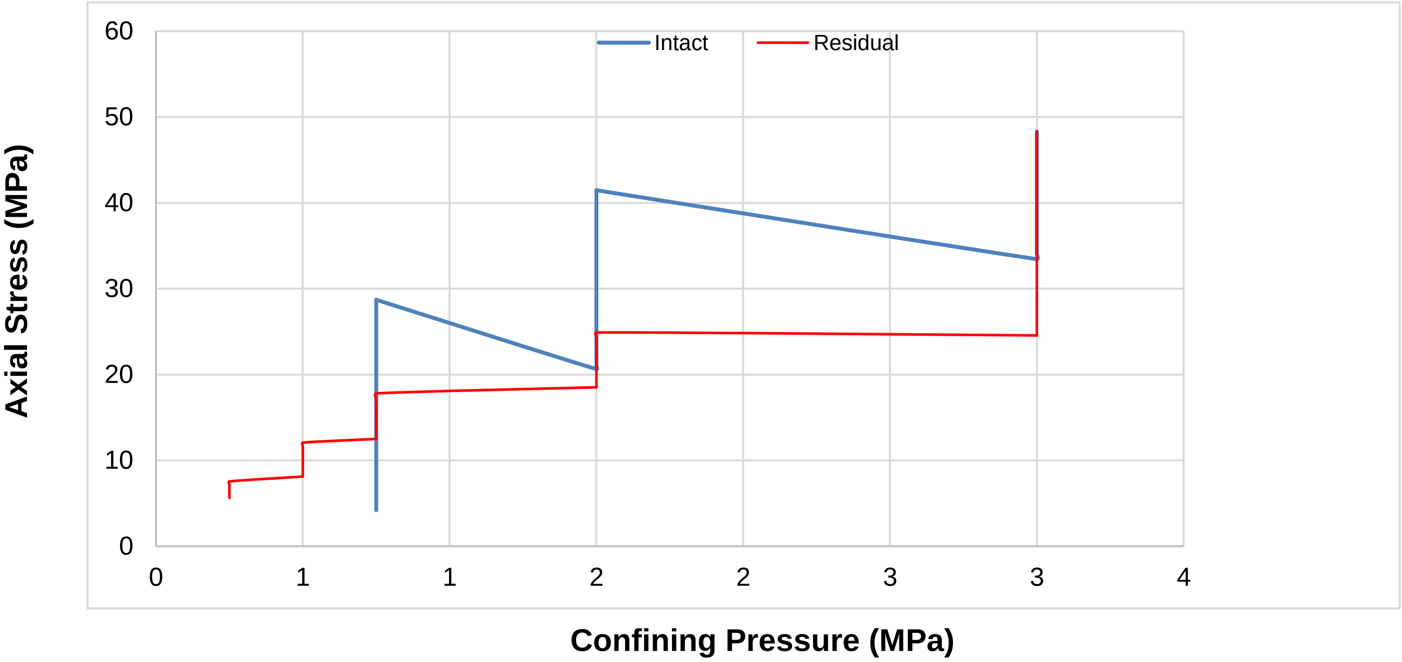
CARDNO (QLD) PTY LTD

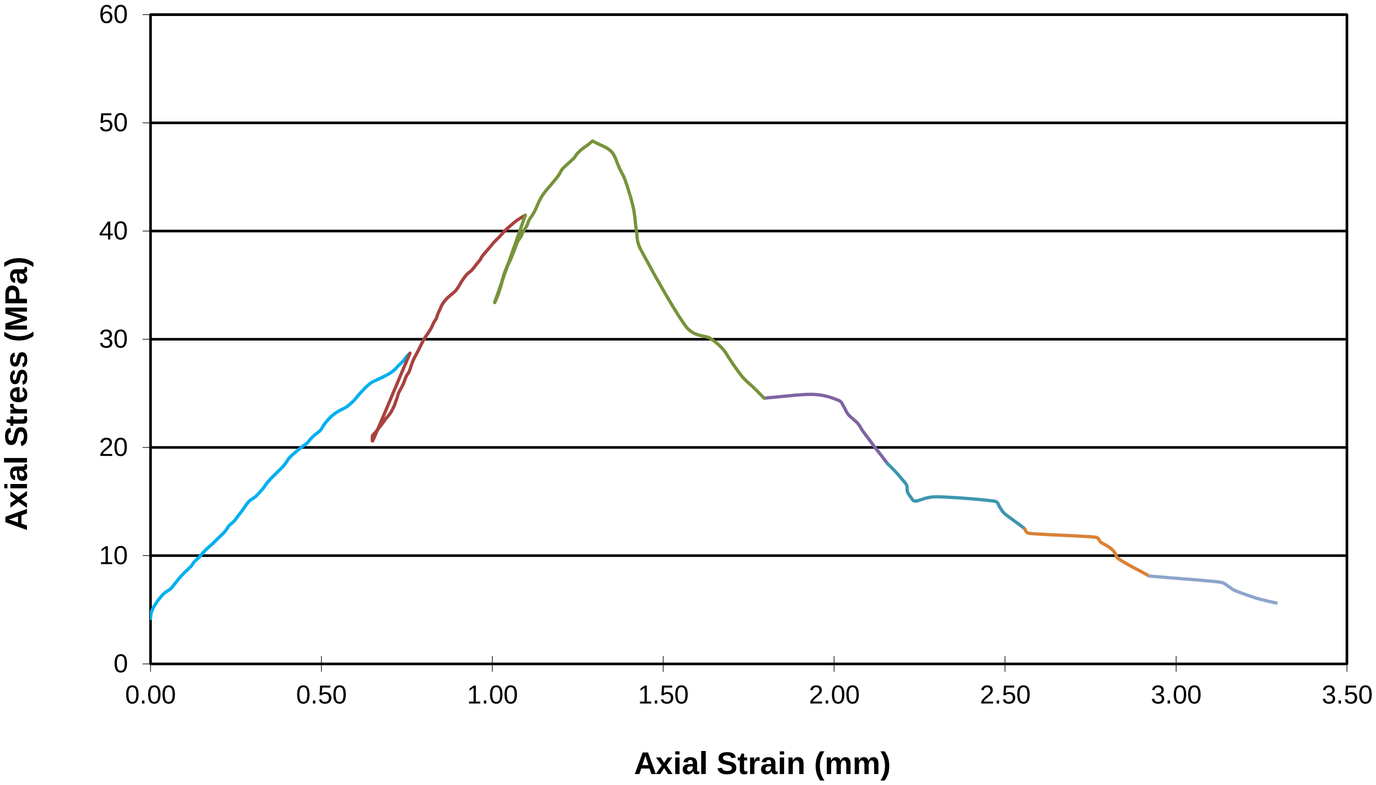
71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 4 of 7 | Mackay Laboratory

LAB REF NO: 19-5502A





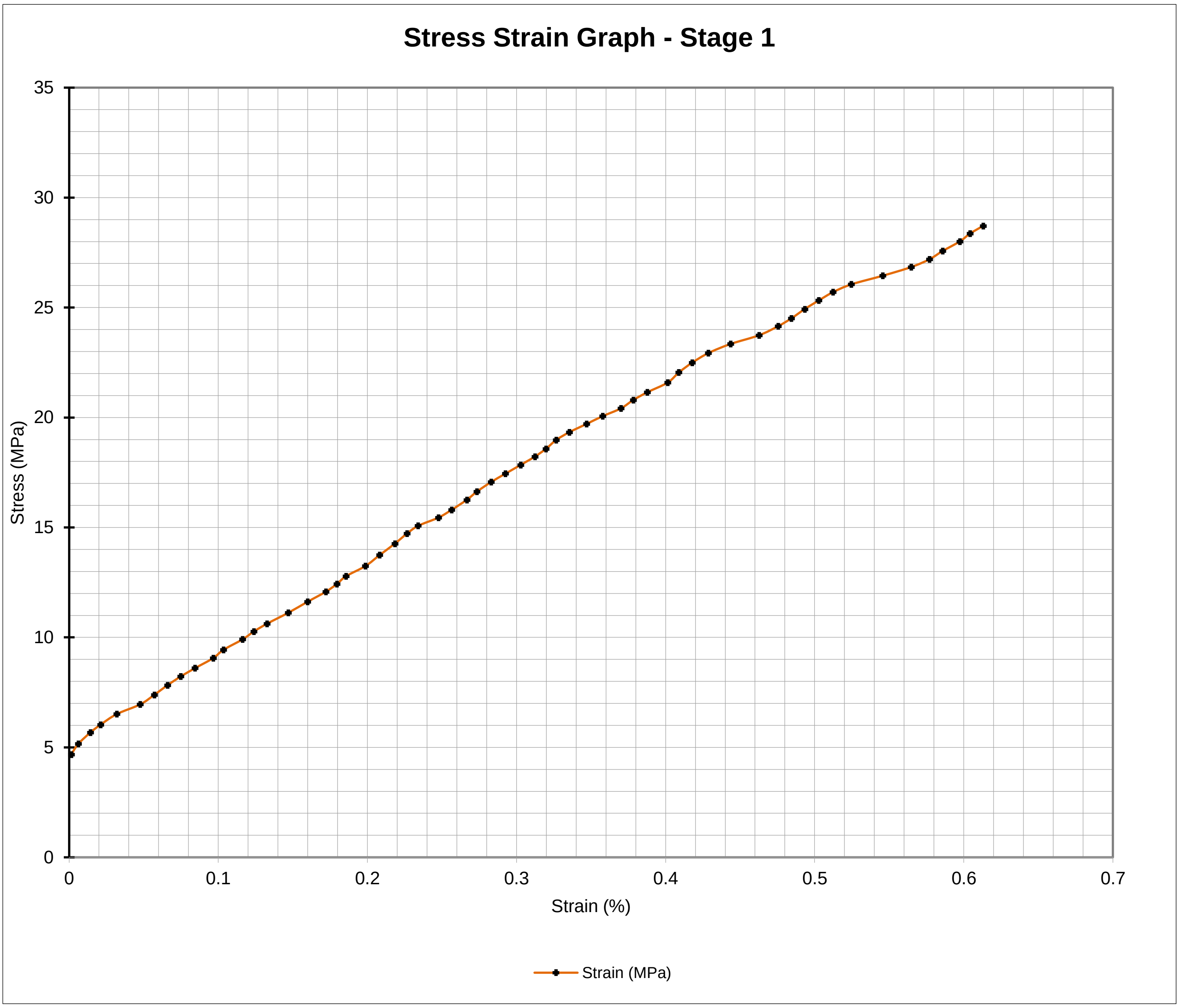
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Mackay Laboratory

LAB REF NO: 19-5502A



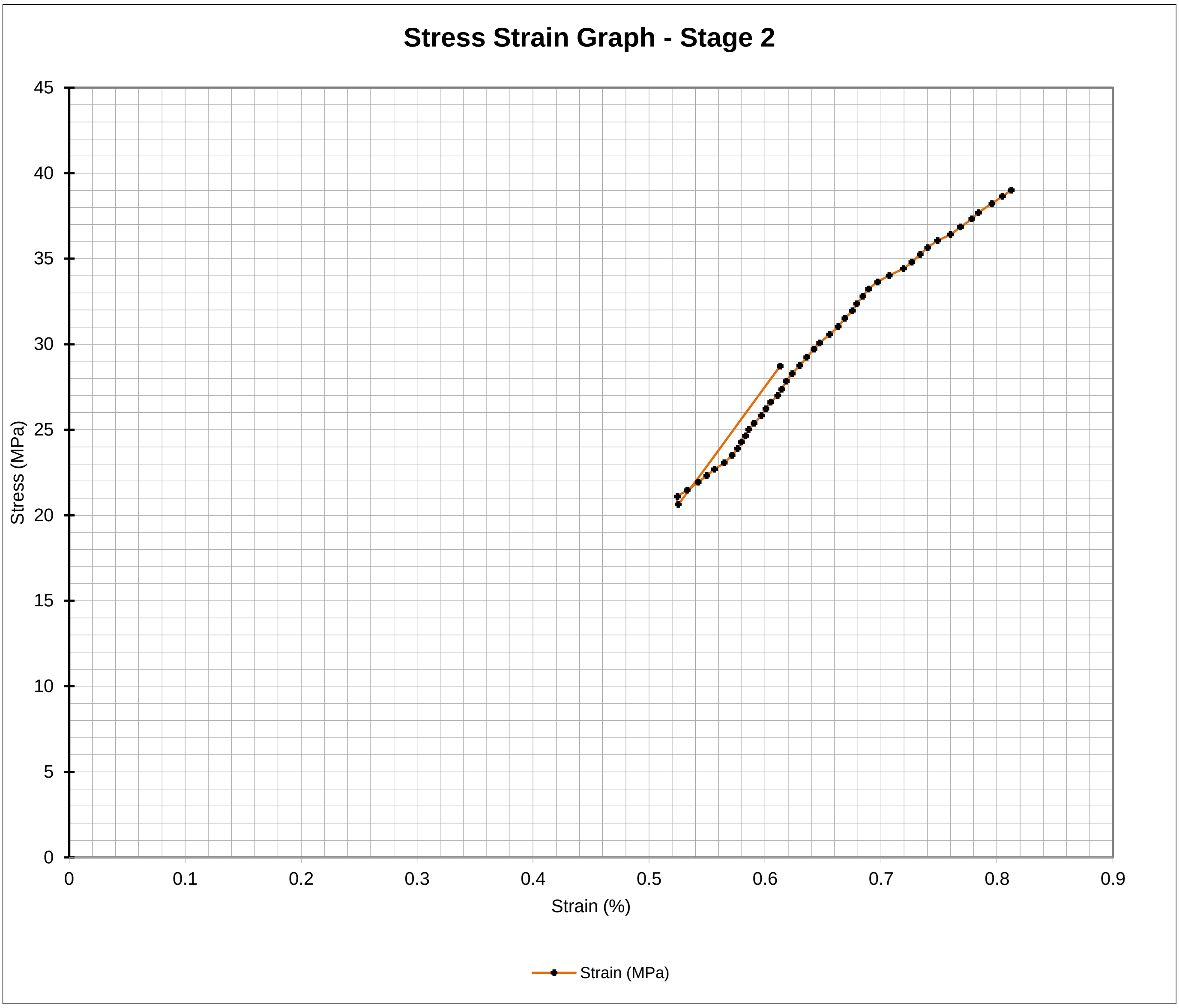
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 6 of 7 Mackay Laboratory

LAB REF NO: 19-5502A

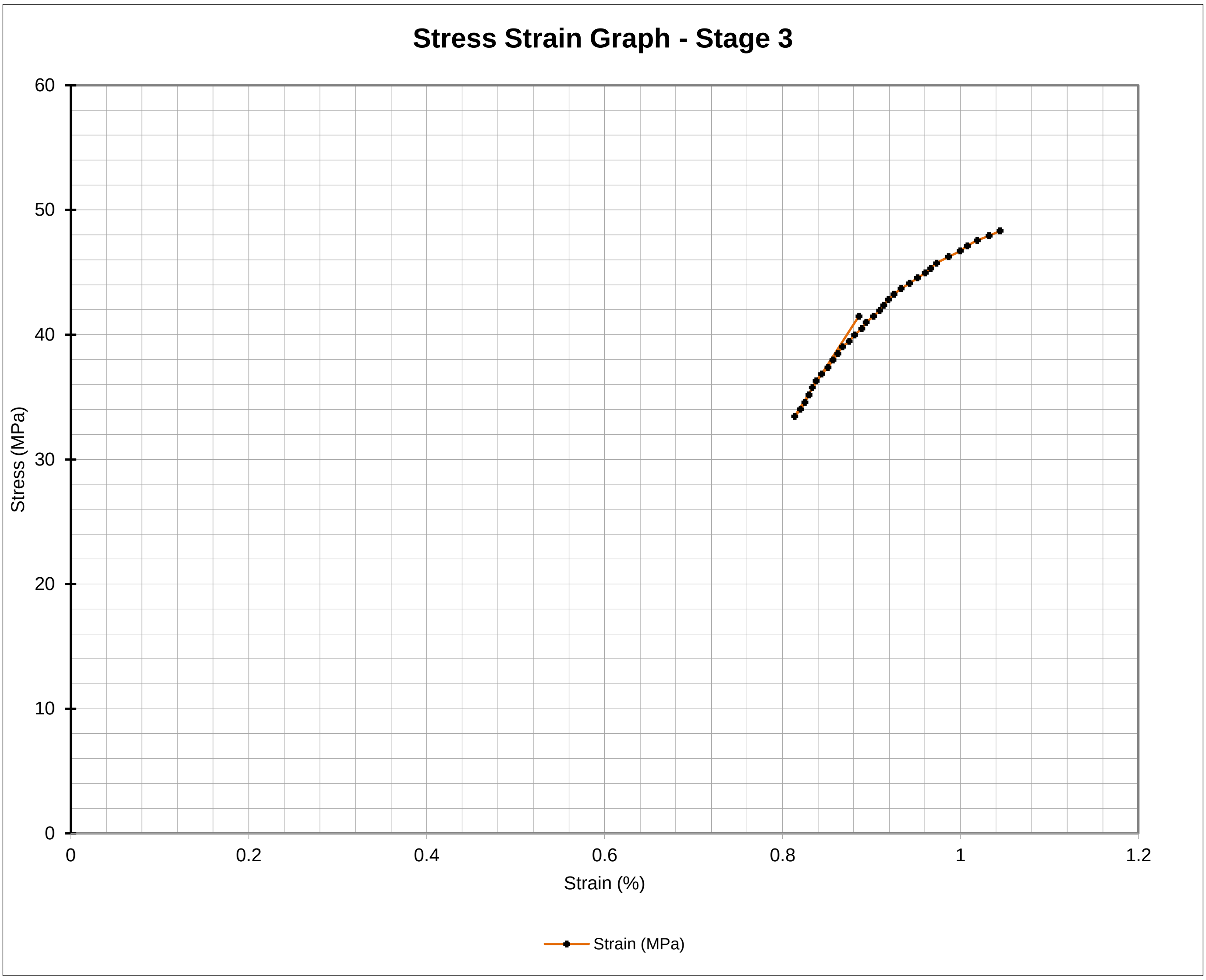


CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5502A



GEO-QF-GR 105 G
(07/17)

CARDNO (QLD) PTY LTD
71 MAGGIOLO DRIVE MACKAY QLD
TRIAXIAL PROPERTIES OF A ROCK

Sheet 1 of 7 Mackay Laboratory

CLIENT:	Central Queenssland Coal	**JOB NO:**	M30863	**LAB REF NO:**	19-5504A
ADDRESS:	Level 17, 240 Queen Street, Brisbane, QLD 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Client	**DATE:**	02-Sep-19
LOCATION:	Styx Coal Mine	**TESTED BY:**	PM	**DATE:**	07-Nov-19
MATERIAL:	Interlaminated Sandstone/Siltstone	**CHECKED BY:**	DH	**DATE:**	08-Nov-19
TEST PROCEDURES:	**D7012-14 Method A; D4543**			**CLIENT REF:**	-

Seam: -

		Sample Details	
		Borehole:	STX1904G
		Sample number:	UCS-56
		Depth from (m):	98.09
		Depth to (m):	98.28
Test Apparatus:	Shimadzu UEH-50	**Length (mm):**	124.7
Measurement:	Displacement Transducer	**Diameter (mm):**	60.9
		Moisture Content (%):	1.2
Rate of Loading (MPa/min):	19.41	**Mass of Sample (g):**	970.9
Time to Failure (min):	5.45	**Dry Density (t/m3):**	2.64
Test Duration (min):	6.15	**Wet Density (t/m3):**	2.67

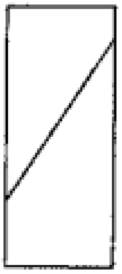
Intact Strength

	Confining Pressure (MPa)	Maximum Principal Stress (MPa):	Axial Strain (%)
Stage 1	0.75	39.0	0.23
Stage 2	1.5	68.5	0.35
Stage 3	3	83.9	0.51

Residual Strength

	Confining Pressure (MPa)	Median Axial Stress (MPa)	
Residual Stress 1	3	65.3	
Residual Stress 2	1.5	48.1	
Residual Stress 3	0.75	35.6	
Residual Stress 4	0.5	28.0	
Residual Stress 5	0.25	19.9	

Dominant structural features with respect to core axis

Before Photo	After Photo	Failure Diagram
		 (a) Single shear plane

Comments: Testing was done at Room Temperature.

Accredited for compliance with ISO/IEC 17025 - Testing. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

APPROVED SIGNATORY

Trudie Bradbury - Analyst
NATA Accreditation Number
910 Mackay Laboratory

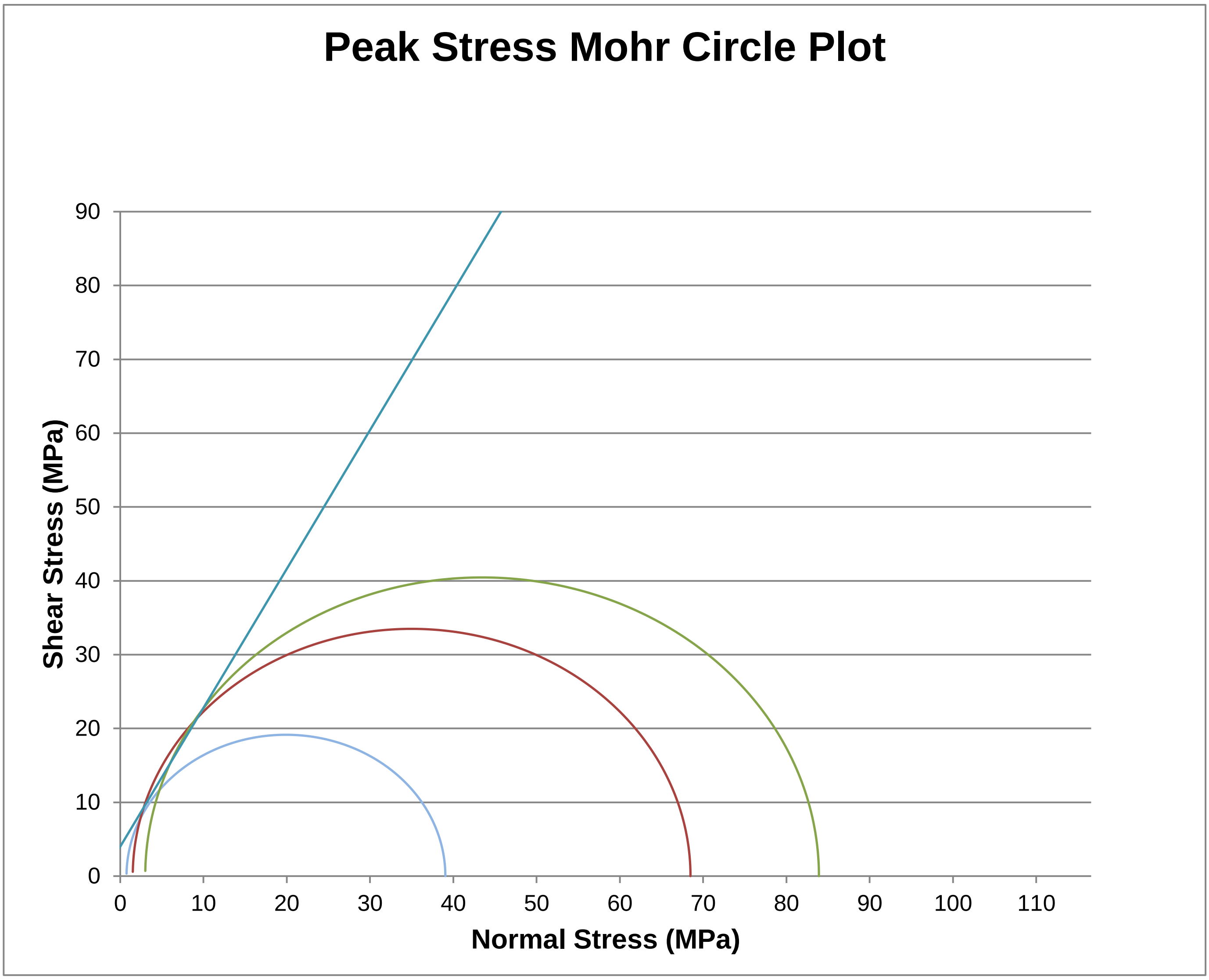
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

Sheet 2 of 7

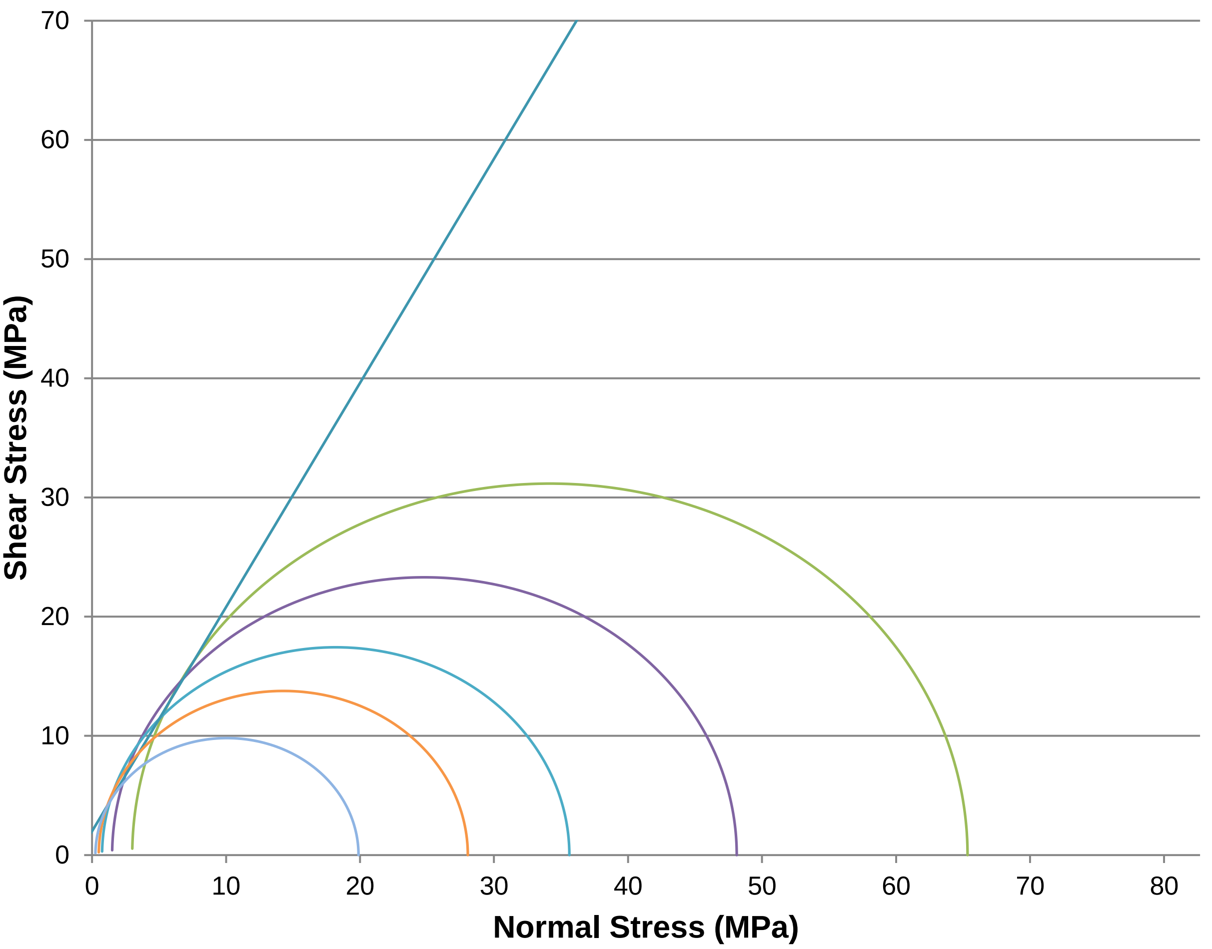
Mackay Laboratory



Estimated Peak Envelope	
Angle	62.0 °
Cohesion	4.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5504A

TRIAXIAL PROPERTIES OF A ROCK

Residual Stress Mohr Circle Plot



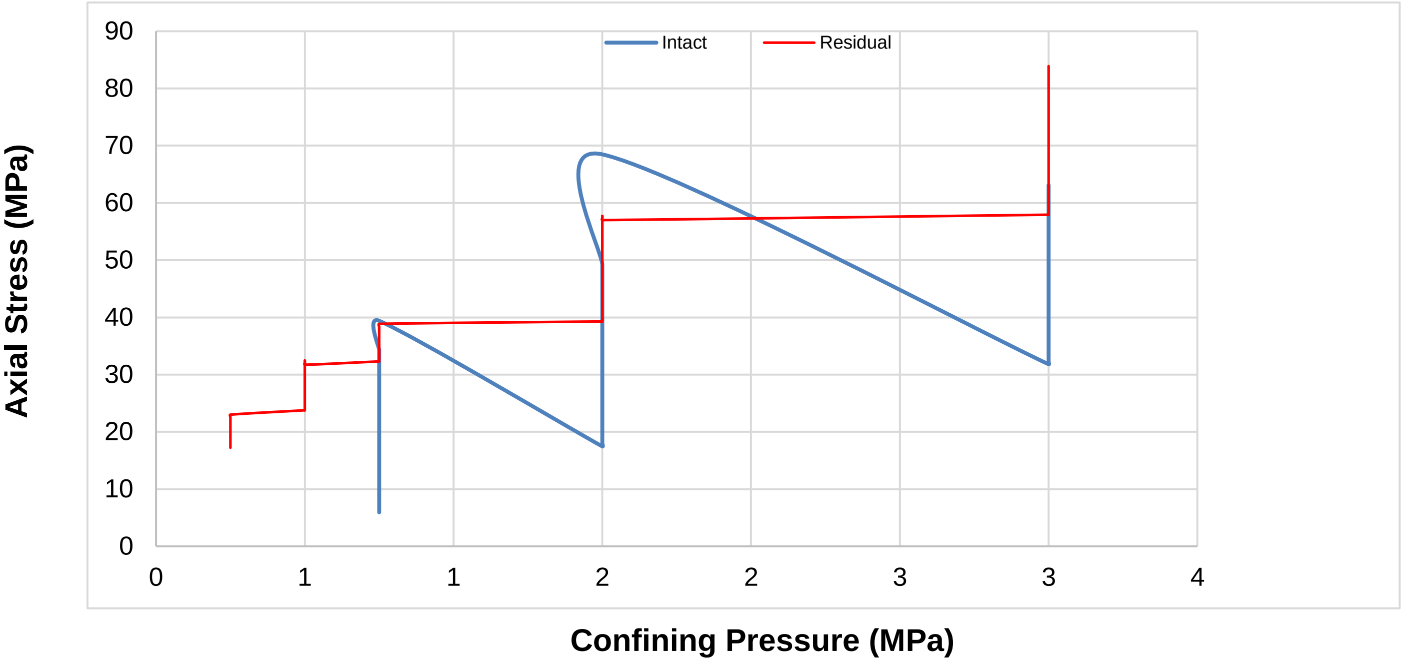
Estimated Residual Envelope	
Angle	62.0 °
Cohesion	2.0 MPa
Notes:	Graph not to scale
Lab Ref No.:	19-5504A

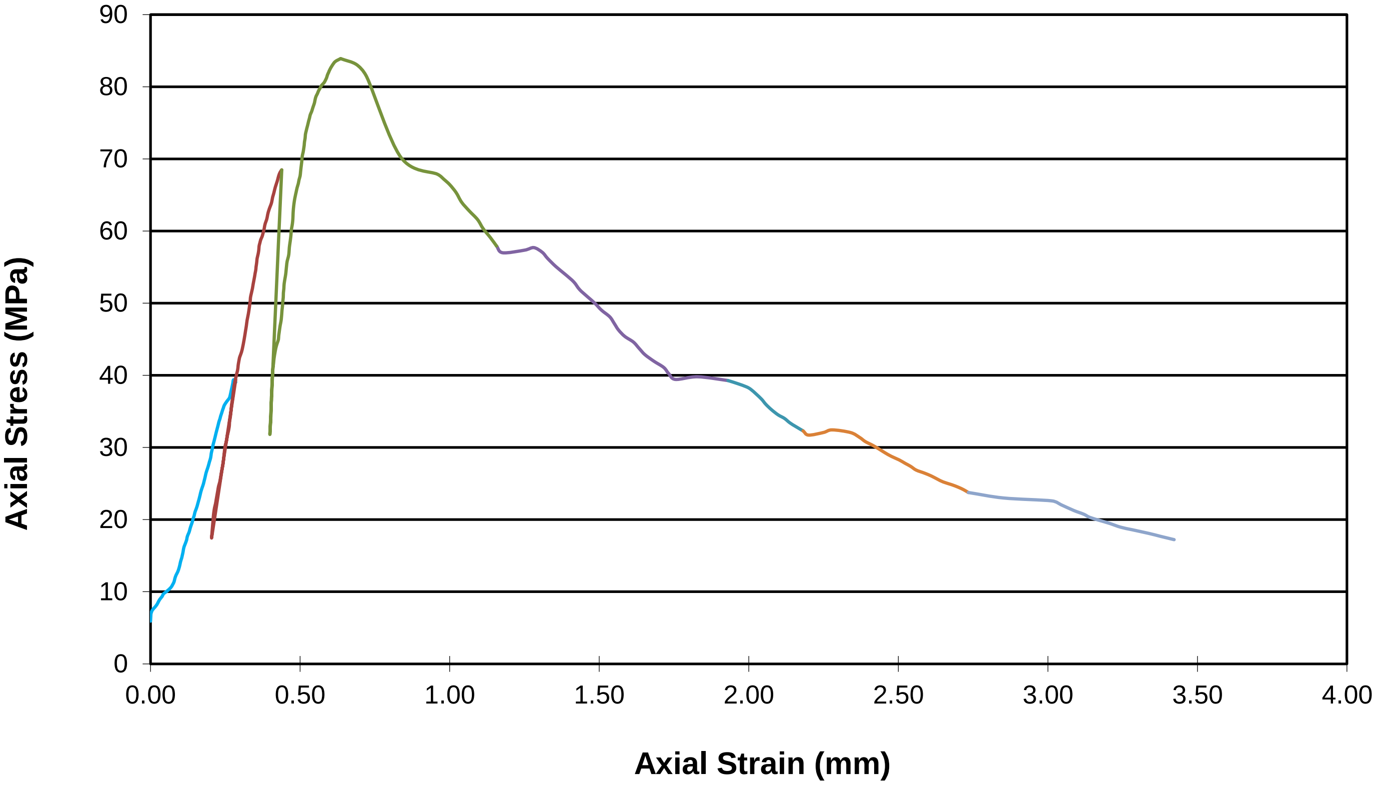
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5504A



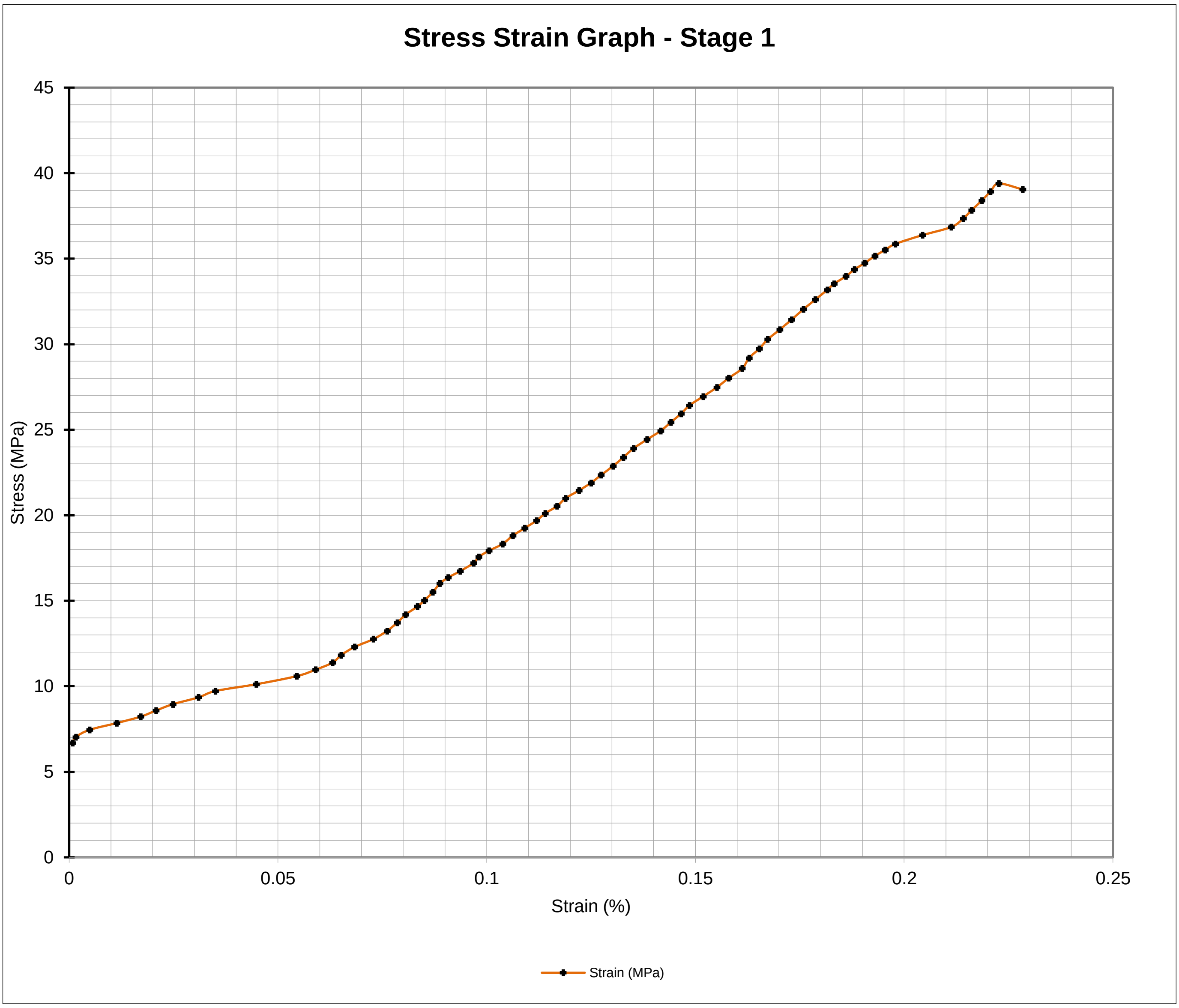


TRIAXIAL PROPERTIES OF A ROCK

Sheet 5 of 7

Mackay Laboratory

LAB REF NO: 19-5504A

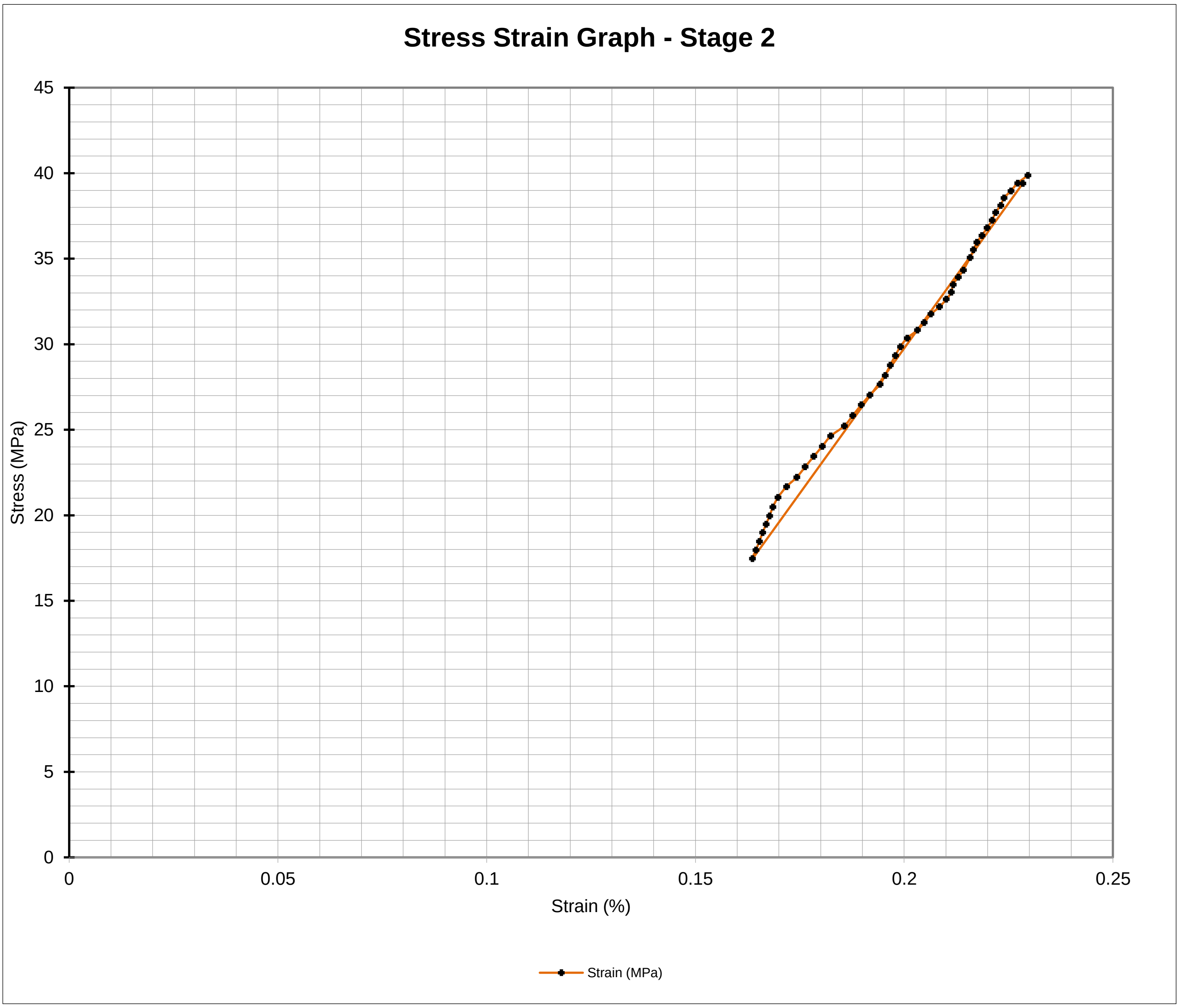


CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

LAB REF NO: 19-5504A



CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

TRIAXIAL PROPERTIES OF A ROCK

GEO-QF-GR 105 G
(07/17)

Sheet 7 of 7

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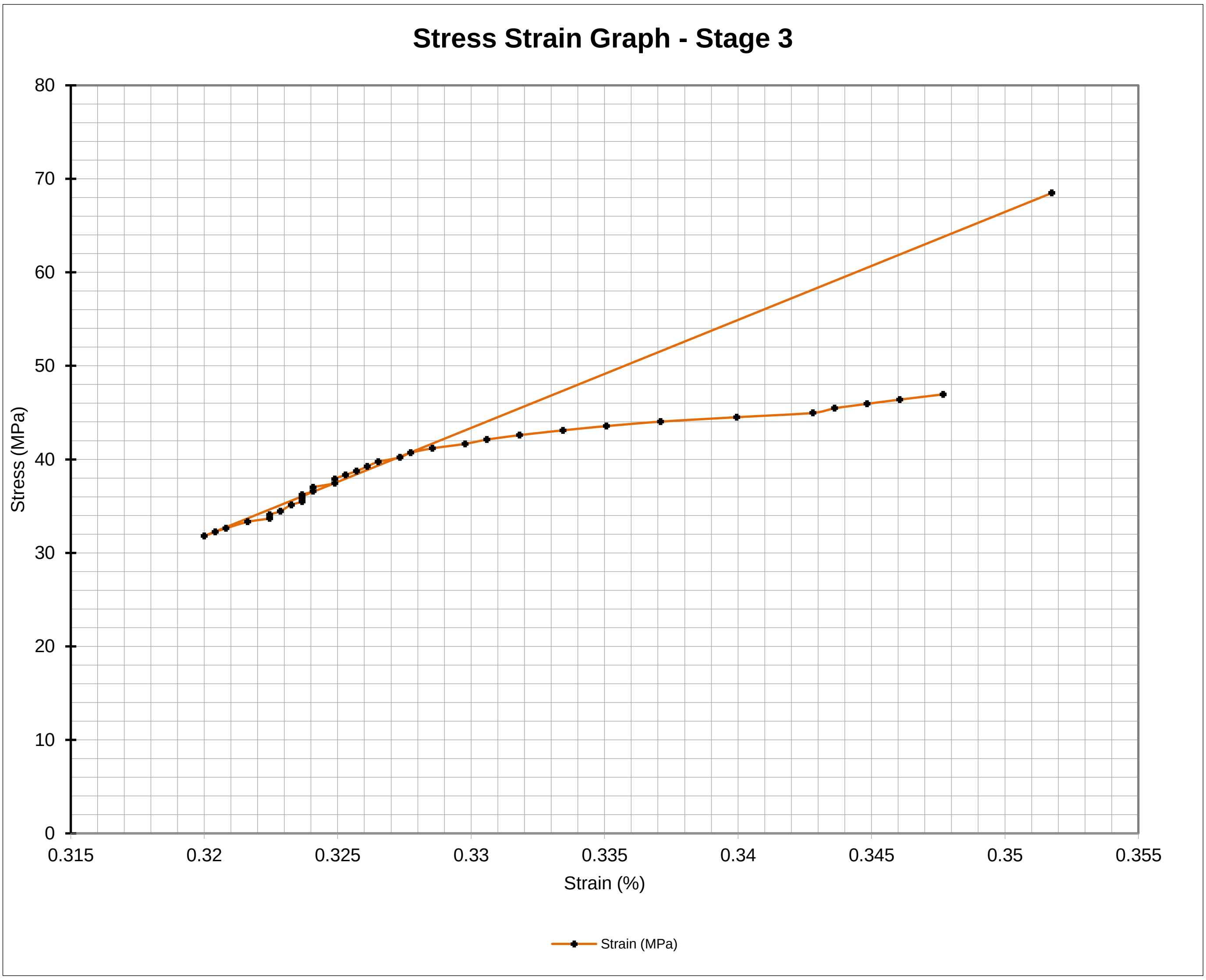
LAB REF NO: 19-5504A



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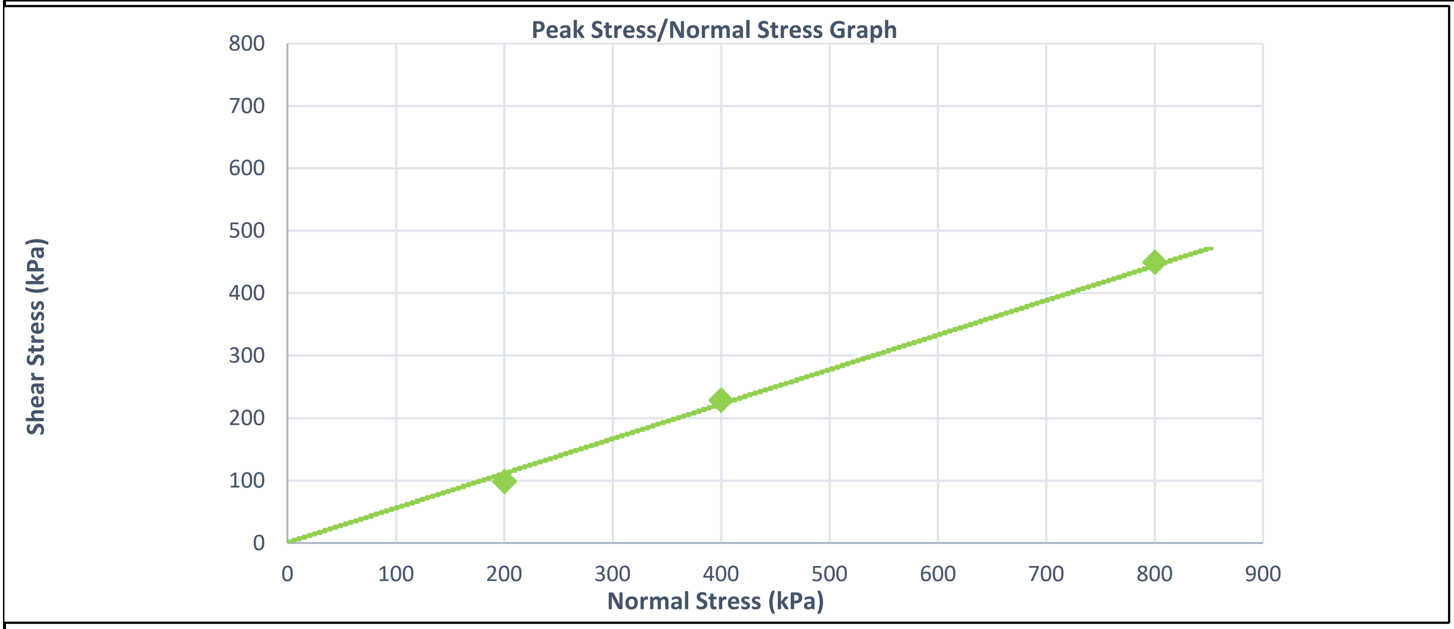
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5472A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G Shear-24**		**Page 1**

Borehole: STX1904G Sample ID: Shear-24 Depth From: 41.97 Depth To: 42.18

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	13/11/2019	Wet Density	2.34	2.31	2.34
Sampled By:	Cardno	Dry Density	2.25	2.23	2.26
Sampling Method:	AS 1289 1.2.1	Moisture (%)	4.1	3.5	3.7
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Siltstone	Peak Shear Stress (kPa)	99	229	450
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.2	0.3
Lab Ref Number:	19-5472A	Strain Rate (mm/min)	0.123	0.102	0.097



Effective Cohesion C' (kPa): 0.0
Effective Angle of Friction ϕ' (Degrees): 29.0
Failure Criteria: Peak Shear Stress

Sample/s supplied by Cardn(Note: Graph not to scale

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D. Hoskins

Derren Hoskins - Lab Manager
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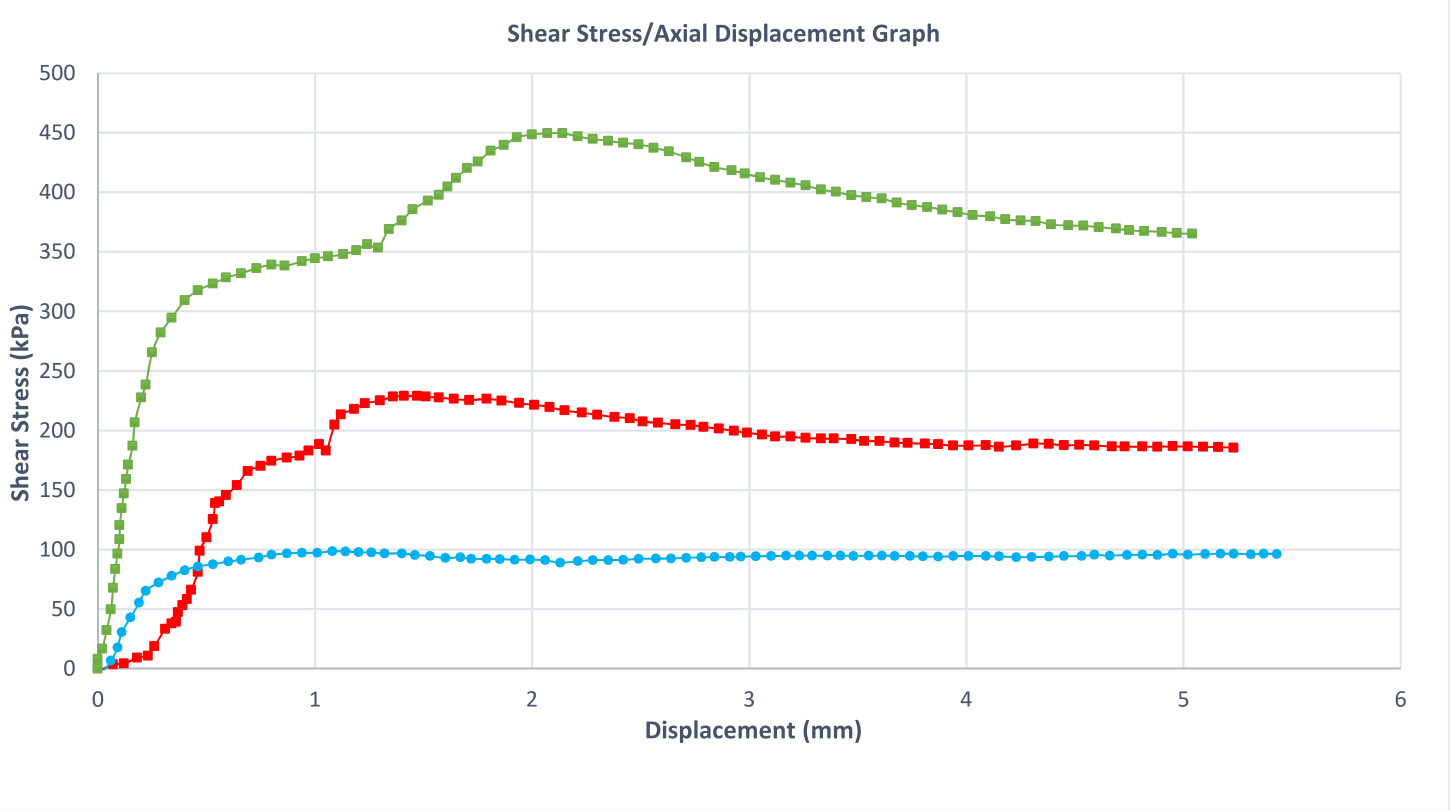
Direct Shear on Rock Report

Client: **Central Queensland Coal**
Address: **Level 17, 240 Queen Street, Brisbane, QLD**
Project Number: **M30863**
Project Name: **CQ Coal Styx Basin Geotechnical Investigatio**
Location: **STX1904G**

Report Number: **19-5472A**
Report Date: **14/11/2019**
Order Number: **-**
Test Method **AS 1289.6.2.2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	99	1.08	44
2	400	229	1.41	49
3	800	450	2.07	56

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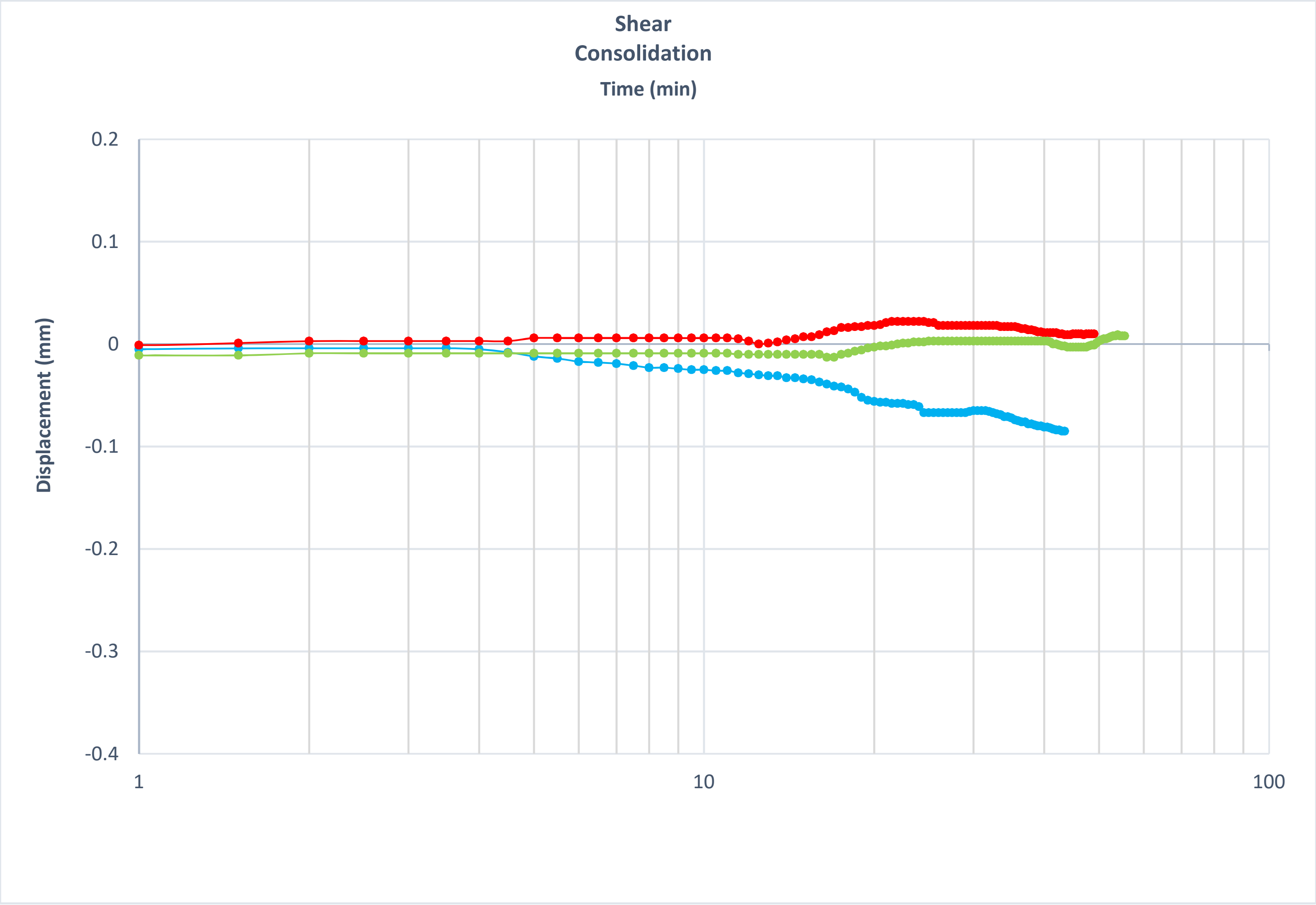
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 3**



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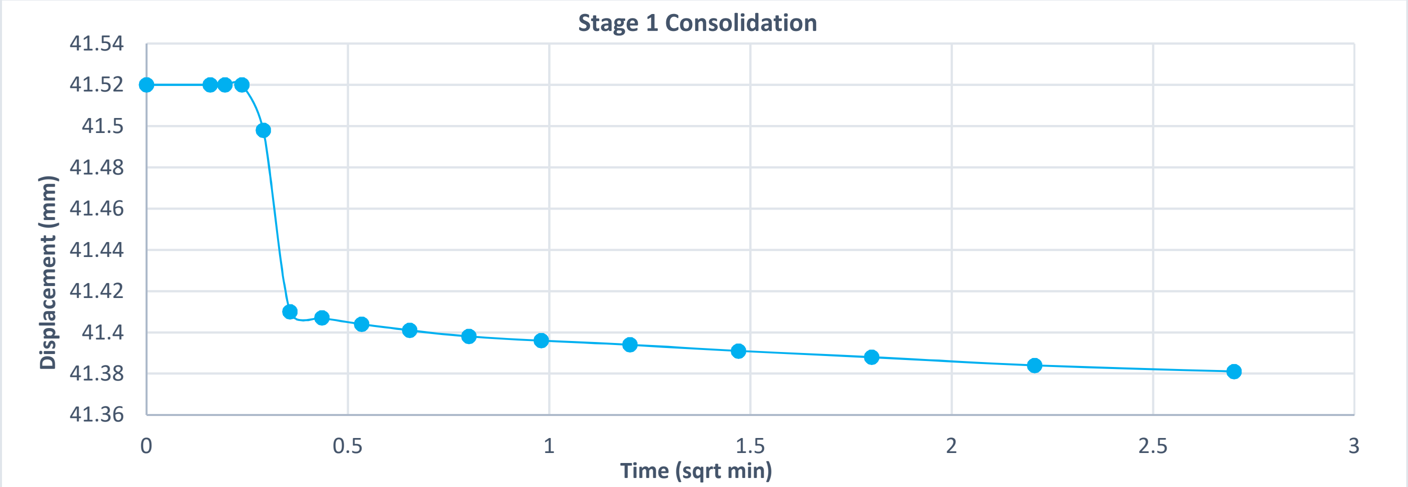
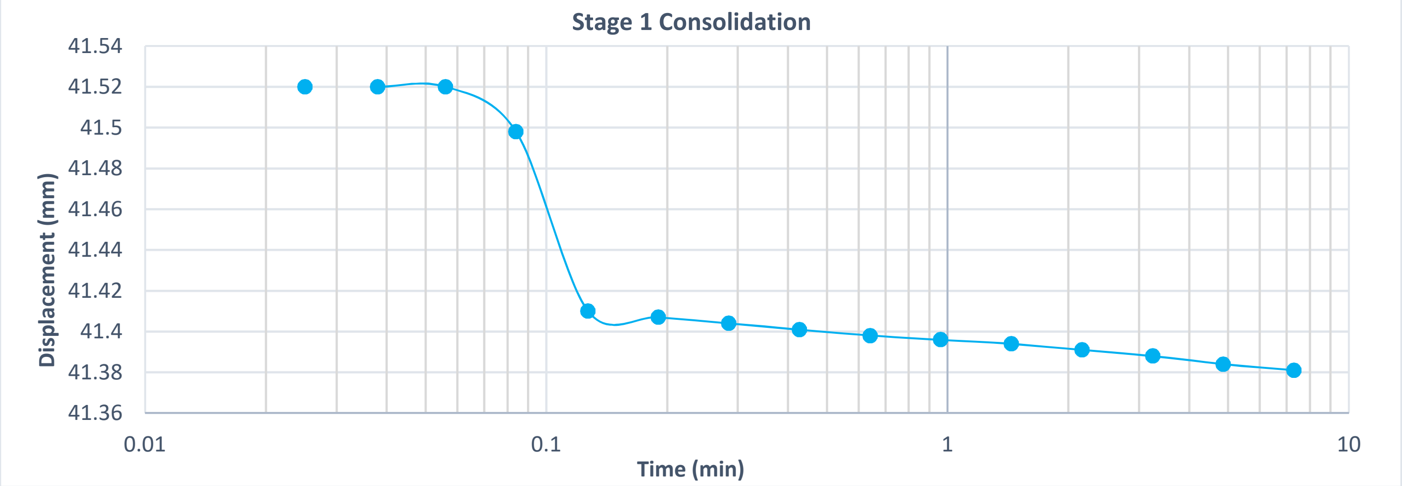
Project Name:	**CQ Coal Styx Basin Geotechnical Investigation**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 4**





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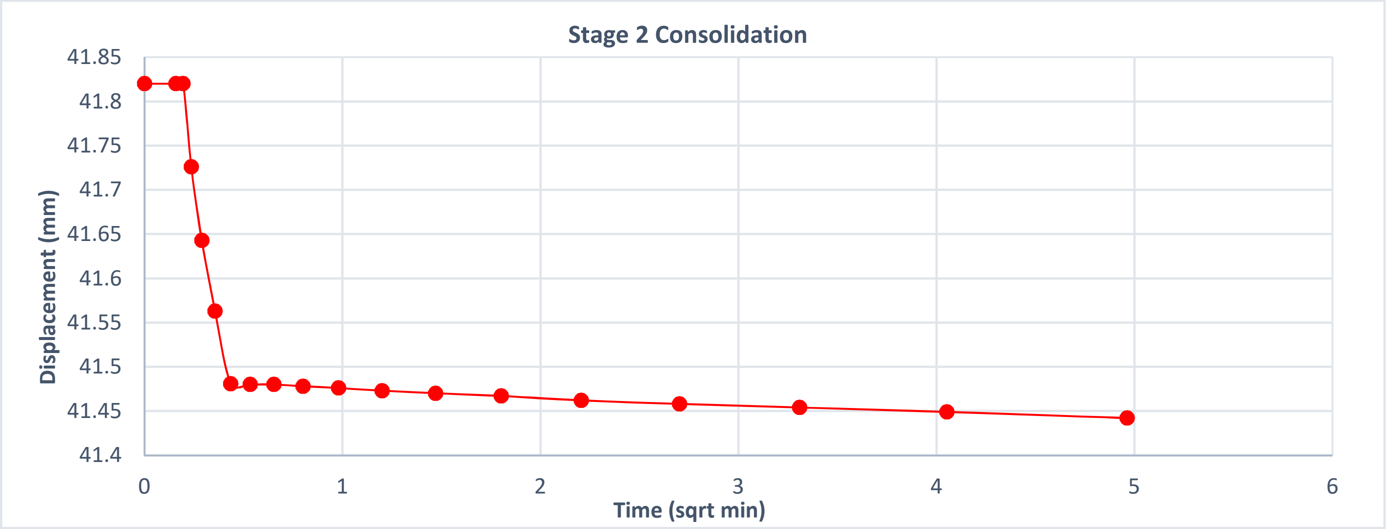
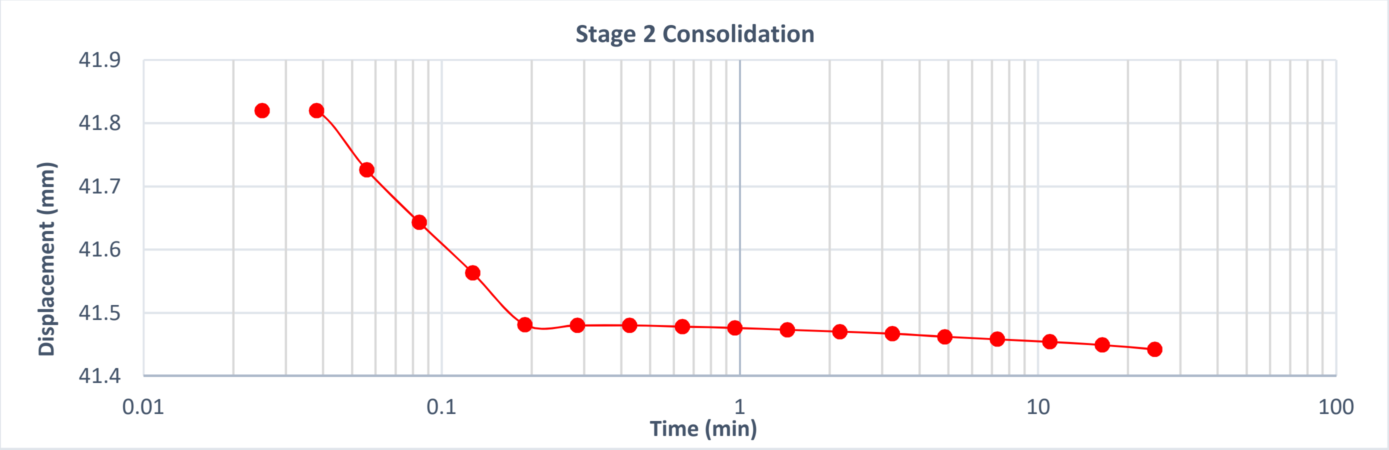
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 5**





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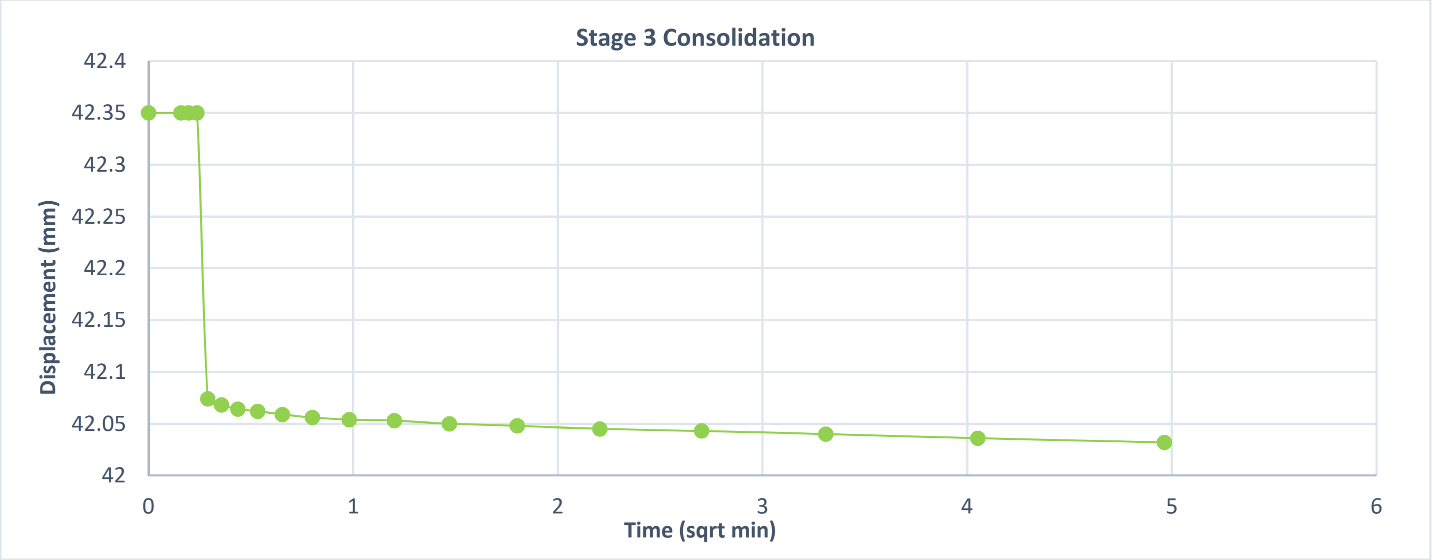
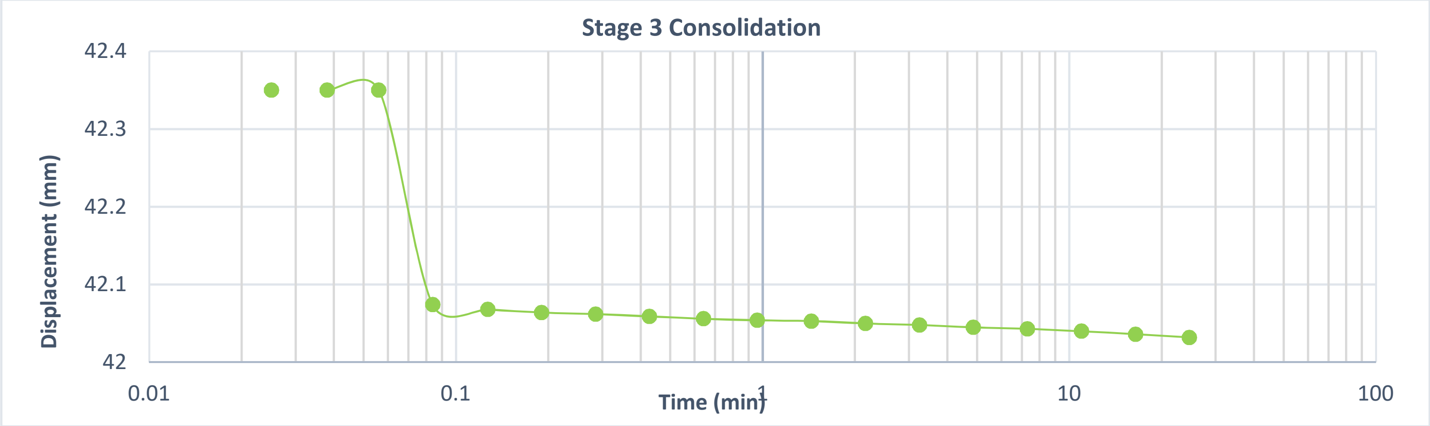
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatior**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 6**





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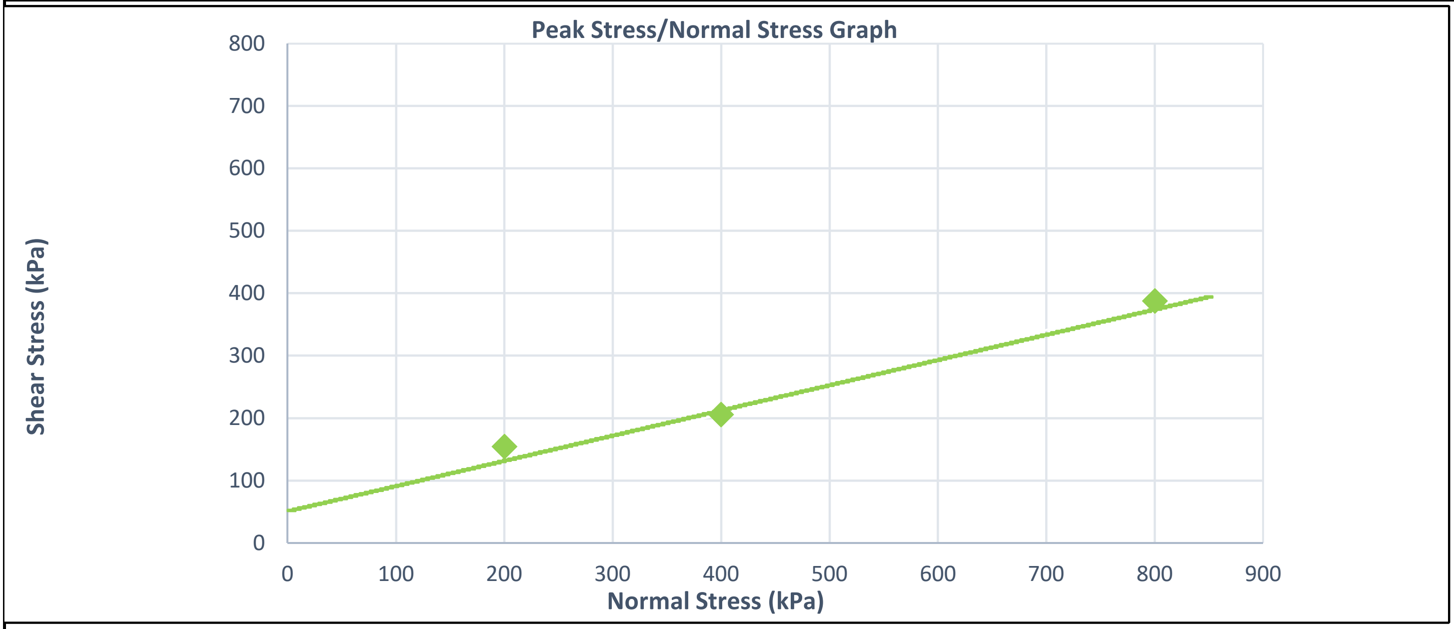
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5479A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G Shear-31**		**Page 1**

Borehole: STX1904G Sample ID: Shear-31 Depth From: 46.97 Depth To: 47.16

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	13/11/2019	Wet Density	2.24	2.36	2.28
Sampled By:	Cardno	Dry Density	2.14	2.25	2.18
Sampling Method:	AS 1289 1.2.1	Moisture (%)	4.9	4.9	4.9
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Interbedded Sandstone and Siltstone	Peak Shear Stress (kPa)	154	206	388
Sample Type:	Core	Primary Consolidation (mm)	0.2	0.1	0.1
Lab Ref Number:	19-5479A	Strain Rate (mm/min)	0.114	0.111	0.100



Effective Cohesion C' (kPa):	50.0
Effective Angle of Friction ϕ' (Degrees):	22.0
Failure Criteria:	Peak Shear Stress

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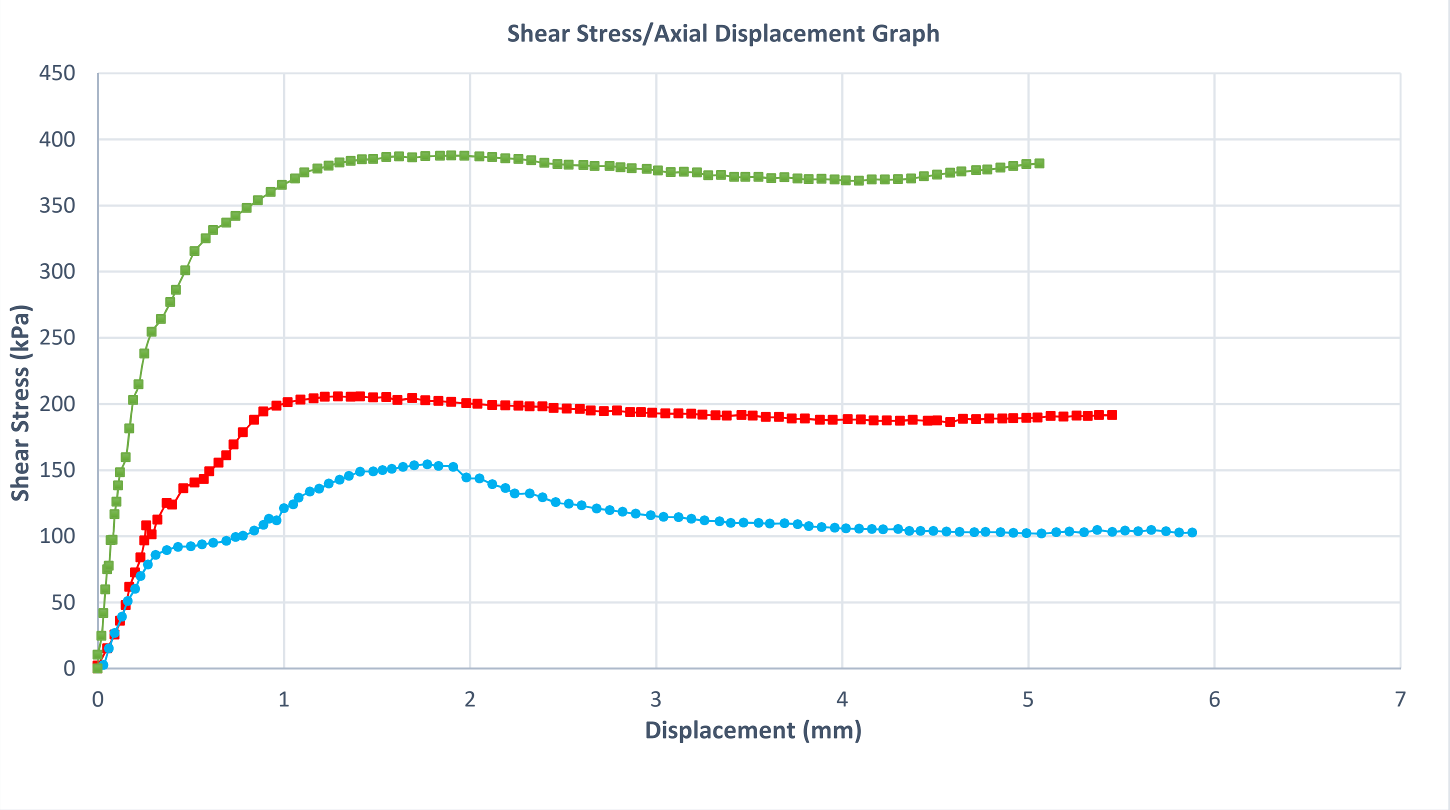
Project Number: **M30863**
Project Name: **CQ Coal Styx Basin Geotechnical Investigatio**
Location: **STX1904G**

Report Number: **19-5479A**
Report Date: **14/11/2019**
Order Number: **-**
Test Method **AS 1289.6.2.2**

Page 2



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	154	1.77	55
2	400	206	1.29	48
3	800	388	1.90	54

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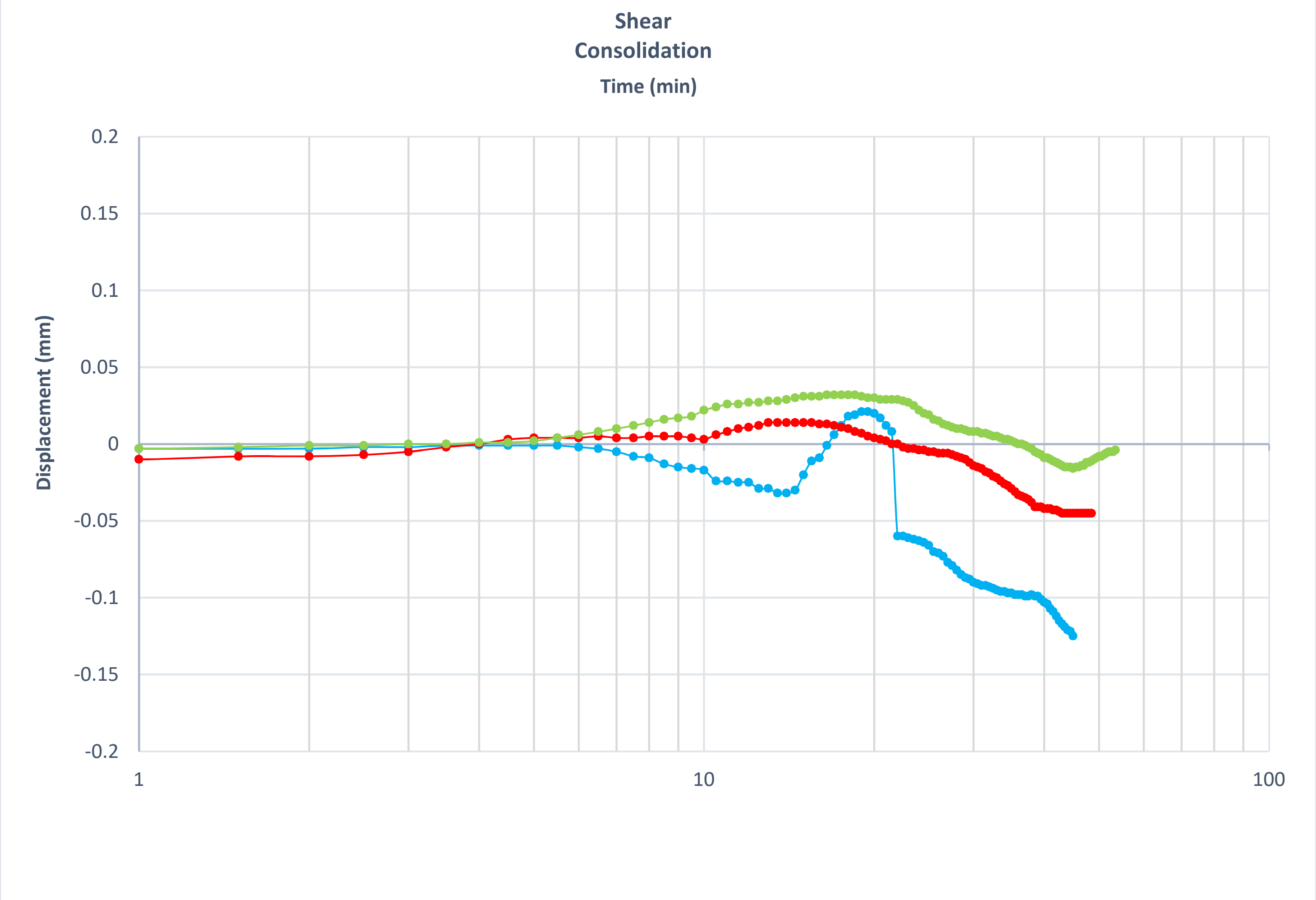
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 3**



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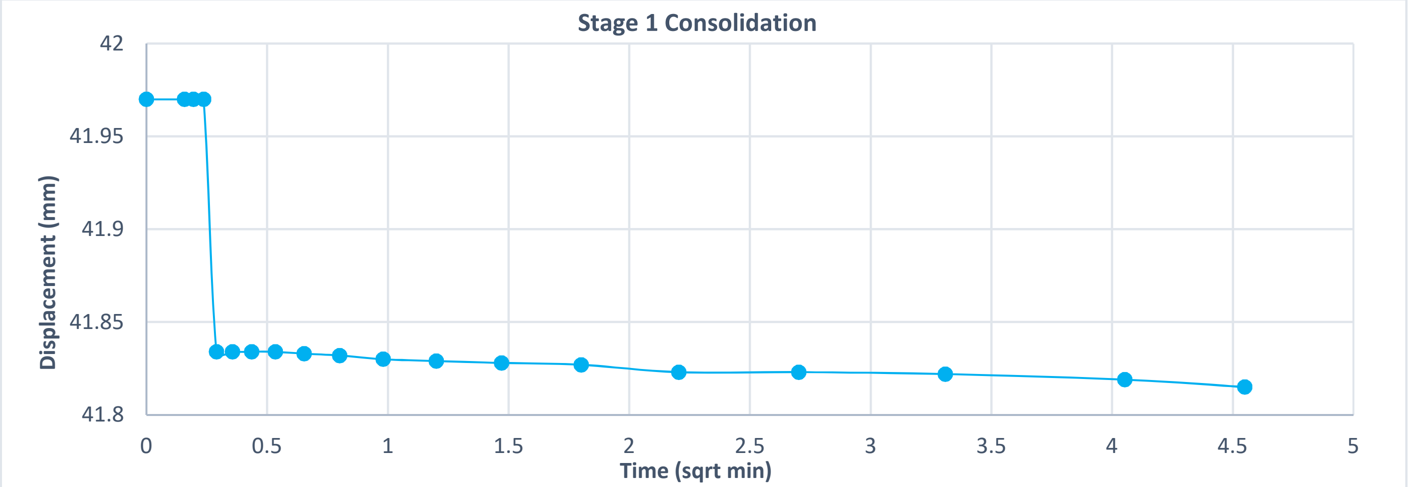
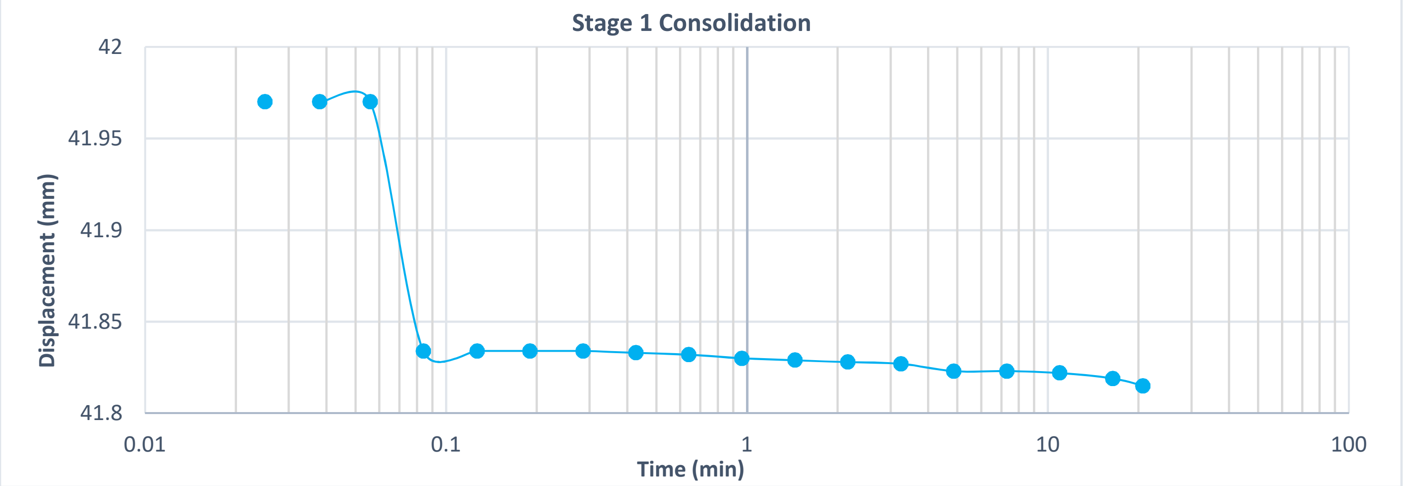
Location:	**STX1904G**		**Page 4**





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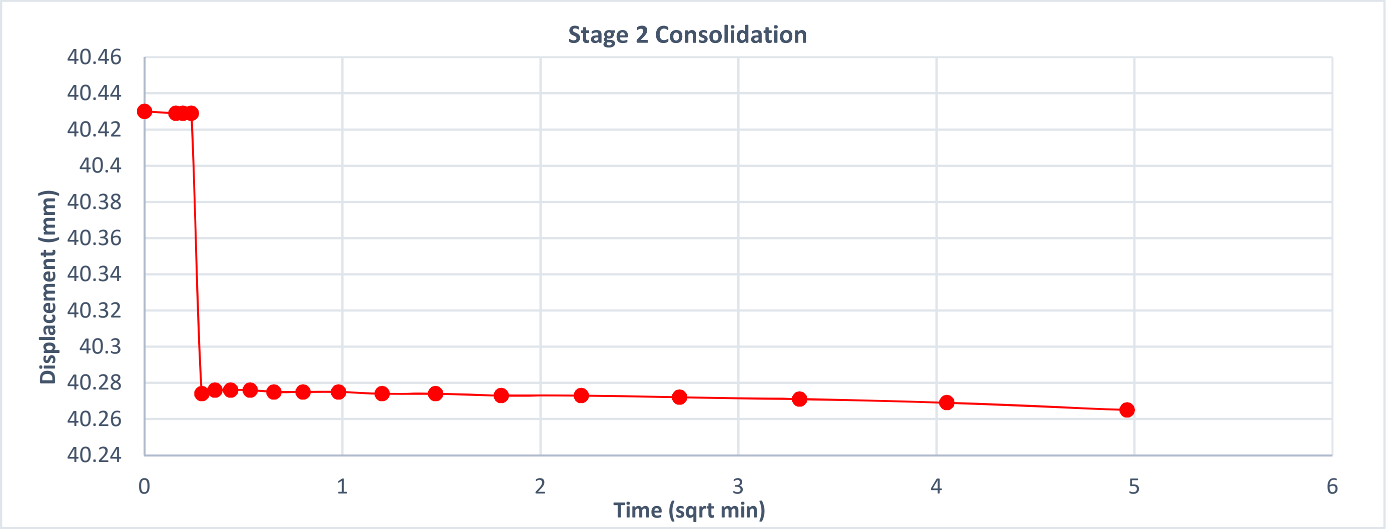
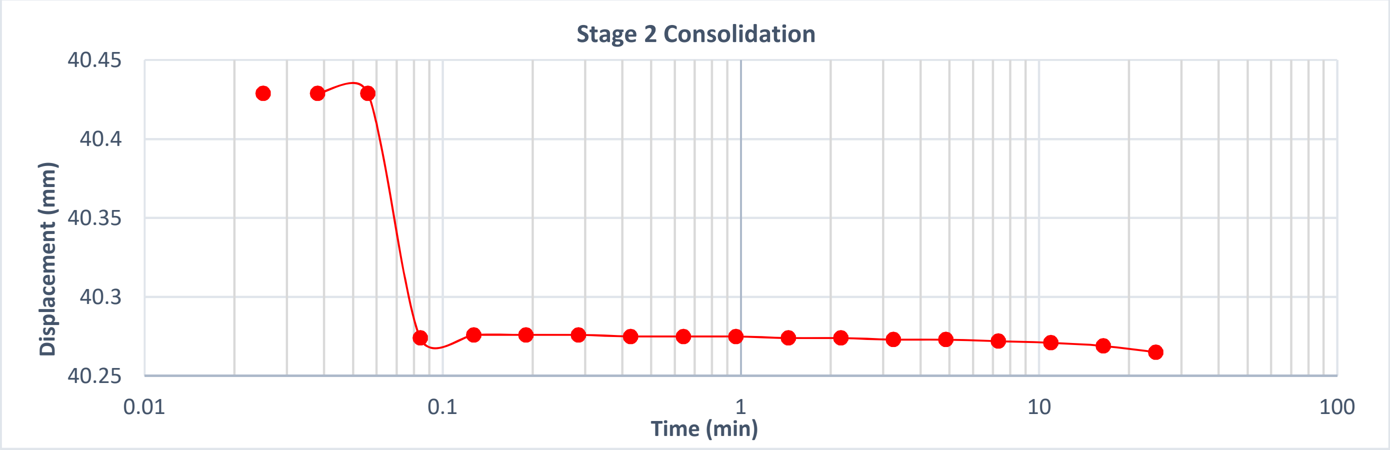
Location:	**STX1904G**		**Page 5**





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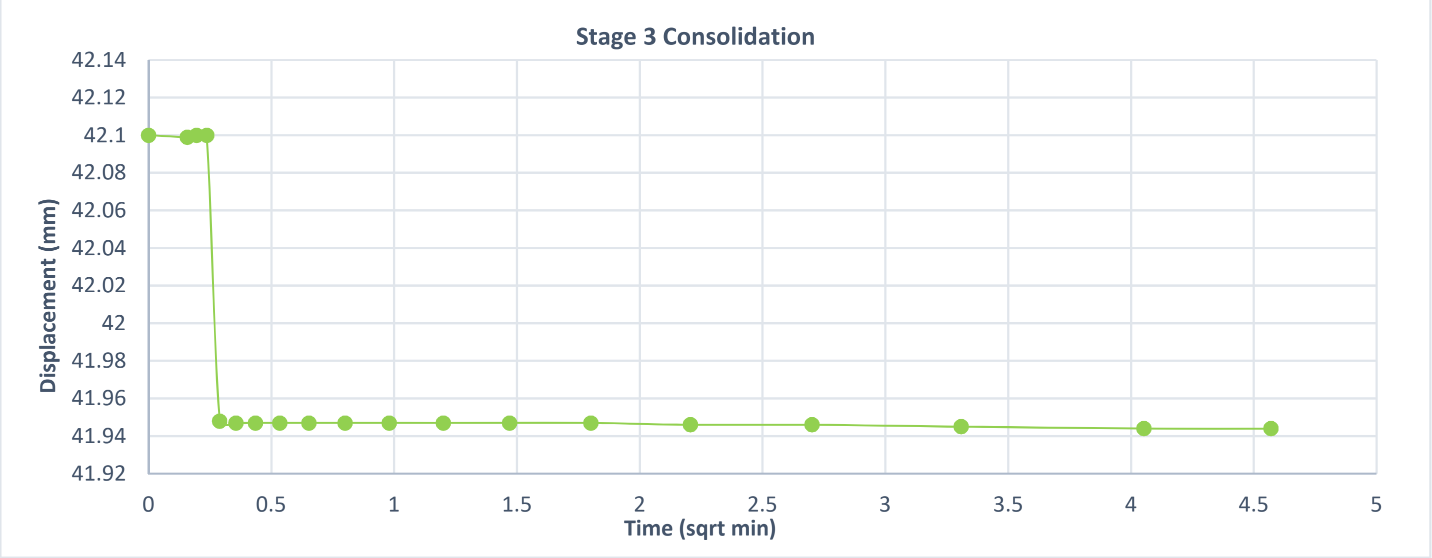
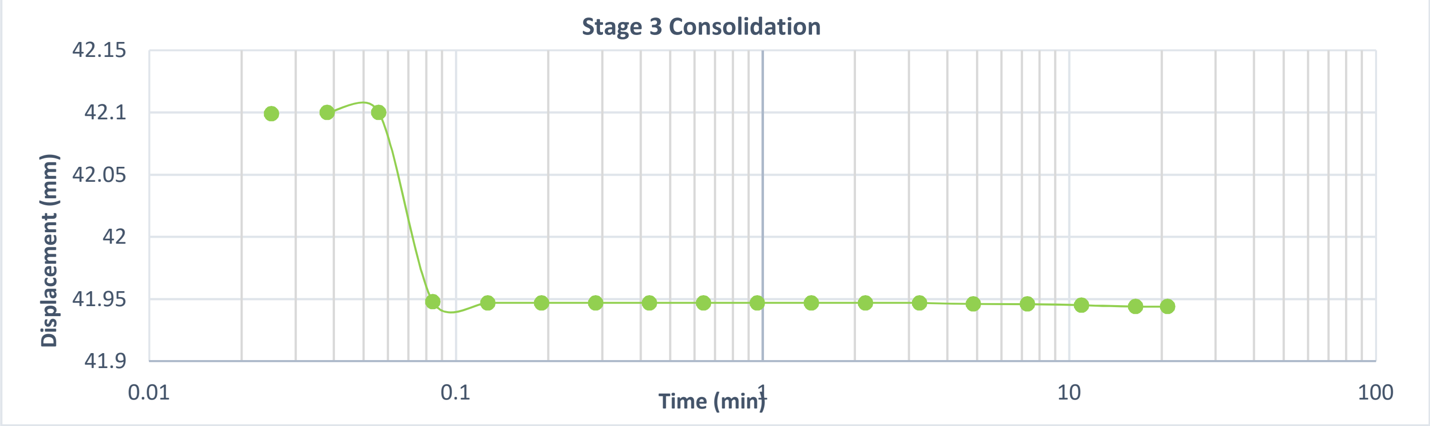
Location:	**STX1904G**		**Page 6**





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Direct Shear on Rock Report

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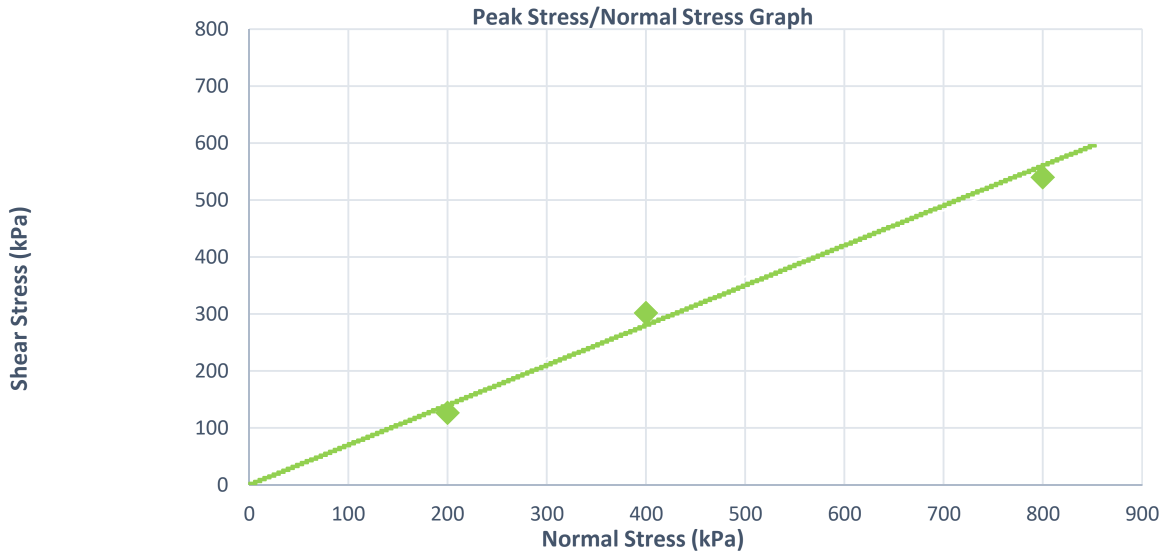
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigati**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G Shear-32**		**Page 1**

Borehole: STX1904G Sample ID: Shear-32 Depth From: 51.80 Depth To: 51.97

Date Sampled:	2/09/2019	Stage No	1	2	3
Date Tested:	13/11/2019	Wet Density	2.37	2.34	2.30
Sampled By:	Cardno	Dry Density	2.26	2.23	2.20
Sampling Method:	AS 1289 1.2.1	Moisture (%)	4.8	5.0	4.9
Moisture Method:	AS 1289.2.1.1	Normal Stress (kPa)	200	400	800
Material Description:	Sandstone	Peak Shear Stress (kPa)	127	302	540
Sample Type:	Core	Primary Consolidation (mm)	0.1	0.1	0.3
Lab Ref Number:	19-5480A	Strain Rate (mm/min)	0.120	0.102	0.095



Effective Cohesion C' (kPa):	0.0
Effective Angle of Friction ϕ' (Degrees):	35.0
Failure Criteria:	Peak Shear Stress

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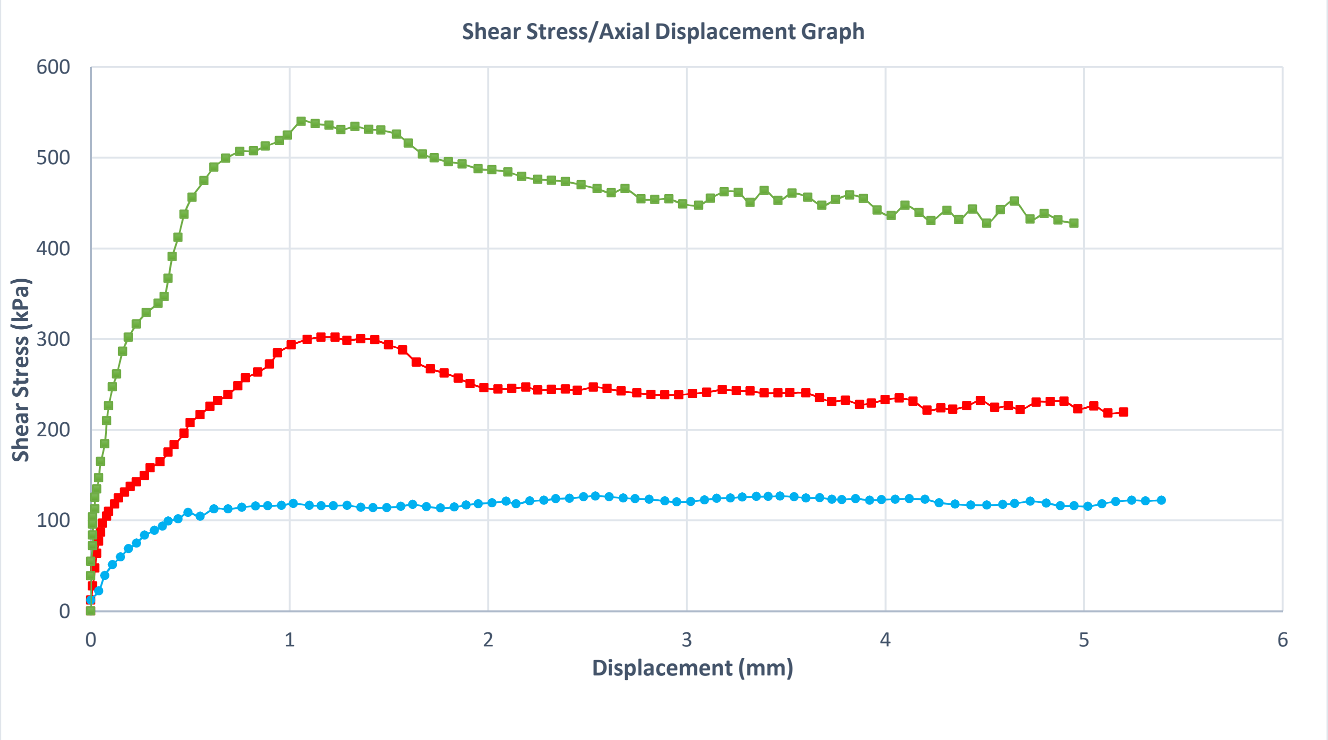
Location:	**STX1904G**		**Page 2**



Failure Details

Stage No	Normal Stress (kPa)	Peak Shear Stress (kPa)	Displacement at Failure (mm)	Test Duration (min)
1	200	127	2.54	45
2	400	302	1.16	58
3	800	540	1.06	60

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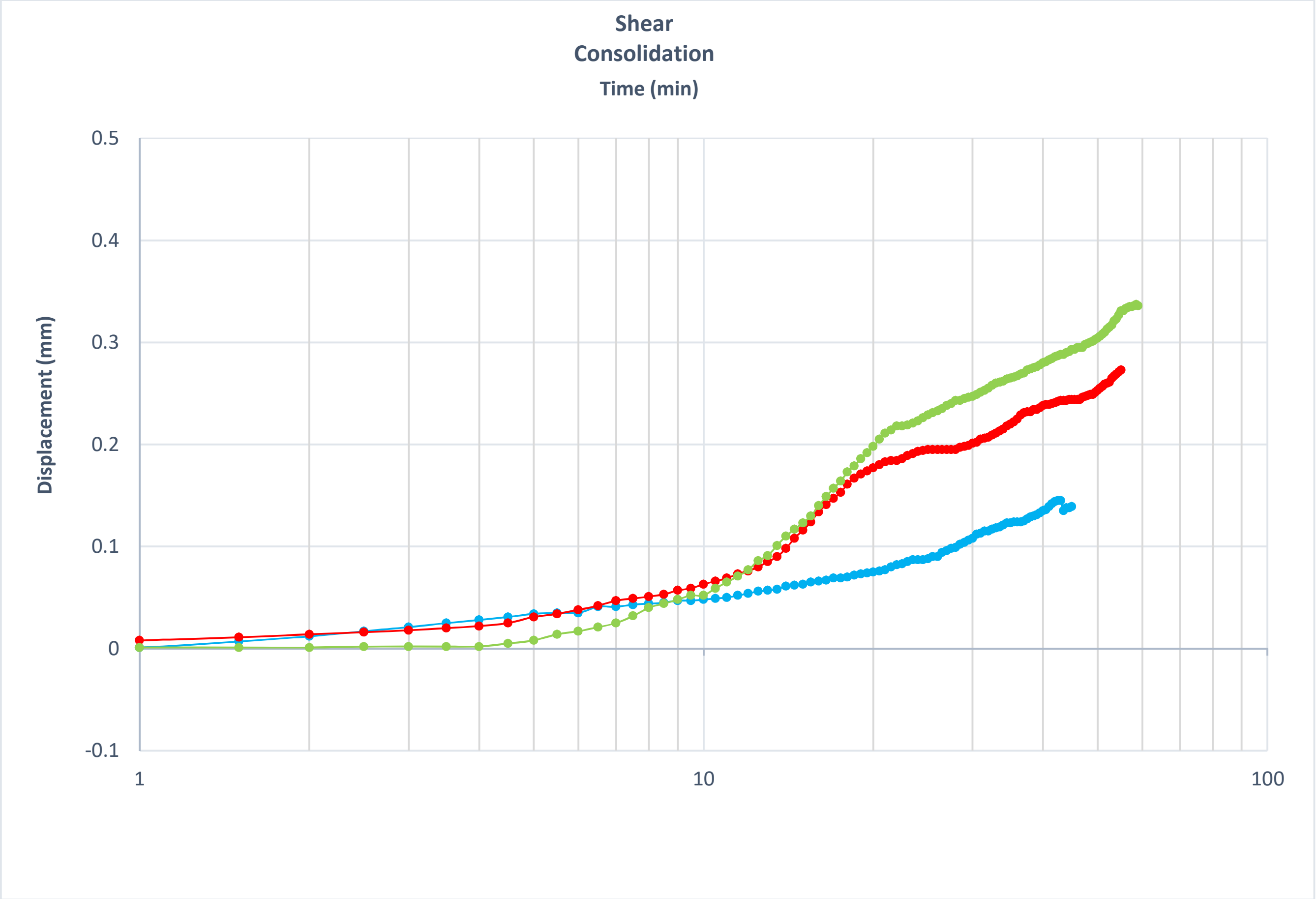

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Report Number: **19-5480A**
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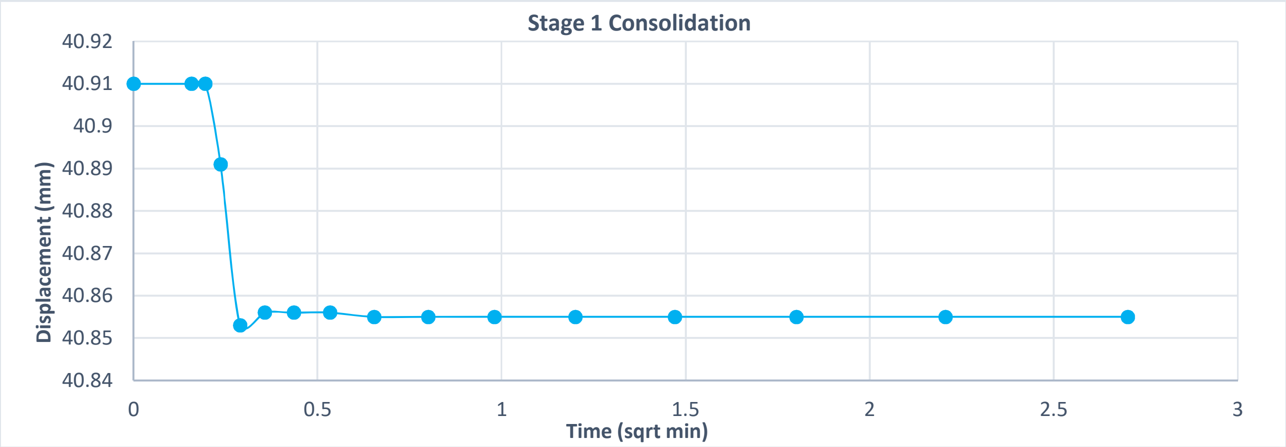
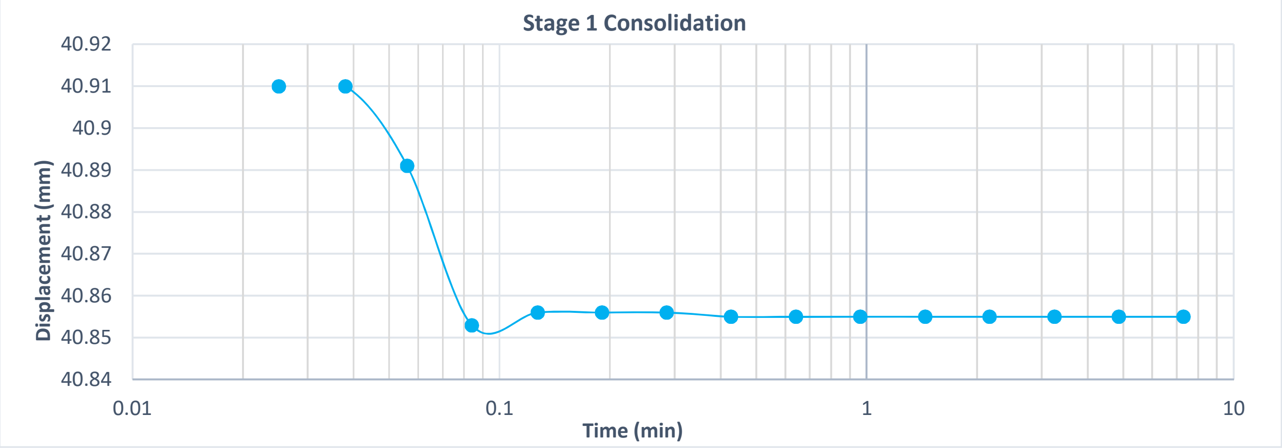
Order Number: **-**
Test Method **AS 1289.6.2.2**

Page 4





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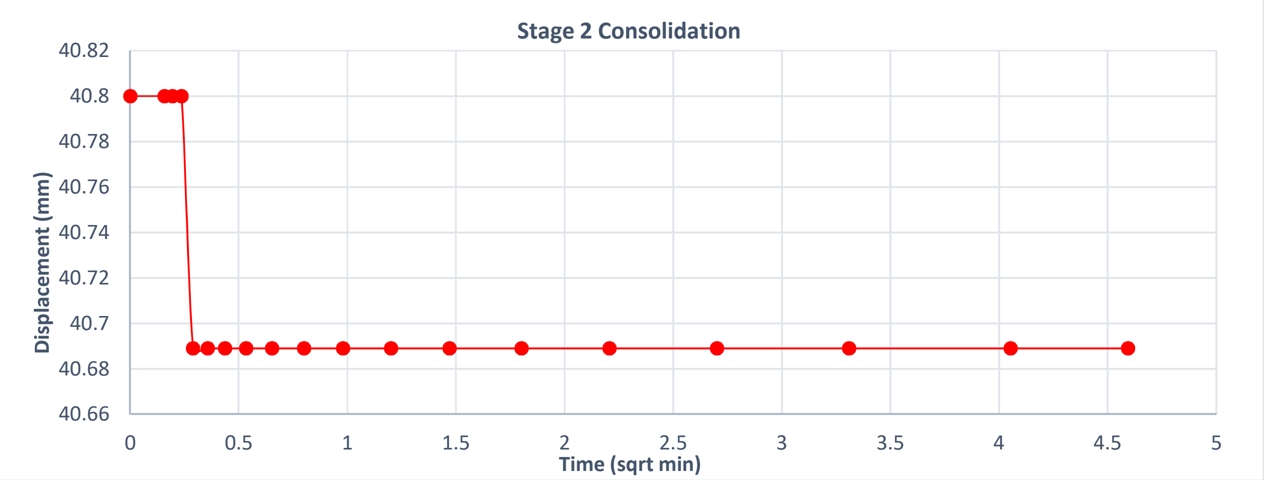
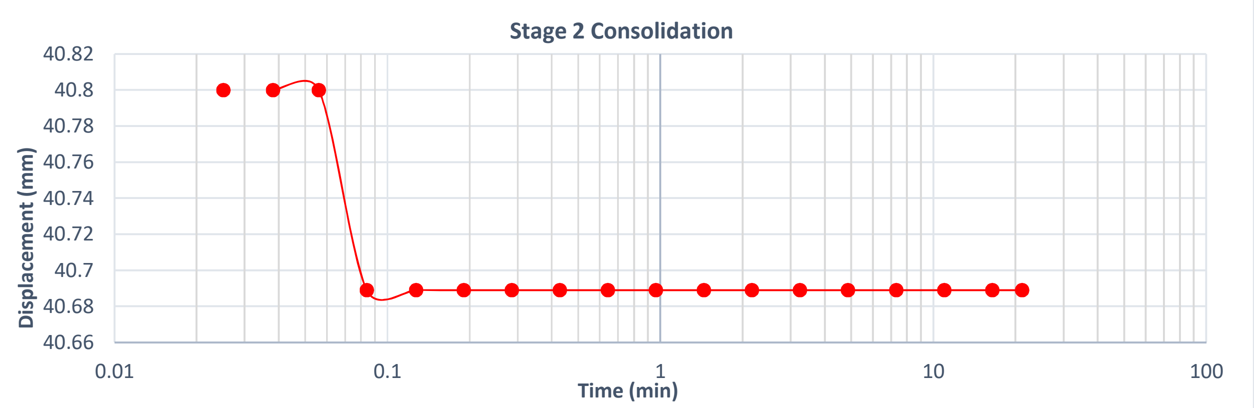
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5480A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 5**





Sample/s supplied by Cardno Note: Graph not to scale

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APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager

NATA Accreditation Number

910 Mackay Laboratory

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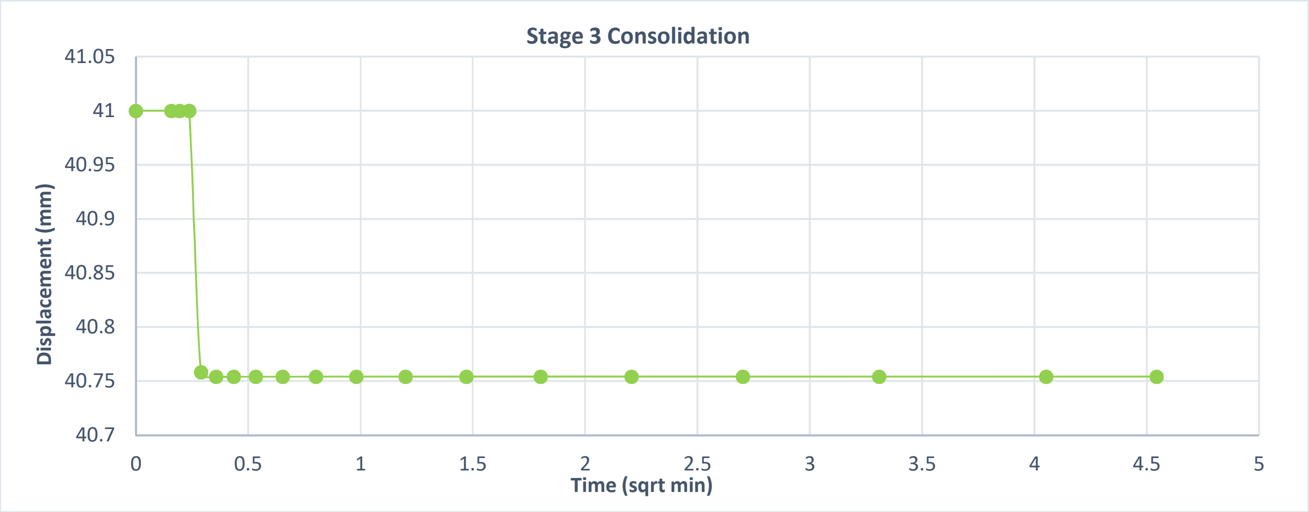
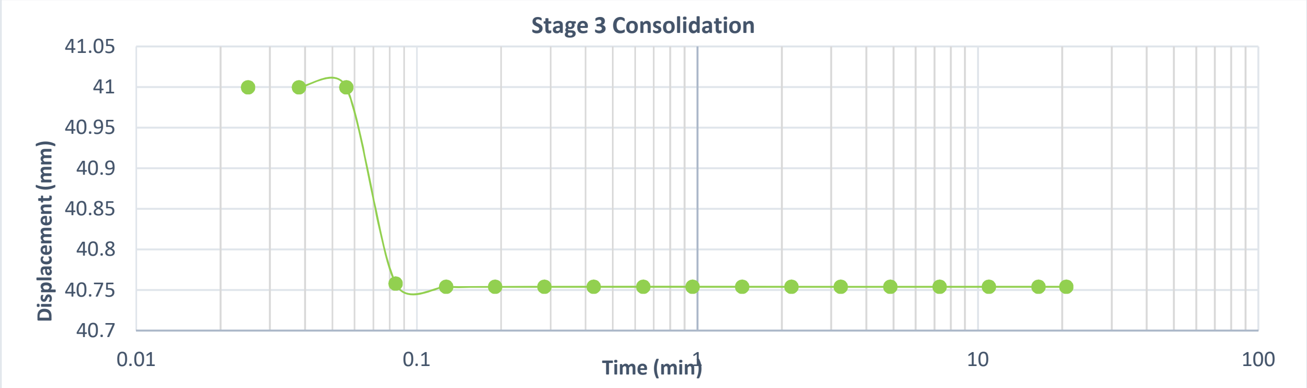
Direct Shear on Rock Report

Client:	**Central Queensland Coal**	Report Number:	**19-5480A**
Address:	**Level 17, 240 Queen Street, Brisbane, QLD**	Report Date:	**14/11/2019**
Project Number:	**M30863**	Order Number:	**-**
Project Name:	**CQ Coal Styx Basin Geotechnical Investigatio**	Test Method	**AS 1289.6.2.2**
Location:	**STX1904G**		**Page 6**





Sample/s supplied by Cardno Note: Graph not to scale

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APPROVED SIGNATORY

D. Hoskins

Derren Hoskins - Lab Manager

NATA Accreditation Number

910 Mackay Laboratory

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5456A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	24-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	25-Oct-19

Borehole No.	STX1904G
Client sample number	ucs-8
Corrected Depth from (m)	23.32
Corrected Depth to (m)	23.52
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	carbonaceous siltstone
Mass of sample (g)	942.4
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	162.4
Length / Diameter ratio (ratio 2.5 to 3)	2.7
Cross sectional area (mm^2)	2913
Uniaxial Comp. Strength (MPa)	**4.6**
Number of specimens in sample	1
Moisture content (%)	5.7
Density at as received moisture content (t/m^3)	1.99
Loading rate (N/min)	2500
Time to failure (min)	5.29
Max. applied load (kN)	13.5
Dominant structural features with respect to core axis  (e) Tensile dominated	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5456A
Date of Issue	25-Oct-19

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Authorised Signatory

A. J. Williams

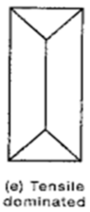
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** 19-5459A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 24-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

Borehole No.		STX1904G
Client sample number		ucs-11
Corrected Depth from (m)		25.44
Corrected Depth to (m)		25.63
Stratigraphic horizon		-
Orientation of core axis		Vertical
Lithological description		siltstone
Mass of sample (g)		1042.1
Average sample diameter (mm)		60.8
Diameter variation > 0.3mm?		No
Average height (mm)		161.7
Length / Diameter ratio (ratio 2.5 to 3)		2.7
Cross sectional area (mm^2)		2907
Uniaxial Comp. Strength (MPa)		**3.3**
Number of specimens in sample		1
Moisture content (%)		5.4
Density at as received moisture content (t/m^3)		2.22
Loading rate (N/min)		1250
Time to failure (min)		7.43
Max. applied load (kN)		9.5
Dominant structural features with respect to core axis  	Before 	After 
Secant Young's Modulus (GPa)		**N/A**
Corrected Poisson's Ratio		**N/A**
Remarks		

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Had a natural crack along a lamination that was glued prior to test.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5459A
Date of Issue	25-Oct-19

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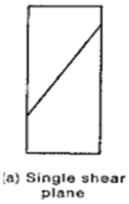
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5460A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	24-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	25-Oct-19

Borehole No.	STX1904G
Client sample number	ucs-12
Corrected Depth from (m)	27.64
Corrected Depth to (m)	27.79
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	carbonate intrusion
Mass of sample (g)	1052.3
Average sample diameter (mm)	60.8
Diameter variation > 0.3mm?	No
Average height (mm)	131.7
Length / Diameter ratio (ratio 2.5 to 3)	2.2
Cross sectional area (mm^2)	2903
Uniaxial Comp. Strength (MPa)	**13.8**
Number of specimens in sample	1
Moisture content (%)	2.3
Density at as received moisture content (t/m^3)	2.75
Loading rate (N/min)	5000
Time to failure (min)	8.02
Max. applied load (kN)	40.0
Dominant structural features with respect to core axis  (a) Single shear plane	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens:	Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.
Compression machine:	Shimadzu U.E.H. -50 S/N 79097
Variations from standard:	Time to failure less than standard 10 to 15 minutes. Height to diameter ratio less than 2.5 due to core structural features.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5460A
Date of Issue	25-Oct-19

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GEO-QF-GR71 Ga
Issue: 1 Rev: 0
(8/17)

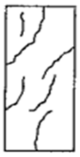
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** 19-5463A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 24-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

Borehole No.	STX1904G
Client sample number	ucs-15
Corrected Depth from (m)	29.5
Corrected Depth to (m)	29.7
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	siltstone
Mass of sample (g)	1156.9
Average sample diameter (mm)	60.8
Diameter variation > 0.3mm?	No
Average height (mm)	160.1
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2903
Uniaxial Comp. Strength (MPa)	**4.3**
Number of specimens in sample	1
Moisture content (%)	3
Density at as received moisture content (t/m^3)	2.49
Loading rate (N/min)	2500
Time to failure (min)	5.01
Max. applied load (kN)	12.5
Dominant structural features with respect to core axis  (c) Mixed mode	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Certificate No.	19-5463A
Date of Issue	25-Oct-19

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** 19-5470A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 24-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

Borehole No.	STX1904G
Client sample number	ucs-22
Corrected Depth from (m)	40.89
Corrected Depth to (m)	41.06
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	siltstone
Mass of sample (g)	1158.6
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	159.4
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2913
Uniaxial Comp. Strength (MPa)	**30.9**
Number of specimens in sample	1
Moisture content (%)	1.8
Density at as received moisture content (t/m^3)	2.50
Loading rate (N/min)	12500
Time to failure (min)	7.16
Max. applied load (kN)	90.0
Dominant structural features with respect to core axis  	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

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Certificate No. 19-5470A
Date of Issue 25-Oct-19

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GEO-QF-GR71 Ga
Issue: 1 Rev: 0
(8/17)

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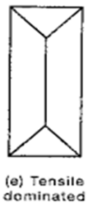
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH
ROCK STRENGTH GREATER THAN 50 MPa

Sheet 1 of 1 | Mackay Laboratory

CLIENT: Central Queensland Coal | **JOB NO.:** M30863 | **LAB REF NO:** 19-5474A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation | **SAMPLED BY:** Cardno | **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin | **TESTED BY:** MS | **TEST DATE:** 24-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.1 (2007) | **CHECKED BY:** AW | **CHECK DATE:** 25-Oct-19

Borehole No.		STX1904G
Client sample number		ucs-26
Corrected Depth from (m)		43.6
Corrected Depth to (m)		43.8
Stratigraphic horizon		-
Orientation of core axis		Vertical
Lithological description		sandstone
Mass of sample (g)		1263.2
Average sample diameter (mm)		61
Diameter variation > 0.3mm?		No
Average height (mm)		161
Length / Diameter ratio (ratio 2.5 to 3)		2.6
Cross sectional area (mm^2)		2922
Uniaxial Comp. Strength (MPa)		**53.4**
Number of specimens in sample		1
Moisture content (%)		1
Density at as received moisture content (t/m^3)		2.68
Loading rate (N/min)		12500
Time to failure (min)		11.17
Max. applied load (kN)		156.2
Dominant structural features with respect to core axis  (e) Tensile dominated	Before 	After 
Secant Young's Modulus (GPa)		**N/A**
Corrected Poisson's Ratio		**N/A**
Remarks		

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard:

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5474A
Date of Issue	25-Oct-19

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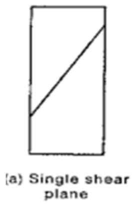
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation
LOCATION: Styx Basin
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013)
JOB NO.: M30863
LAB REF NO: 19-5482A
SAMPLED BY: Cardno
SAMPLE DATE: 02-Sep-19
TESTED BY: MS
TEST DATE: 24-Oct-19
CHECKED BY: AW
CHECK DATE: 25-Oct-19

Borehole No.	STX1904G	
Client sample number	ucs-34	
Corrected Depth from (m)	52.64	
Corrected Depth to (m)	52.82	
Stratigraphic horizon	-	
Orientation of core axis	Vertical	
Lithological description	siltstone	
Mass of sample (g)	1113.9	
Average sample diameter (mm)	60.9	
Diameter variation > 0.3mm?	No	
Average height (mm)	160.1	
Length / Diameter ratio (ratio 2.5 to 3)	2.6	
Cross sectional area (mm^2)	2913	
Uniaxial Comp. Strength (MPa)	**8.8**	
Number of specimens in sample	1	
Moisture content (%)	2.5	
Density at as received moisture content (t/m^3)	2.39	
Loading rate (N/min)	5000	
Time to failure (min)	5.03	
Max. applied load (kN)	25.5	
Dominant structural features with respect to core axis 	Before 	After 
Secant Young's Modulus (GPa)	**N/A**	
Corrected Poisson's Ratio	**N/A**	
Remarks		

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5482A
Date of Issue	25-Oct-19

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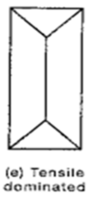
71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5485A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	24-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	25-Oct-19

Borehole No.	STX1904G
Client sample number	ucs-37
Corrected Depth from (m)	55.62
Corrected Depth to (m)	55.79
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	sandstone
Mass of sample (g)	1121.4
Average sample diameter (mm)	60.9
Diameter variation > 0.3mm?	No
Average height (mm)	158.5
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2913
Uniaxial Comp. Strength (MPa)	**13.9**
Number of specimens in sample	1
Moisture content (%)	2.5
Density at as received moisture content (t/m^3)	2.43
Loading rate (N/min)	5000
Time to failure (min)	8.12
Max. applied load (kN)	40.5
Dominant structural features with respect to core axis  	Before  After 
Secant Young's Modulus (GPa)	**N/A**
Corrected Poisson's Ratio	**N/A**
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

Accredited No.	910
Certificate No.	19-5485A
Date of Issue	25-Oct-19

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71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** 19-5498A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 24-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

Borehole No.		STX1904G
Client sample number		ucs-50
Corrected Depth from (m)		77.63
Corrected Depth to (m)		77.88
Stratigraphic horizon		-
Orientation of core axis		Vertical
Lithological description		siltstone
Mass of sample (g)		1126.6
Average sample diameter (mm)		60.9
Diameter variation > 0.3mm?		No
Average height (mm)		158.7
Length / Diameter ratio (ratio 2.5 to 3)		2.6
Cross sectional area (mm^2)		2913
Uniaxial Comp. Strength (MPa)		**13.7**
Number of specimens in sample		1
Moisture content (%)		3.3
Density at as received moisture content (t/m^3)		2.44
Loading rate (N/min)		5000
Time to failure (min)		9.51
Max. applied load (kN)		40.0
Dominant structural features with respect to core axis 	Before 	After 
Secant Young's Modulus (GPa)		**N/A**
Corrected Poisson's Ratio		**N/A**
Remarks		

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

Accredited No.	910
Certificate No.	19-5498A
Date of Issue	25-Oct-19

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Authorised Signatory

A. J. Williams

GEO-QF-GR71 Ga
Issue: 1 Rev: 0
(8/17)

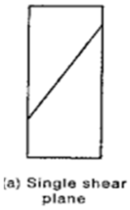
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** 19-5499A
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 24-Oct-19
TEST PROCEDURES: AS 4133.1.1.1; 4.2.2 (2013) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

<table>
<tr><td colspan="2">Borehole No.</td><td>STX1904G</td></tr>
<tr><td colspan="2">Client sample number</td><td>ucs-51</td></tr>
<tr><td colspan="2">Corrected Depth from (m)</td><td>85.16</td></tr>
<tr><td colspan="2">Corrected Depth to (m)</td><td>85.36</td></tr>
<tr><td colspan="2">Stratigraphic horizon</td><td>-</td></tr>
<tr><td colspan="2">Orientation of core axis</td><td>Vertical</td></tr>
<tr><td colspan="2">Lithological description</td><td>siltstone</td></tr>
<tr><td colspan="2">Mass of sample (g)</td><td>1145.1</td></tr>
<tr><td colspan="2">Average sample diameter (mm)</td><td>60.7</td></tr>
<tr><td colspan="2">Diameter variation > 0.3mm?</td><td>No</td></tr>
<tr><td colspan="2">Average height (mm)</td><td>160.3</td></tr>
<tr><td colspan="2">Length / Diameter ratio (ratio 2.5 to 3)</td><td>2.6</td></tr>
<tr><td colspan="2">Cross sectional area (mm^2)</td><td>2897</td></tr>
<tr><td colspan="2">Uniaxial Comp. Strength (MPa)</td><td>**1.7**</td></tr>
<tr><td colspan="2">Number of specimens in sample</td><td>1</td></tr>
<tr><td colspan="2">Moisture content (%)</td><td>3.2</td></tr>
<tr><td colspan="2">Density at as received moisture content (t/m^3)</td><td>2.47</td></tr>
<tr><td colspan="2">Loading rate (N/min)</td><td>1250</td></tr>
<tr><td colspan="2">Time to failure (min)</td><td>4.03</td></tr>
<tr><td colspan="2">Max. applied load (kN)</td><td>5.0</td></tr>
<tr><td>Dominant structural features with respect to core axis

(a) Single shear plane</td><td>Before
</td><td>After
</td></tr>
<tr><td colspan="2">Secant Young's Modulus (GPa)</td><td>**N/A**</td></tr>
<tr><td colspan="2">Corrected Poisson's Ratio</td><td>**N/A**</td></tr>
<tr><td>Remarks</td><td colspan="2"></td></tr>
</table>

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory.
Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

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Date of Issue	25-Oct-19

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Authorised Signatory

A. J. Williams

GEO-QF-GR71 Ga
Issue: 1 Rev: 0
(8/17)

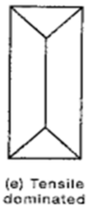
CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON DETERMINATION OF UNIAXIAL COMPRESSIVE STRENGTH ROCK STRENGTH LESS THAN 50 MPa

Sheet 1 of 1 Mackay Laboratory

CLIENT:	Central Queensland Coal	**JOB NO.:**	M30863	**LAB REF NO:**	19-5506A
ADDRESS:	Level 17, 240 Queen Street, Brisbane Qld 4000				
PROJECT:	CQ Coal Styx Basin Geotechnical Investigation	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	02-Sep-19
LOCATION:	Styx Basin	**TESTED BY:**	MS	**TEST DATE:**	24-Oct-19
TEST PROCEDURES:	AS 4133.1.1.1; 4.2.2 (2013)	**CHECKED BY:**	AW	**CHECK DATE:**	25-Oct-19

Borehole No.	STX1904G
Client sample number	ucs-58
Corrected Depth from (m)	100.54
Corrected Depth to (m)	100.75
Stratigraphic horizon	-
Orientation of core axis	Vertical
Lithological description	interlaminated sandstone and siltstone
Mass of sample (g)	1186.7
Average sample diameter (mm)	60.8
Diameter variation > 0.3mm?	No
Average height (mm)	160.2
Length / Diameter ratio (ratio 2.5 to 3)	2.6
Cross sectional area (mm^2)	2907
Uniaxial Comp. Strength (MPa)	**27.5**
Number of specimens in sample	1
Moisture content (%)	1.8
Density at as received moisture content (t/m^3)	2.55
Loading rate (N/min)	12500
Time to failure (min)	6.33
Max. applied load (kN)	80.0
Dominant structural features with respect to core axis 	Before  After 
Secant Young's Modulus (GPa)	**N/A**
	N/A
Remarks	

Storage History of specimens: Drilled by client, sampled by Cardno, wrapped and sealed, transported to Mackay laboratory. Stored at room temperature and humidity and tested at as received moisture content.

Compression machine: Shimadzu U.E.H. -50 S/N 79097

Variations from standard: Time to failure less than standard 10 to 15 minutes.

Young's Modulus method: N/A
Poisson's Ratio method: N/A

NATA

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Certificate No.	19-5506A
Date of Issue	25-Oct-19

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CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON POINT LOAD STRENGTH INDEX

Sheet 1 of 2 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 23-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5455A	STX1904G	pl-7	22.52	22.62	Diametral	61	0.30	0.09	VERY LOW
19-5455B	STX1904G	pl-7	22.52	22.62	Axial	32	0.70	0.28	LOW
19-5457A	STX1904G	pl-9	24.00	24.12	Diametral	61	0.40	0.12	LOW
19-5457B	STX1904G	pl-9	24.00	24.12	Axial	33	0.40	0.16	LOW
19-5458A	STX1904G	pl-10	25.29	25.44	Diametral	61	0.02	0.01	EXTREMELY LOW
19-5458B	STX1904G	pl-10	25.29	25.44	Axial	32	0.50	0.20	LOW
19-5461A	STX1904G	pl-13	28.12	28.25	Diametral	61	0.60	0.18	LOW
19-5461B	STX1904G	pl-13	28.12	28.25	Axial	32	0.60	0.24	LOW
19-5462A	STX1904G	pl-14	28.62	28.71	Diametral	61	0.20	0.06	VERY LOW
19-5462B	STX1904G	pl-14	28.62	28.71	Axial	32	1.20	0.49	MEDIUM
19-5464A	STX1904G	pl-16	33.23	33.34	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5464B	STX1904G	pl-16	33.23	33.34	Axial	28	0.80	0.36	MEDIUM
19-5465A	STX1904G	pl-17	33.37	33.47	Diametral	61	0.60	0.18	LOW
19-5465B	STX1904G	pl-17	33.37	33.47	Axial	32	0.50	0.20	LOW
19-5467A	STX1904G	pl-19	35.95	36.07	Diametral	61	0.20	0.06	VERY LOW
19-5467B	STX1904G	pl-19	35.95	36.07	Axial	33	0.40	0.16	LOW
19-5468A	STX1904G	pl-20	39.64	39.78	Diametral	61	0.20	0.06	VERY LOW
19-5468B	STX1904G	pl-20	39.64	39.78	Axial	33	0.80	0.32	MEDIUM
19-5469A	STX1904G	pl-21	40.33	40.48	Diametral	61	1.10	0.32	MEDIUM
19-5469B	STX1904G	pl-21	40.33	40.48	Axial	32	0.70	0.28	LOW
19-5471A	STX1904G	pl-23	41.06	41.18	Diametral	61	1.40	0.41	MEDIUM
19-5471B	STX1904G	pl-23	41.06	41.18	Axial	31	3.50	1.44	HIGH
19-5473A	STX1904G	pl-25	43.47	43.60	Diametral	61	1.60	0.47	MEDIUM
19-5473B	STX1904G	pl-25	43.47	43.60	Axial	32	4.90	1.97	HIGH
19-5475A	STX1904G	pl-27	44.12	44.23	Diametral	61	4.90	1.44	HIGH
19-5475B	STX1904G	pl-27	44.12	44.23	Axial	32	9.30	3.77	VERY HIGH
19-5476A	STX1904G	pl-28	44.50	44.61	Diametral	61	0.50	0.15	LOW
19-5476B	STX1904G	pl-28	44.50	44.61	Axial	34	3.00	1.15	HIGH
19-5477A	STX1904G	pl-29	45.96	46.19	Diametral	61	0.50	0.15	LOW
19-5477B	STX1904G	pl-29	45.96	46.19	Axial	32	0.80	0.32	MEDIUM

Notes: Moisture contents of each specimen was not determined.

NATA

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A. J. Williams

CARDNO (QLD) PTY LTD

71 MAGGIOLO DRIVE MACKAY QLD

REPORT ON POINT LOAD STRENGTH INDEX

Sheet 2 of 2 Mackay Laboratory

CLIENT: Central Queensland Coal **JOB NO.:** M30863 **LAB REF NO:** Refer below
ADDRESS: Level 17, 240 Queen Street, Brisbane Qld 4000
PROJECT: CQ Coal Styx Basin Geotechnical Investigation **SAMPLED BY:** Cardno **SAMPLE DATE:** 02-Sep-19
LOCATION: Styx Basin **TESTED BY:** MS **TEST DATE:** 23-Oct-19
TEST PROCEDURE: AS4133.4.1 (2007) **CHECKED BY:** AW **CHECK DATE:** 25-Oct-19

Lab Ref No	Borehole	Material / Client sample Ref'	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
19-5478A	STX1904G	pl-30	46.78	46.92	Diametral	61	1.00	0.29	LOW
19-5478B	STX1904G	pl-30	46.78	46.92	Axial	31	1.10	0.45	MEDIUM
19-5481A	STX1904G	pl-33	52.37	52.50	Diametral	61	0.06	0.02	EXTREMELY LOW
19-5481B	STX1904G	pl-33	52.37	52.50	Axial	31	0.10	0.04	VERY LOW
19-5483A	STX1904G	pl-35	53.28	53.39	Diametral	61	1.00	0.29	LOW
19-5483B	STX1904G	pl-35	53.28	53.39	Axial	32	1.10	0.44	MEDIUM
19-5484A	STX1904G	pl-36	53.78	53.88	Diametral	62	1.20	0.34	MEDIUM
19-5484B	STX1904G	pl-36	53.78	53.88	Axial	32	2.10	0.84	MEDIUM
19-5486A	STX1904G	pl-38	55.79	55.94	Diametral	61	1.20	0.35	MEDIUM
19-5486B	STX1904G	pl-38	55.79	55.94	Axial	33	2.90	1.15	HIGH
19-5489A	STX1904G	pl-41	61.40	61.56	Diametral	61	0.50	0.15	LOW
19-5489B	STX1904G	pl-41	61.40	61.56	Axial	32	6.30	2.51	HIGH
19-5491A	STX1904G	pl-43	62.78	62.88	Diametral	61	0.60	0.18	LOW
19-5491B	STX1904G	pl-43	62.78	62.88	Axial	32	0.05	0.02	EXTREMELY LOW
19-5493A	STX1904G	pl-45	70.46	70.58	Diametral	61	2.40	0.70	MEDIUM
19-5493B	STX1904G	pl-45	70.46	70.58	Axial	32	4.60	1.85	HIGH
19-5495A	STX1904G	pl-47	71.12	71.24	Diametral	61	1.60	0.47	MEDIUM
19-5495B	STX1904G	pl-47	71.12	71.24	Axial	32	2.20	0.89	MEDIUM
19-5496A	STX1904G	pl-48	75.65	75.78	Diametral	60	0.20	0.06	VERY LOW
19-5496B	STX1904G	pl-48	75.65	75.78	Axial	32	0.60	0.24	LOW
19-5497A	STX1904G	pl-49	76.47	76.60	Diametral	61	0.10	0.03	EXTREMELY LOW
19-5497B	STX1904G	pl-49	76.47	76.60	Axial	31	2.00	0.83	MEDIUM
19-5500A	STX1904G	pl-52	88.40	88.54	Diametral	61	0.01	0.00	EXTREMELY LOW
19-5500B	STX1904G	pl-52	88.40	88.54	Axial	32	1.00	0.40	MEDIUM
19-5501A	STX1904G	pl-53	92.58	92.61	Diametral	61	1.00	0.29	LOW
19-5501B	STX1904G	pl-53	92.58	92.61	Axial	33	1.50	0.60	MEDIUM
19-5503A	STX1904G	pl-55	97.96	98.09	Diametral	61	4.90	1.44	HIGH
19-5503B	STX1904G	pl-55	97.96	98.09	Axial	32	4.80	1.94	HIGH
19-5505A	STX1904G	pl-57	100.42	100.54	Diametral	61	1.80	0.53	MEDIUM
19-5505B	STX1904G	pl-57	100.42	100.54	Axial	32	3.30	1.32	HIGH

Notes: Moisture contents of each specimen was not determined.

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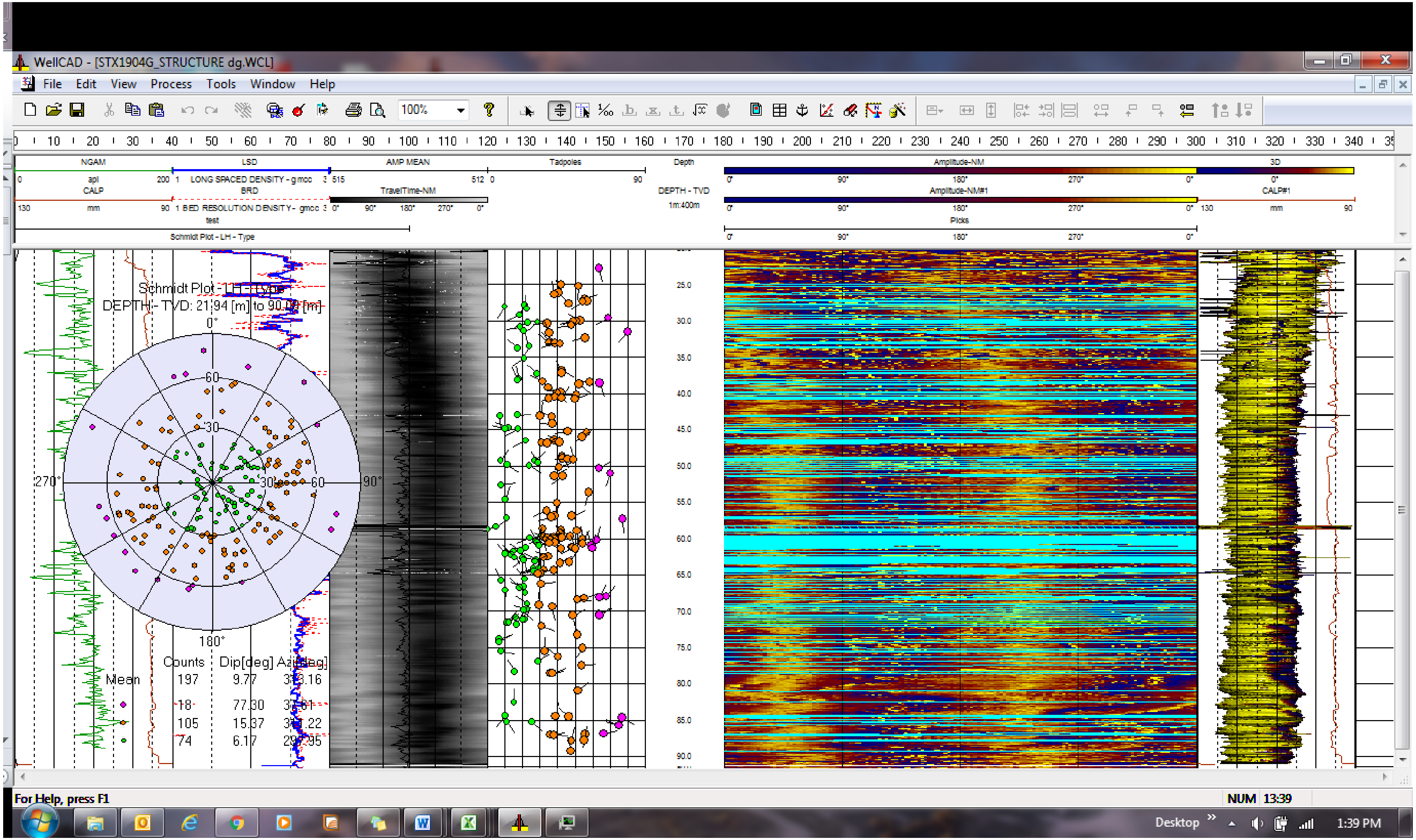
A. J. Williams

APPENDIX

E

ACCOUSTIC TELEVIEWER LOGGING

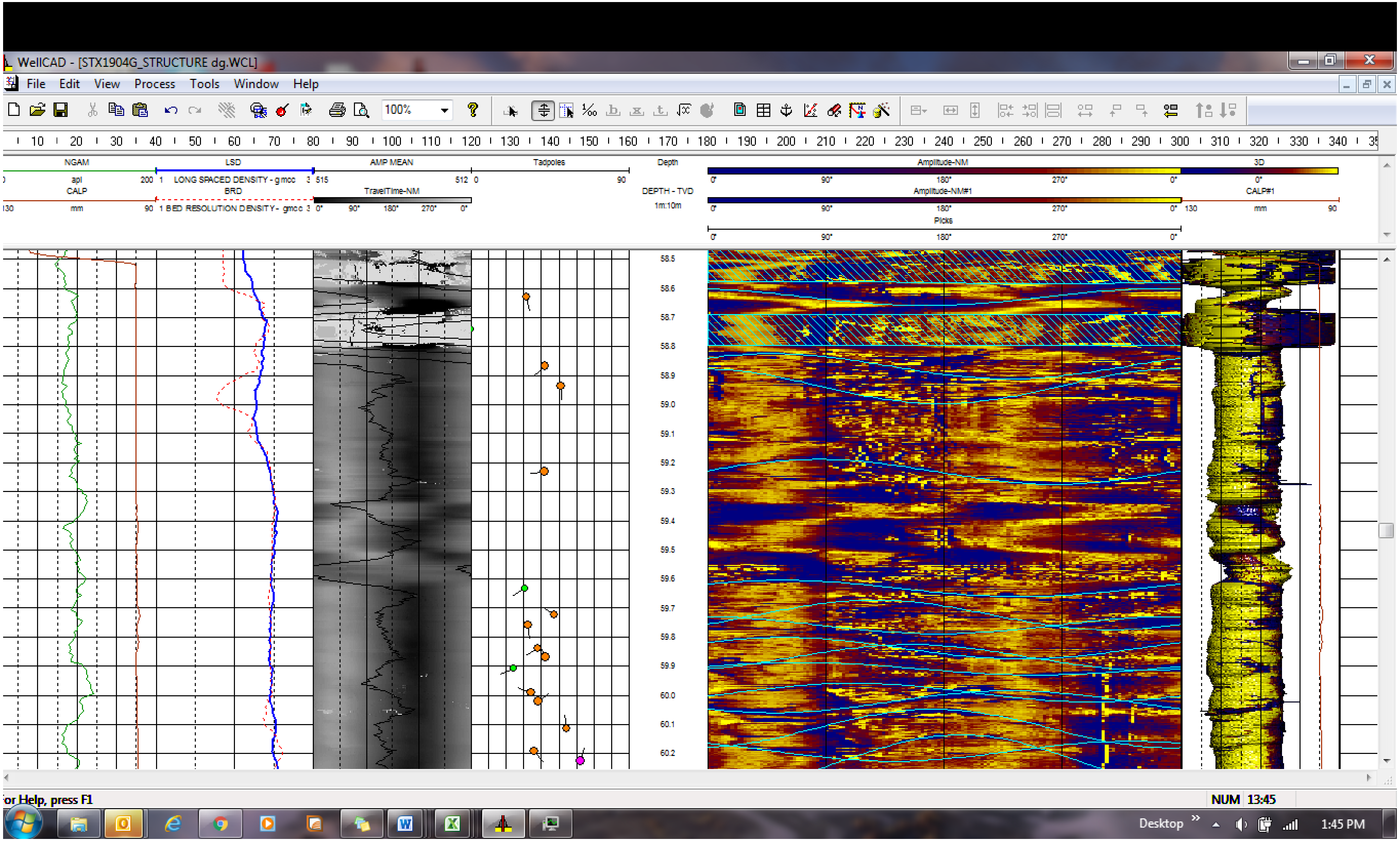


WellCAD - [STX1904G_STRUCTURE dg.WCL]

Schmidt Plot - LH - Type

DEPTH - TVD: 21.94 [m] to 90.09 [m]

	Counts	Dip[deg]	Azi[deg]
Mean	197	9.77	313.16
●	18	77.30	37.61
●	105	15.37	311.22
●	74	6.17	297.95


WellCAD - [STX1904G_STRUCTURE dg.WCL]
File
Edit
View
Process
Tools
Window
Help
100%
NGAM
api
200
CALP
mm
90
LSD
LONG SPACED DENSITY - g/mcc
BRD
BED RESOLUTION DENSITY - g/mcc
AMP MEAN
515
512
TravelTime-NM
Tadpoles
0
90
Depth
DEPTH - TVD
1m:10m
Amplitude-NM
Amplitude-NM#1
Picks
0°
90°
180°
270°
3D
CALP#1
130
mm
90
58.5
58.6
58.7
58.8
58.9
59.0
59.1
59.2
59.3
59.4
59.5
59.6
59.7
59.8
59.9
60.0
60.1
60.2
or Help, press F1
NUM
13:45
Desktop
1:45 PM

Depth	Azimuth	Dip	Aperture	Type	Group Interp
m	deg	deg	mm		
22.75	166.49	63.88	0	2	Fracture
24.98	224.47	42.16	0	3	Fracture
25.18	186.08	52.20	0	3	Fracture
26.13	349.56	40.71	0	3	Fracture
26.36	349.72	38.27	0	3	Fracture
26.90	71.35	55.60	0	3	Intrusion
27.25	247.26	56.99	0	3	Fracture
27.33	235.48	54.57	0	3	Fracture
27.59	315.95	46.50	0	3	Fracture
27.80	211.40	21.52	0	1	Intrusion
28.03	212.92	9.99	0	1	Bedding
28.33	353.67	22.33	0	5	Fracture
29.17	245.49	18.22	0	1	Fracture
29.59	241.75	69.14	0	2	Fracture
29.92	297.30	53.02	0	3	Fracture
29.98	257.28	50.57	0	3	Fracture
30.04	259.73	49.28	0	3	Fracture
30.15	230.66	28.63	0	1	Fracture
30.24	251.15	23.13	0	1	Fracture
30.36	266.90	34.11	0	3	Fracture
30.61	264.24	47.99	0	3	Fracture
30.83	262.04	18.80	0	1	Bedding
31.39	162.94	20.92	0	5	Fracture
31.52	222.85	80.18	0	2	Fracture
31.65	336.84	35.29	0	3	Fracture
32.31	258.09	55.77	0	3	Fracture
32.87	318.81	35.71	0	3	Fracture
32.94	312.06	35.06	0	3	Fracture
33.06	252.06	38.58	0	3	Fracture
33.13	270.81	41.56	0	3	Fracture
33.53	211.32	24.04	0	1	Bedding
33.73	313.01	17.01	0	5	Bedding
35.13	238.07	21.09	0	1	Fracture
36.77	117.70	42.35	0	3	Fracture
37.16	335.68	42.37	0	3	Fracture
37.24	313.57	28.54	0	5	Fracture
38.02	347.30	18.02	0	5	Fracture
38.09	334.49	17.36	0	5	Bedding
38.32	299.53	31.50	0	3	Fracture
38.46	277.48	58.44	0	3	Fracture
38.57	160.28	64.20	0	2	Fracture
38.74	129.09	52.34	0	3	Fracture
39.18	108.87	34.95	0	3	Fracture
39.72	278.45	41.96	0	3	Fracture
39.89	136.32	39.70	0	3	Fracture
40.16	269.37	50.96	0	3	Fracture
40.42	255.46	38.44	0	3	Fracture
40.58	32.11	42.42	0	3	Fracture

Depth	Azimuth	Dip	Aperture	Type	Group Interp
m	deg	deg	mm		
40.68	38.47	35.07	0	3	Fracture
40.77	70.34	50.08	0	3	Fracture
42.95	89.15	17.09	0	5	Fracture
43.04	10.56	30.12	0	3	Fracture
43.08	176.86	7.35	0	1	Fracture
43.20	293.50	36.88	0	3	Fracture
44.20	272.80	37.22	0	3	Bedding
44.73	293.04	12.08	0	4	Bedding
44.91	241.88	17.57	0	5	Fracture
44.93	286.81	10.46	0	4	Bedding
45.26	262.59	46.11	0	3	Fracture
45.41	232.24	56.73	0	3	Fracture
46.01	53.62	54.17	0	3	Fracture
46.43	272.62	38.33	0	3	Fracture
46.53	245.94	21.95	0	5	Fracture
46.72	299.42	41.31	0	3	Fracture
46.78	84.18	30.93	0	3	Fracture
46.83	65.64	34.10	13.26	3	Fracture
48.66	146.75	42.67	0	3	Fracture
48.97	215.29	43.15	0	3	Fracture
49.07	271.38	46.11	0	3	Fracture
49.11	348.77	49.09	0	3	Fracture
49.26	34.58	7.64	0	4	Bedding
49.30	49.36	27.10	0	5	Fracture
49.59	325.35	29.17	0	5	Fracture
49.82	120.02	11.31	0	5	Bedding
49.90	124.69	23.97	0	5	Fracture
50.15	70.78	40.97	0	3	Fracture
50.35	61.14	63.71	0	2	Fracture
51.00	197.66	70.08	0	2	Fracture
51.34	59.33	38.22	0	3	Fracture
51.37	235.06	43.17	0	3	Fracture
52.61	81.89	7.99	0	5	Bedding
53.65	193.27	57.78	0	3	Fracture
54.58	19.03	10.31	0	4	Bedding
55.17	188.98	39.84	9.14	3	Fracture
56.15	248.43	33.89	0	3	Fracture
56.88	22.09	38.23	0	3	Fracture
56.92	68.13	48.40	0	3	Fracture
57.04	255.77	36.62	0	3	Fracture
57.20	226.16	11.07	0	1	Bedding
57.32	176.40	77.30	0	2	Fracture
58.38	253.35	4.88	400.75	6	Fracture
58.63	165.23	31.49	0	3	Fracture
58.74	0.00	0.00	106.08	6	Fracture
58.87	228.91	42.23	0	3	Fracture
58.94	177.00	51.26	0	3	Fracture
59.23	264.48	41.91	0	3	Fracture

Depth	Azimuth	Dip	Aperture	Type	Group Interp
m	deg	deg	mm		
59.63	237.59	30.61	0	3	Fracture
59.72	306.81	47.48	0	3	Fracture
59.76	175.55	32.51	0	3	Fracture
59.84	238.01	38.05	0	3	Fracture
59.87	334.93	42.39	0	3	Fracture
59.91	250.32	24.33	0	5	Fracture
59.99	291.10	34.08	0	3	Fracture
60.02	49.99	38.52	0	3	Fracture
60.11	351.44	54.32	0	3	Fracture
60.19	140.68	35.94	0	3	Fracture
60.23	12.15	62.38	0	2	Fracture
60.34	21.28	27.99	0	5	Fracture
60.43	23.81	27.71	0	5	Fracture
60.49	336.09	28.24	0	5	Fracture
60.55	300.35	38.68	0	3	Fracture
60.64	273.77	35.46	0	3	Fracture
60.68	23.53	54.40	0	3	Fracture
60.87	343.41	59.50	0	2	Fracture
60.95	27.52	29.44	0	5	Fracture
61.14	51.57	48.26	0	3	Fracture
61.15	238.97	48.84	0	3	Fracture
61.27	268.43	21.88	0	5	Fracture
61.31	10.45	59.89	0	2	Fracture
61.38	337.86	50.34	0	3	Fracture
61.42	342.01	42.31	0	3	Fracture
61.72	301.83	19.25	0	5	Fracture
61.75	151.66	14.87	0	5	Bedding
62.15	323.95	10.39	0	4	Bedding
62.25	318.23	13.55	0	4	Bedding
62.49	290.77	34.91	0	3	Fracture
62.61	181.90	32.29	0	3	Fracture
62.61	316.10	15.52	0	4	Fracture
62.74	229.68	20.43	18.28	1	Fracture
62.91	165.18	20.92	0	5	Fracture
62.92	302.20	27.93	0	5	Fracture
62.98	287.05	27.76	0	5	Fracture
63.15	62.48	27.01	9.36	5	Fracture
63.24	33.00	46.97	12.29	3	Fracture
63.36	58.46	41.45	12	3	Fracture
64.09	255.00	29.53	0	5	Fracture
64.12	252.88	26.35	0	5	Fracture
64.32	252.80	32.23	0	3	Fracture
64.39	270.37	37.93	15	3	Fracture
64.54	263.15	26.49	0	5	Fracture
64.79	1.86	30.35	0	3	Fracture
64.84	4.90	28.78	12.28	3	Fracture
65.57	323.71	21.27	0	5	Fracture
65.80	333.90	7.91	0	4	Bedding

Depth	Azimuth	Dip	Aperture	Type	Group Interp
m	deg	deg	mm		
66.24	81.96	30.67	0	3	Fracture
66.64	289.94	20.96	0	4	Fracture
66.76	317.05	18.19	0	4	Fracture
67.12	181.90	10.41	0	5	Fracture
67.53	320.83	21.76	0	5	Fracture
68.01	40.52	67.72	0	2	Fracture
68.09	29.07	64.04	0	2	Fracture
68.28	70.03	55.38	0	3	Fracture
68.37	94.62	51.58	0	3	Fracture
69.01	303.97	22.88	0	5	Fracture
69.20	357.37	29.62	0	3	Fracture
69.35	168.67	37.16	0	3	Fracture
69.71	282.81	22.59	0	5	Fracture
69.89	138.30	20.68	0	5	Fracture
70.36	70.98	63.63	0	2	Fracture
70.60	50.97	64.07	0	2	Fracture
70.61	64.06	48.91	0	3	Fracture
70.90	241.18	16.00	0	1	Fracture
71.14	22.16	21.68	9.76	4	Fracture
71.54	46.97	12.25	0	4	Bedding
71.78	25.12	16.84	0	4	Bedding
72.02	109.13	30.99	0	3	Fracture
73.24	346.97	51.38	0	3	Fracture
73.85	69.36	6.85	0	5	Bedding
74.27	56.42	6.56	0	5	Bedding
75.13	215.87	54.55	0	3	Fracture
75.49	0.88	32.65	0	3	Fracture
75.57	99.41	7.96	0	5	Bedding
76.28	311.46	40.30	27.18	3	Fracture
76.92	58.62	28.84	0	5	Fracture
77.53	82.86	53.75	0	3	Fracture
78.29	328.15	15.51	0	4	Bedding
78.55	83.67	35.67	8.54	3	Fracture
78.57	68.68	37.27	0	3	Fracture
80.94	48.20	51.90	0	3	Fracture
82.52	1.63	15.28	0	4	Bedding
84.39	219.00	10.28	0	1	Bedding
84.46	8.22	38.87	0	3	Fracture
84.56	311.16	46.50	0	3	Fracture
84.70	114.79	76.95	0	2	Fracture
85.23	146.53	11.17	0	5	Bedding
85.25	131.53	25.35	0	5	Fracture
85.72	291.83	75.01	0	2	Fracture
85.77	284.49	75.19	0	2	Fracture
86.88	77.67	66.37	0	2	Fracture
86.92	191.64	56.06	0	3	Fracture
87.06	83.55	35.89	0	3	Fracture
87.10	92.81	38.08	0	3	Intrusion

Depth m	Azimuth deg	Dip deg	Aperture mm	Type	Group Interp
87.75	9.26	55.30	0	3	Fracture
87.82	11.77	47.82	0	3	Fracture
89.25	346.00	47.77	0	3	Fracture

APPENDIX

F

DESCRIPTION OF HOEK-BROWN PARAMETERS

HOEK-BROWN FAILURE CRITERION – 2002 EDITION

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ABSTRACT: The Hoek-Brown failure criterion for rock masses is widely accepted and has been applied in a large number of projects around the world. While, in general, it has been found to be satisfactory, there are some uncertainties and inaccuracies that have made the criterion inconvenient to apply and to incorporate into numerical models and limit equilibrium programs. In particular, the difficulty of finding an acceptable equivalent friction angle and cohesive strength for a given rock mass has been a problem since the publication of the criterion in 1980. This paper resolves all these issues and sets out a recommended sequence of calculations for applying the criterion. An associated Windows program called "RocLab" has been developed to provide a convenient means of solving and plotting the equations presented in this paper.

1. INTRODUCTION

Hoek and Brown [1, 2] introduced their failure criterion in an attempt to provide input data for the analyses required for the design of underground excavations in hard rock. The criterion was derived from the results of research into the brittle failure of intact rock by Hoek [3] and on model studies of jointed rock mass behaviour by Brown [4]. The criterion started from the properties of intact rock and then introduced factors to reduce these properties on the basis of the characteristics of joints in a rock mass. The authors sought to link the empirical criterion to geological observations by means of one of the available rock mass classification schemes and, for this purpose, they chose the Rock Mass Rating proposed by Bieniawski [5].

Because of the lack of suitable alternatives, the criterion was soon adopted by the rock mechanics community and its use quickly spread beyond the original limits used in deriving the strength reduction relationships. Consequently, it became necessary to re-examine these relationships and to introduce new elements from time to time to account for the wide range of practical problems to which the criterion was being applied. Typical of these enhancements were the introduction of the idea of "undisturbed" and "disturbed" rock masses Hoek and Brown [6], and the introduction of a modified criterion to force the rock mass tensile strength to zero for very poor quality rock masses (Hoek, Wood and Shah, [7]).

One of the early difficulties arose because many geotechnical problems, particularly slope stability issues, are more conveniently dealt with in terms of shear and normal stresses rather than the principal stress relationships of the original Hoek-Brown criterion, defined by the equation:

$$\sigma_1' = \sigma_3' + \sigma_{ci}\left(m\frac{\sigma_3'}{\sigma_{ci}} + s\right)^{0.5} \quad (1)$$

where σ_1' and σ_3' are the major and minor effective principal stresses at failure

σ_{ci} is the uniaxial compressive strength of the intact rock material and

m and s are material constants, where $s = 1$ for intact rock.

An exact relationship between equation 1 and the normal and shear stresses at failure was derived by J. W. Bray (reported by Hoek [8]) and later by Ucar [9] and Londe[1] [10].

Hoek [12] discussed the derivation of equivalent friction angles and cohesive strengths for various practical situations. These derivations were based

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[1] Londe's equations were later found to contain errors although the concepts introduced by Londe were extremely important in the application of the Hoek-Brown criterion to tunnelling problems (Carranza-Torres and Fairhurst, [11])

upon tangents to the Mohr envelope derived by Bray. Hoek [13] suggested that the cohesive strength determined by fitting a tangent to the curvilinear Mohr envelope is an upper bound value and may give optimistic results in stability calculations. Consequently, an average value, determined by fitting a linear Mohr-Coulomb relationship by least squares methods, may be more appropriate. In this paper Hoek also introduced the concept of the Generalized Hoek-Brown criterion in which the shape of the principal stress plot or the Mohr envelope could be adjusted by means of a variable coefficient *a* in place of the square root term in equation 1.

Hoek and Brown [14] attempted to consolidate all the previous enhancements into a comprehensive presentation of the failure criterion and they gave a number of worked examples to illustrate its practical application.

In addition to the changes in the equations, it was also recognised that the Rock Mass Rating of Bieniawski was no longer adequate as a vehicle for relating the failure criterion to geological observations in the field, particularly for very weak rock masses. This resulted in the introduction of the Geological Strength Index (GSI) by Hoek, Wood and Shah [7], Hoek [13] and Hoek, Kaiser and Bawden [15]. This index was subsequently extended for weak rock masses in a series of papers by Hoek, Marinos and Benissi [16], Hoek and Marinos [17, 18] and Marinos and Hoek [19].

The Geological Strength Index will not be discussed in the following text, which will concentrate on the sequence of calculations now proposed for the application of the Generalized Hoek Brown criterion to jointed rock masses.

2. GENERALIZED HOEK-BROWN CRITERION

This is expressed as

$$\sigma_1' = \sigma_3' + \sigma_{ci}\left(m_b \frac{\sigma_3'}{\sigma_{ci}} + s \right)^a \qquad (2)$$

where m_b is a reduced value of the material constant m_i and is given by

$$m_b = m_i \exp\left(\frac{GSI - 100}{28 - 14D} \right) \qquad (3)$$

s and *a* are constants for the rock mass given by the following relationships:

$$s = \exp\left(\frac{GSI - 100}{9 - 3D} \right) \qquad (4)$$

$$a = \frac{1}{2} + \frac{1}{6}\left(e^{-GSI/15} - e^{-20/3} \right) \qquad (5)$$

D is a factor which depends upon the degree of disturbance to which the rock mass has been subjected by blast damage and stress relaxation. It varies from 0 for undisturbed in situ rock masses to 1 for very disturbed rock masses. Guidelines for the selection of *D* are discussed in a later section.

The uniaxial compressive strength is obtained by setting $\sigma_3' = 0$ in equation 2, giving:

$$\sigma_c = \sigma_{ci} . s^a \qquad (6)$$

and, the tensile strength is:

$$\sigma_t = -\frac{s\sigma_{ci}}{m_b} \qquad (7)$$

Equation 7 is obtained by setting $\sigma_1' = \sigma_3' = \sigma_t$ in equation 2. This represents a condition of biaxial tension. Hoek [8] showed that, for brittle materials, the uniaxial tensile strength is equal to the biaxial tensile strength.

Note that the “switch” at GSI = 25 for the coefficients *s* and *a* (Hoek and Brown, [14]) has been eliminated in equations 4 and 5 which give smooth continuous transitions for the entire range of GSI values. The numerical values of *a* and *s*, given by these equations, are very close to those given by the previous equations and it is not necessary for readers to revisit and make corrections to old calculations.

Normal and shear stresses are related to principal stresses by the equations published by Balmer [20].

$$\sigma_n' = \frac{\sigma_1' + \sigma_3'}{2} - \frac{\sigma_1' - \sigma_3'}{2} \cdot \frac{d\sigma_1' / d\sigma_3' - 1}{d\sigma_1' / d\sigma_3' + 1} \qquad (8)$$

$$\tau = \left(\sigma_1' - \sigma_3' \right) \frac{\sqrt{d\sigma_1' / d\sigma_3'}}{d\sigma_1' / d\sigma_3' + 1} \qquad (9)$$

where

$$d\sigma_1' / d\sigma_3' = 1 + a m_b \left(m_b \sigma_3' / \sigma_{ci} + s \right)^{a-1} \qquad (10)$$

3. MODULUS OF DEFORMATION

The rock mass modulus of deformation is given by:

$$E_m(GPa) = \left(1 - \frac{D}{2} \right) \sqrt{\frac{\sigma_{ci}}{100}} \cdot 10^{((GSI-10)/40)} \qquad (11a)$$

Equation 11a applies for $\sigma_{ci} \leq$ 100 MPa. For $\sigma_{ci} >$ 100 MPa, use equation 11b.

$$E_m(GPa) = \left(1 - \frac{D}{2}\right) \cdot 10^{((GSI-10)/40)} \qquad (11b)$$

Note that the original equation proposed by Hoek and Brown [14] has been modified, by the inclusion of the factor *D*, to allow for the effects of blast damage and stress relaxation.

4. MOHR-COULOMB CRITERION

Since most geotechnical software is still written in terms of the Mohr-Coulomb failure criterion, it is necessary to determine equivalent angles of friction and cohesive strengths for each rock mass and stress range. This is done by fitting an average linear relationship to the curve generated by solving equation 2 for a range of minor principal stress values defined by $\sigma_t < \sigma_3 < \sigma'_{3\max}$, as illustrated in Figure 1. The fitting process involves balancing the areas above and below the Mohr-Coulomb plot. This results in the following equations for the angle of friction ϕ' and cohesive strength c':

$$\phi' = \sin^{-1}\left[\frac{6am_b(s+m_b\sigma'_{3n})^{a-1}}{2(1+a)(2+a)+6am_b(s+m_b\sigma'_{3n})^{a-1}}\right] \qquad (12)$$

$$c' = \frac{\sigma_{ci}\left[(1+2a)s+(1-a)m_b\sigma'_{3n}\right](s+m_b\sigma'_{3n})^{a-1}}{(1+a)(2+a)\sqrt{1+\left(6am_b(s+m_b\sigma'_{3n})^{a-1}\right)\big/\left((1+a)(2+a)\right)}}$$

(13)

where $\sigma_{3n} = \sigma'_{3\max} / \sigma_{ci}$

Note that the value of $\sigma'_{3\max}$, the upper limit of confining stress over which the relationship between the Hoek-Brown and the Mohr-Coulomb criteria is considered, has to be determined for each individual case. Guidelines for selecting these values for slopes as well as shallow and deep tunnels are presented later.

The Mohr-Coulomb shear strength τ, for a given normal stress σ, is found by substitution of these values of c' and ϕ' in to the equation:

$$\tau = c' + \sigma \tan\phi' \qquad (14)$$

The equivalent plot, in terms of the major and minor principal stresses, is defined by:

$$\sigma'_1 = \frac{2c'\cos\phi'}{1-\sin\phi'} + \frac{1+\sin\phi'}{1-\sin\phi'}\sigma'_3 \qquad (15)$$

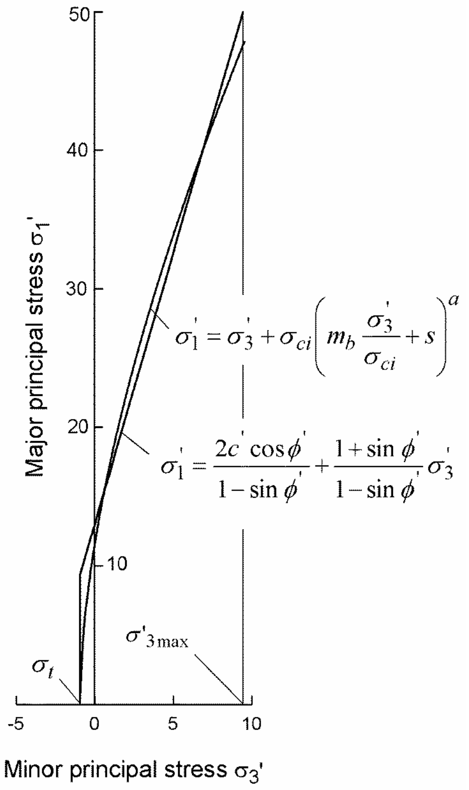

Figure 1: Relationships between major and minor principal stresses for Hoek-Brown and equivalent Mohr-Coulomb criteria.

5. ROCK MASS STRENGTH

The uniaxial compressive strength of the rock mass σ_c is given by equation 6. Failure initiates at the boundary of an excavation when σ_c is exceeded by the stress induced on that boundary. The failure propagates from this initiation point into a biaxial stress field and it eventually stabilizes when the local strength, defined by equation 2, is higher than the induced stresses σ'_1 and σ'_3. Most numerical models can follow this process of fracture propagation and this level of detailed analysis is very important when considering the stability of excavations in rock and when designing support systems.

However, there are times when it is useful to consider the overall behaviour of a rock mass rather than the detailed failure propagation process described above. For example, when considering the strength of a pillar, it is useful to have an estimate of the overall strength of the pillar rather than a detailed knowledge of the extent of fracture propagation in the pillar. This leads to the concept of a global “rock mass strength” and Hoek and Brown [14] proposed that this could be estimated from the Mohr-Coulomb relationship:

$$\sigma'_{cm} = \frac{2c' \cos\phi'}{1-\sin\phi'} \qquad (16)$$

with c' and ϕ' determined for the stress range $\sigma_t < \sigma'_3 < \sigma_{ci}/4$ giving

$$\sigma'_{cm} = \sigma_{ci} \cdot \frac{(m_b + 4s - a(m_b - 8s))(m_b/4 + s)^{a-1}}{2(1+a)(2+a)} \qquad (17)$$

6. DETERMINATION OF σ′3MAX

The issue of determining the appropriate value of $\sigma'_{3\max}$ for use in equations 12 and 13 depends upon the specific application. Two cases will be investigated:

1. Tunnels – where the value of $\sigma'_{3\max}$ is that which gives equivalent characteristic curves for the two failure criteria for deep tunnels or equivalent subsidence profiles for shallow tunnels.
2. Slopes – here the calculated factor of safety and the shape and location of the failure surface have to be equivalent.

For the case of deep tunnels, closed form solutions for both the Generalized Hoek-Brown and the Mohr-Coulomb criteria have been used to generate hundreds of solutions and to find the value of $\sigma'_{3\max}$ that gives equivalent characteristic curves.

For shallow tunnels, where the depth below surface is less than 3 tunnel diameters, comparative numerical studies of the extent of failure and the magnitude of surface subsidence gave an identical relationship to that obtained for deep tunnels, provided that caving to surface is avoided.

The results of the studies for deep tunnels are plotted in Figure 2 and the fitted equation for both cases is:

$$\frac{\sigma'_{3\max}}{\sigma'_{cm}} = 0.47\left(\frac{\sigma'_{cm}}{\gamma H}\right)^{-0.94} \qquad (18)$$

where σ'_{cm} is the rock mass strength, defined by equation 17, γ is the unit weight of the rock mass and H is the depth of the tunnel below surface. In cases where the horizontal stress is higher than the vertical stress, the horizontal stress value should be used in place of γH.

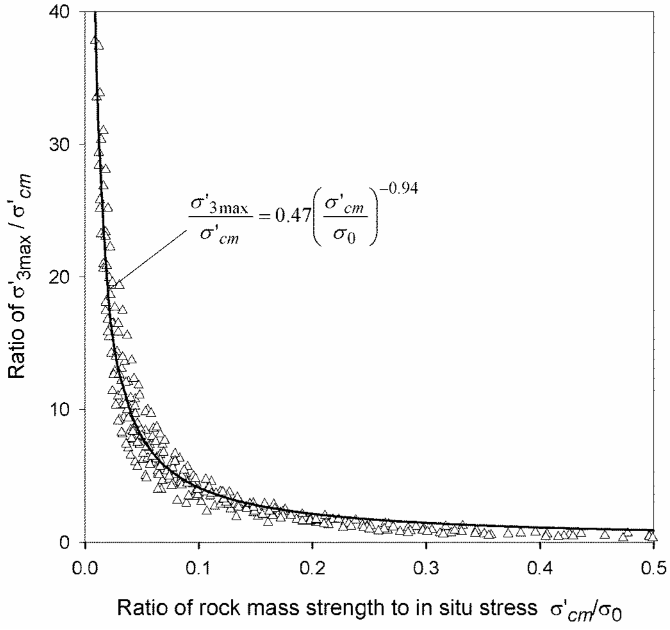

Figure 2: Relationship for the calculation of σ′3max for equivalent Mohr-Coulomb and Hoek-Brown parameters for tunnels.

Equation 18 applies to all underground excavations, which are surrounded by a zone of failure that does not extend to surface. For studies of problems such as block caving in mines it is recommended that no attempt should be made to relate the Hoek-Brown and Mohr-Coulomb parameters and that the determination of material properties and subsequent analysis should be based on only one of these criteria.

Similar studies for slopes, using Bishop’s circular failure analysis for a wide range of slope geometries and rock mass properties, gave:

$$\frac{\sigma'_{3\max}}{\sigma'_{cm}} = 0.72\left(\frac{\sigma'_{cm}}{\gamma H}\right)^{-0.91} \qquad (19)$$

where H is the height of the slope.

7. ESTIMATION OF DISTURBANCE FACTOR D

Experience in the design of slopes in very large open pit mines has shown that the Hoek-Brown criterion for undisturbed in situ rock masses (D = 0) results in rock mass properties that are too optimistic [21, 22]. The effects of heavy blast damage as well as stress relief due to removal of the overburden result in disturbance of the rock mass. It is considered that the "disturbed" rock mass properties [6], $D = 1$ in equations 3 and 4, are more appropriate for these rock masses.

Lorig and Varona [23] showed that factors such as the lateral confinement produced by different radii of curvature of slopes (in plan) as compared with their height also have an influence on the degree of disturbance.

Sonmez and Ulusay [24] back-analysed five slope failures in open pit coal mines in Turkey and attempted to assign disturbance factors to each rock mass based upon their assessment of the rock mass properties predicted by the Hoek-Brown criterion. Unfortunately, one of the slope failures appears to be structurally controlled while another consists of a transported waste pile. The authors consider that the Hoek-Brown criterion is not applicable to these two cases.

Cheng and Liu [25] report the results of very careful back analysis of deformation measurements, from extensometers placed before the commencement of excavation, in the Mingtan power cavern in Taiwan. It was found that a zone of blast damage extended for a distance of approximately 2 m around all large excavations. The back-calculated strength and deformation properties of the damaged rock mass give an equivalent disturbance factor $D = 0.7$.

From these references it is clear that a large number of factors can influence the degree of disturbance in the rock mass surrounding an excavation and that it may never be possible to quantify these factors precisely. However, based on their experience and on an analysis of all the details contained in these papers, the authors have attempted to draw up a set of guidelines for estimating the factor D and these are summarised in Table 1.

The influence of this disturbance factor can be large. This is illustrated by a typical example in which σ_{ci} = 50 MPa, m_i = 10 and GSI = 45. For an undisturbed in situ rock mass surrounding a tunnel at a depth of 100 m, with a disturbance factor $D = 0$, the equivalent friction angle is $\phi' = 47.16°$ while the cohesive strength is $c' =$ 0.58 MPa. A rock mass with the same basic parameters but in highly disturbed slope of 100 m height, with a disturbance factor of $D = 1$, has an equivalent friction angle of $\phi' = 27.61°$ and a cohesive strength of $c' =$ 0.35 MPa.

Note that these are guidelines only and the reader would be well advised to apply the values given with caution. However, they can be used to provide a realistic starting point for any design and, if the observed or measured performance of the excavation turns out to be better than predicted, the disturbance factors can be adjusted downwards.

8. CONCLUSION

A number of uncertainties and practical problems in using the Hoek-Brown failure criterion have been addressed in this paper. Wherever possible, an attempt has been made to provide a rigorous and unambiguous method for calculating or estimating the input parameters required for the analysis. These methods have all been implemented in a Windows program called "RocLab" that can be downloaded (free) from www.rocscience.com. This program includes tables and charts for estimating the uniaxial compressive strength of the intact rock elements (σ_{ci}), the material constant m_i and the Geological Strength Index (*GSI*).

9. ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions of Professor E.T. Brown in reviewing a draft of this paper and in participating in the development of the Hoek-Brown criterion for the past 25 years.

Table 1: Guidelines for estimating disturbance factor *D*

Appearance of rock mass	Description of rock mass	Suggested value of *D*
	Excellent quality controlled blasting or excavation by Tunnel Boring Machine results in minimal disturbance to the confined rock mass surrounding a tunnel.	*D* = 0
	Mechanical or hand excavation in poor quality rock masses (no blasting) results in minimal disturbance to the surrounding rock mass. Where squeezing problems result in significant floor heave, disturbance can be severe unless a temporary invert, as shown in the photograph, is placed.	*D* = 0 *D* = 0.5 No invert
	Very poor quality blasting in a hard rock tunnel results in severe local damage, extending 2 or 3 m, in the surrounding rock mass.	*D* = 0.8
	Small scale blasting in civil engineering slopes results in modest rock mass damage, particularly if controlled blasting is used as shown on the left hand side of the photograph. However, stress relief results in some disturbance.	*D* = 0.7 Good blasting *D* = 1.0 Poor blasting
	Very large open pit mine slopes suffer significant disturbance due to heavy production blasting and also due to stress relief from overburden removal. In some softer rocks excavation can be carried out by ripping and dozing and the degree of damage to the slopes is less.	*D* = 1.0 Production blasting *D* = 0.7 Mechanical excavation

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APPENDIX

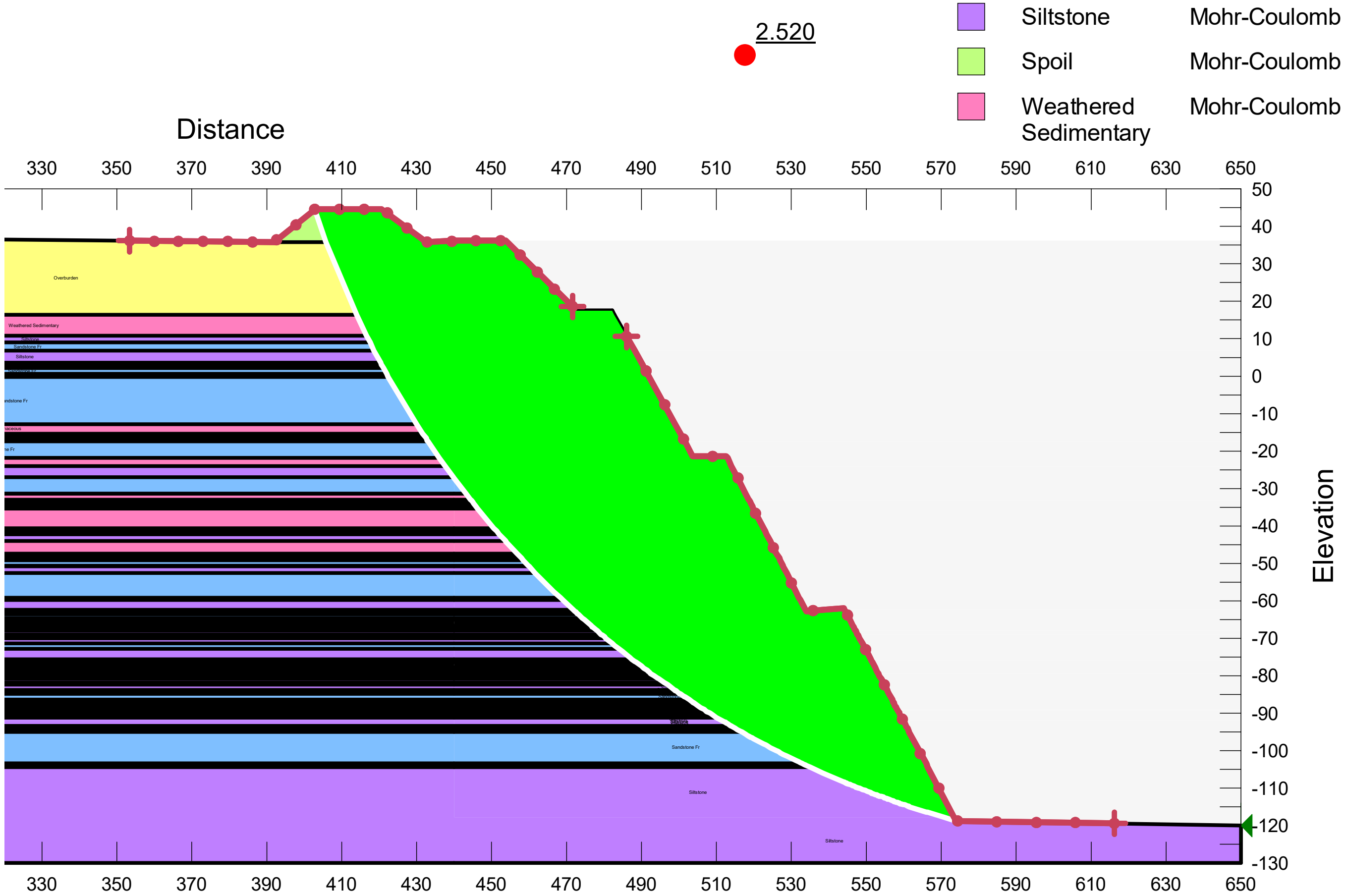
G

SLOPE STABILITY MODELLING

File Name: STX1903V6Mean Props.gsz

Kind: SLOPE/WMethod: {CurrentAnalysis.MetPWP Conditions from: Ruhod}Name: Cut2a

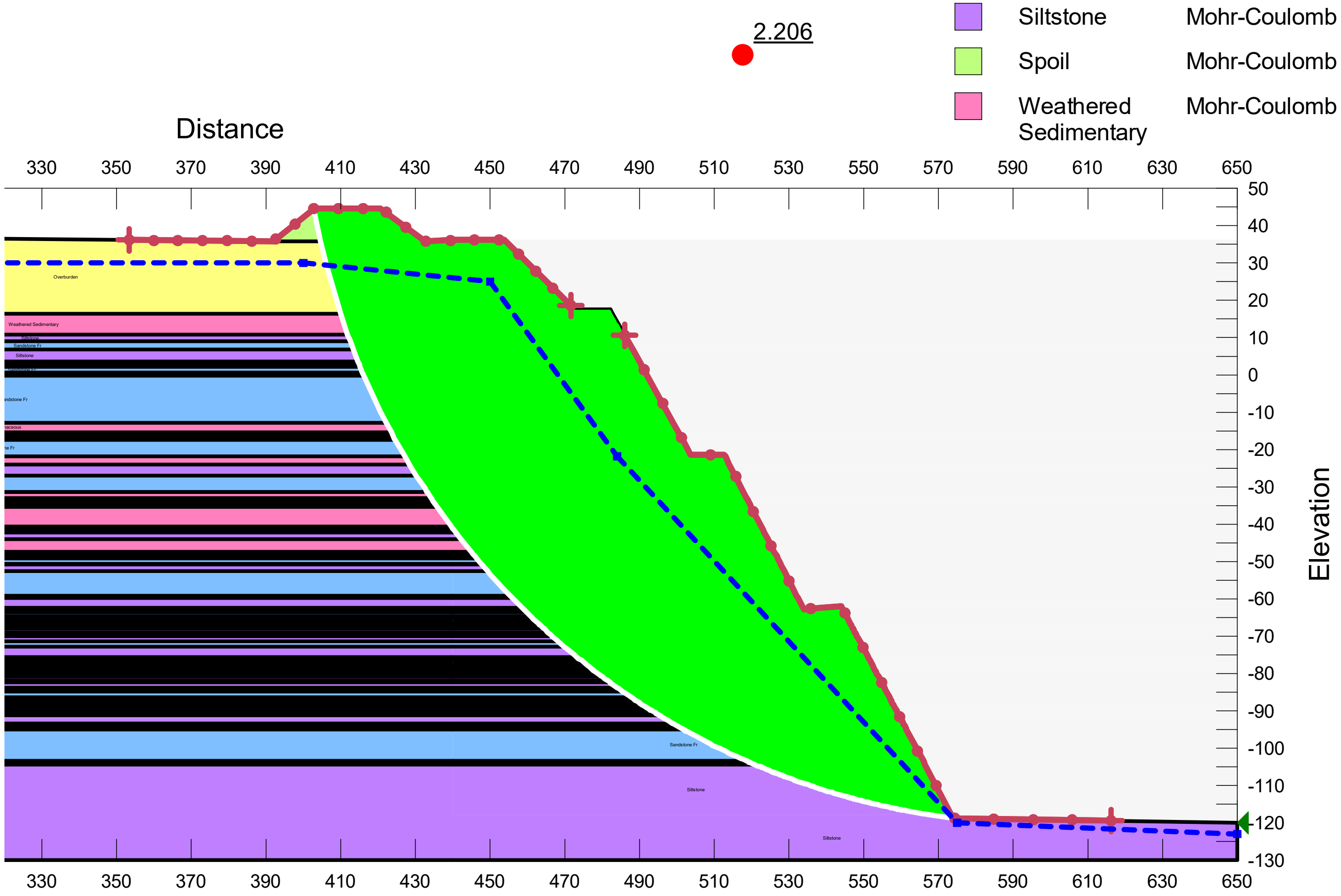
Color	**Name**	**Model**	**Unit Weight (kN/m³)**	**Cohesion' (kPa)**	**Phi' (°)**	**Phi-B (°)**	**Ru**
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	0.15
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	0.15
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	0.15
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	0.15
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	0.15
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	0.15
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	0.15



File Name: STX1903V6Mean Props.gsz

Kind: SLOPE/WMethod: {CurrentAnalysis.MetPWP Conditions from: Piezometric Linehod}Name: Cut2b

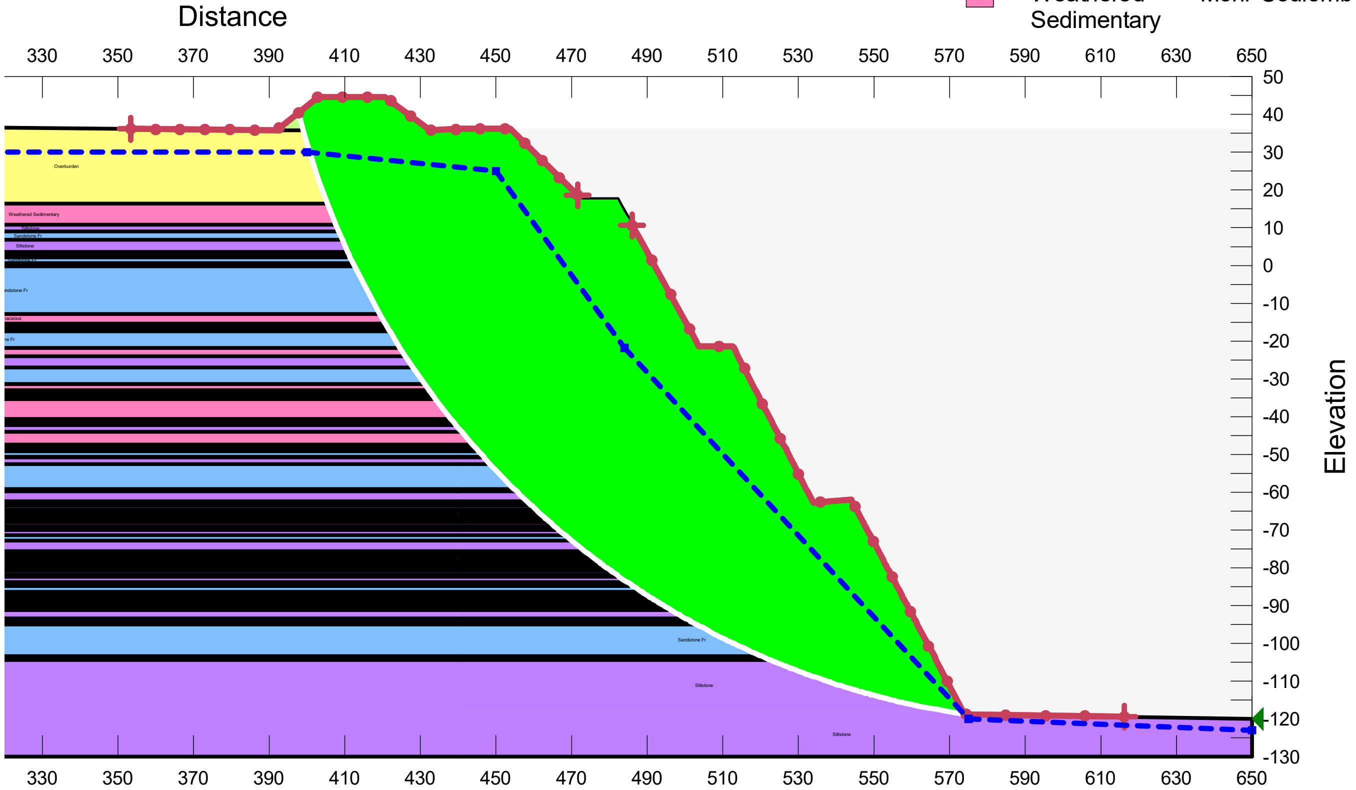
Color	**Name**	**Model**	**Unit Weight (kN/m³)**	**Cohesion' (kPa)**	**Phi' (°)**	**Phi-B (°)**	**Piezometric Line**
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



File Name: STX1903V6Mean Props.gsz

Kind: SLOPE/WMethod: {CurrentAnalysis.MetPWP Conditions from: Piezometric Linehod}Name: Cut2c Seis

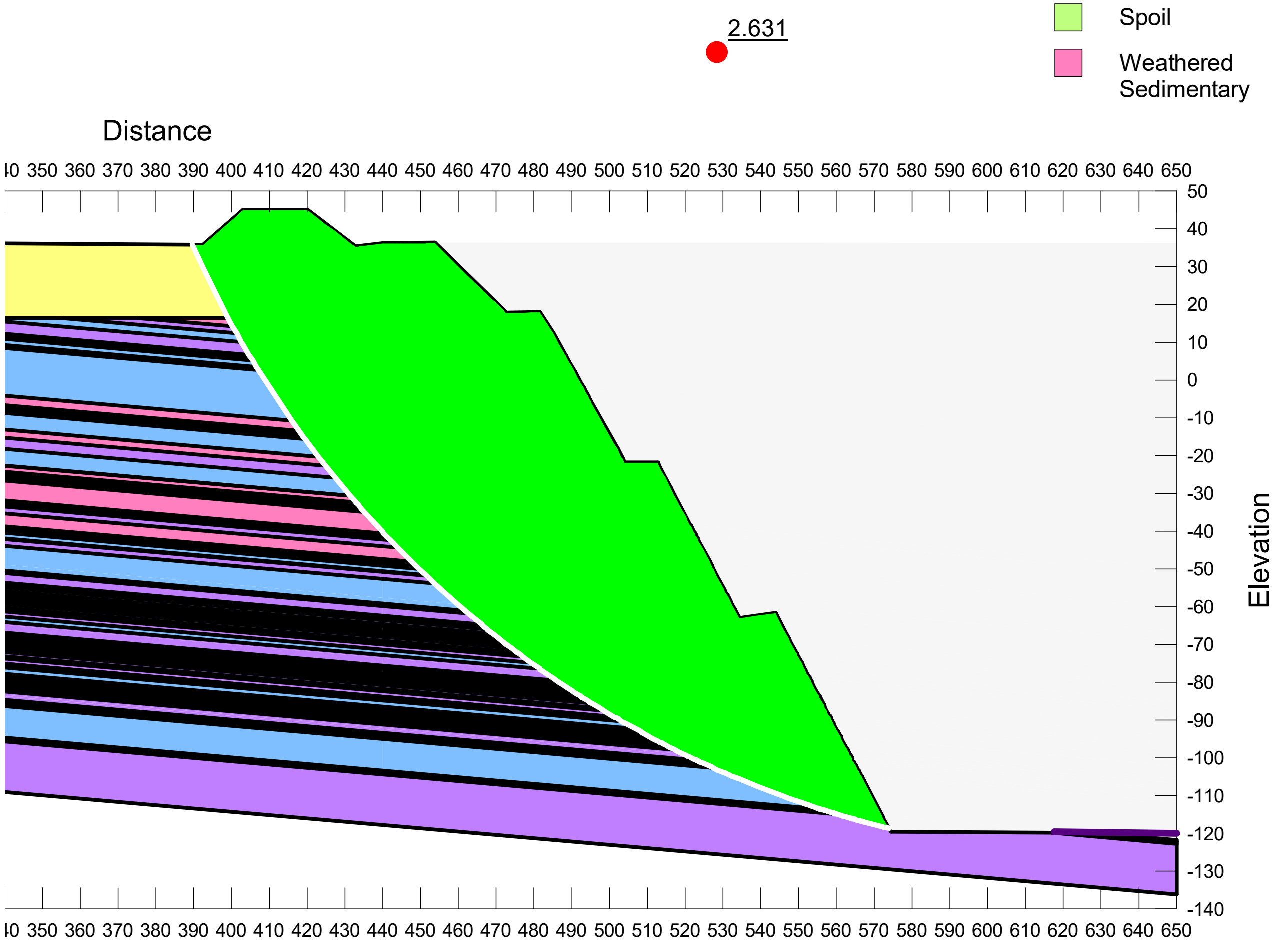
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Method: {CurrentAnalysis.MetName: Cut2ahod}Kind: SLOPE/W

File Name: STX1903V7MeanPropsPlanar.gsz

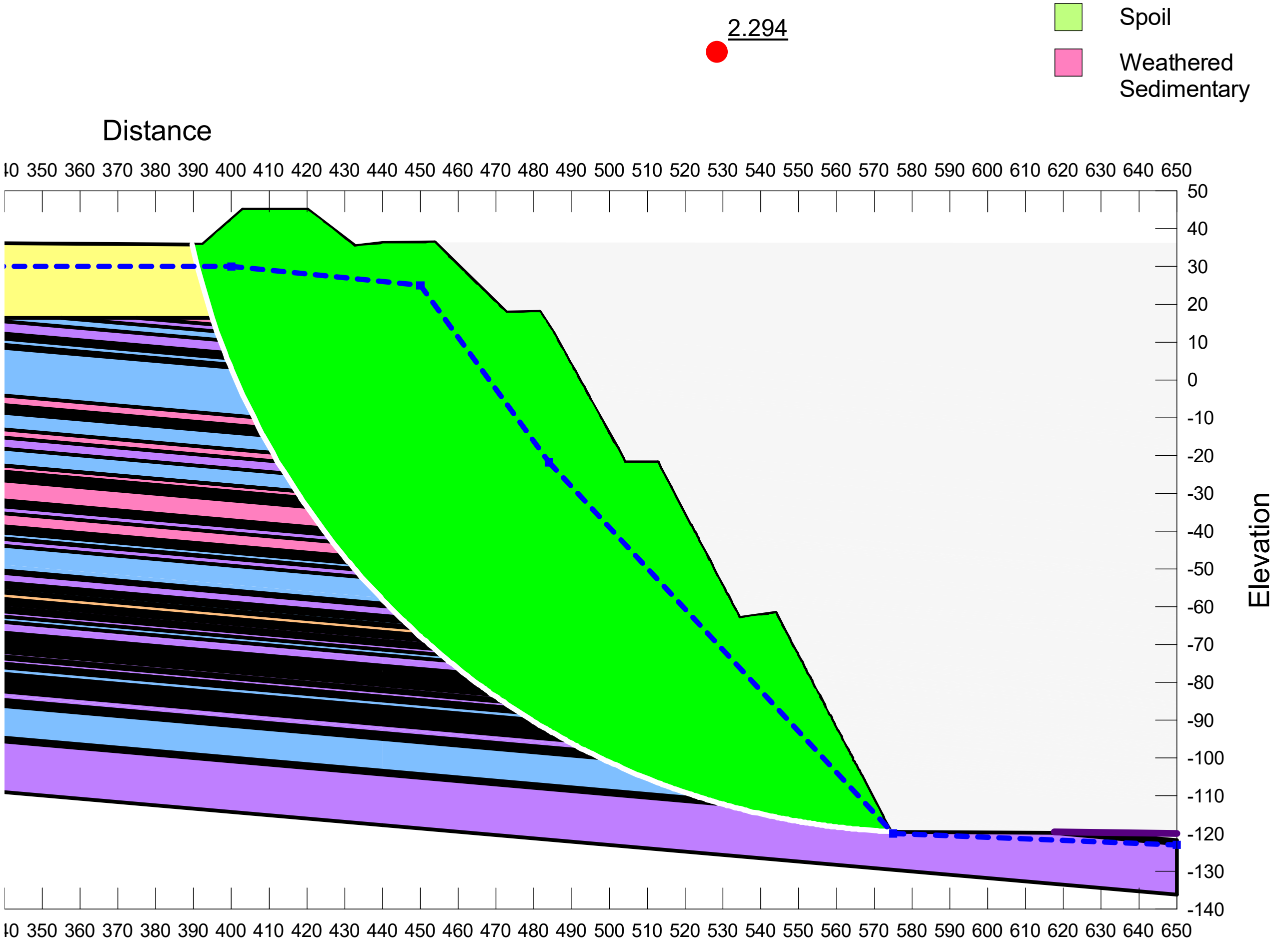
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Ru
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	0.15
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	0.15
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	0.15
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	0.15
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	0.15
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	0.15
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	0.15



Method: {CurrentAnalysis.MetName: Cut2bhod}Kind: SLOPE/W

File Name: STX1903V7MeanPropsPlanar.gsz

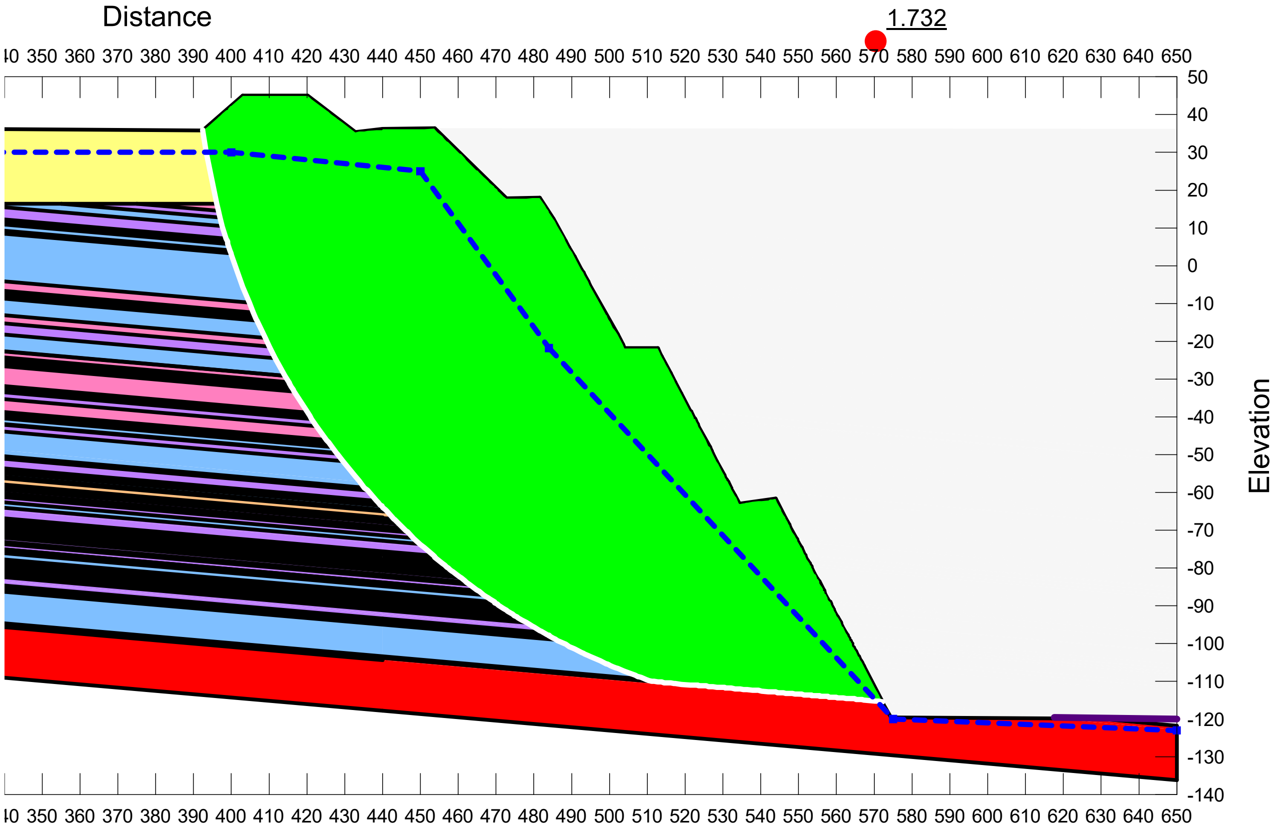
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
■	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Method: {CurrentAnalysis.MetName: Cut2c shear zonehod}Kind: SLOPE/W

File Name: STX1903V7MeanPropsPlanar.gsz

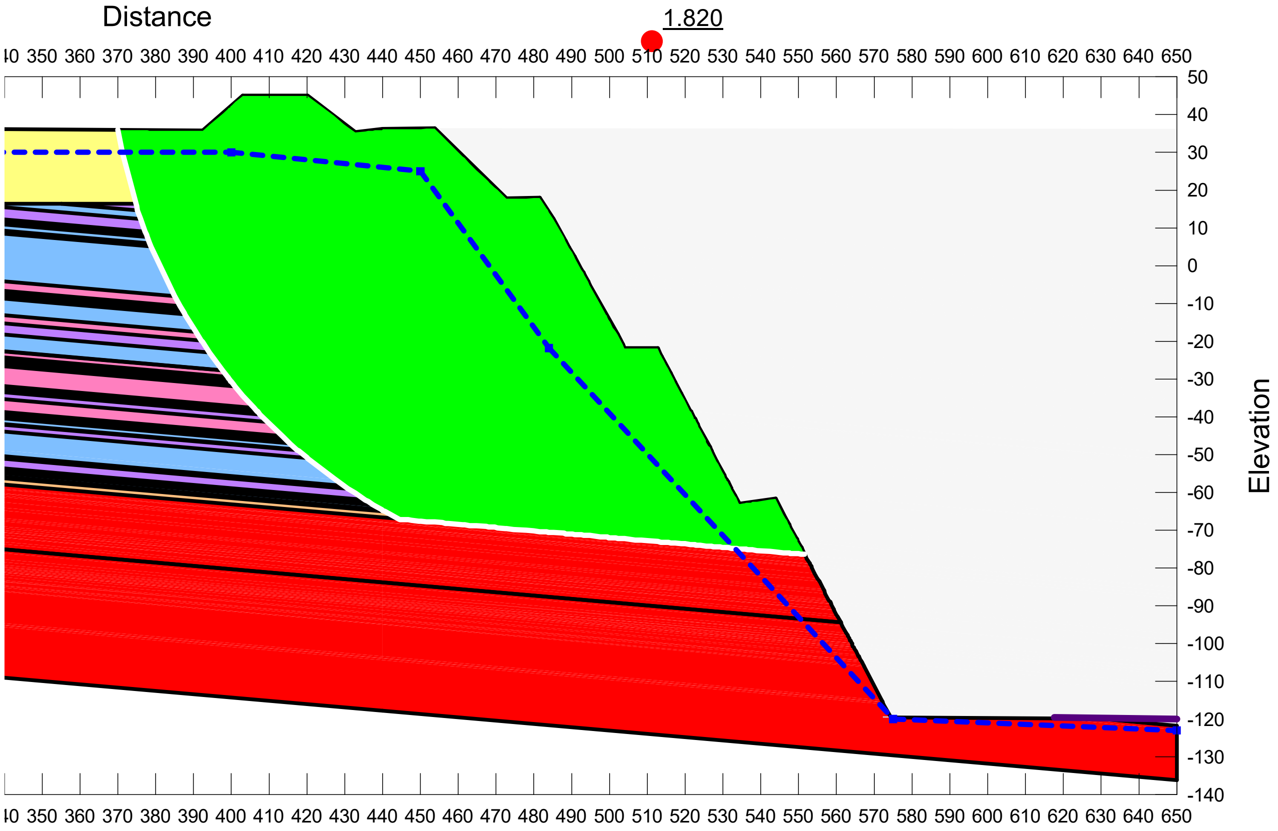
Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Phi (°)	Phi-B (°)	Piezometric Line
▨	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟥	Impenetrable	Bedrock (Impenetrable)					
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
▨	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Phi (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟥	Impenetrable	Bedrock (Impenetrable)					1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1

Method: {CurrentAnalysis.MetName: Cut2d Shear Zonehod}Kind: SLOPE/W

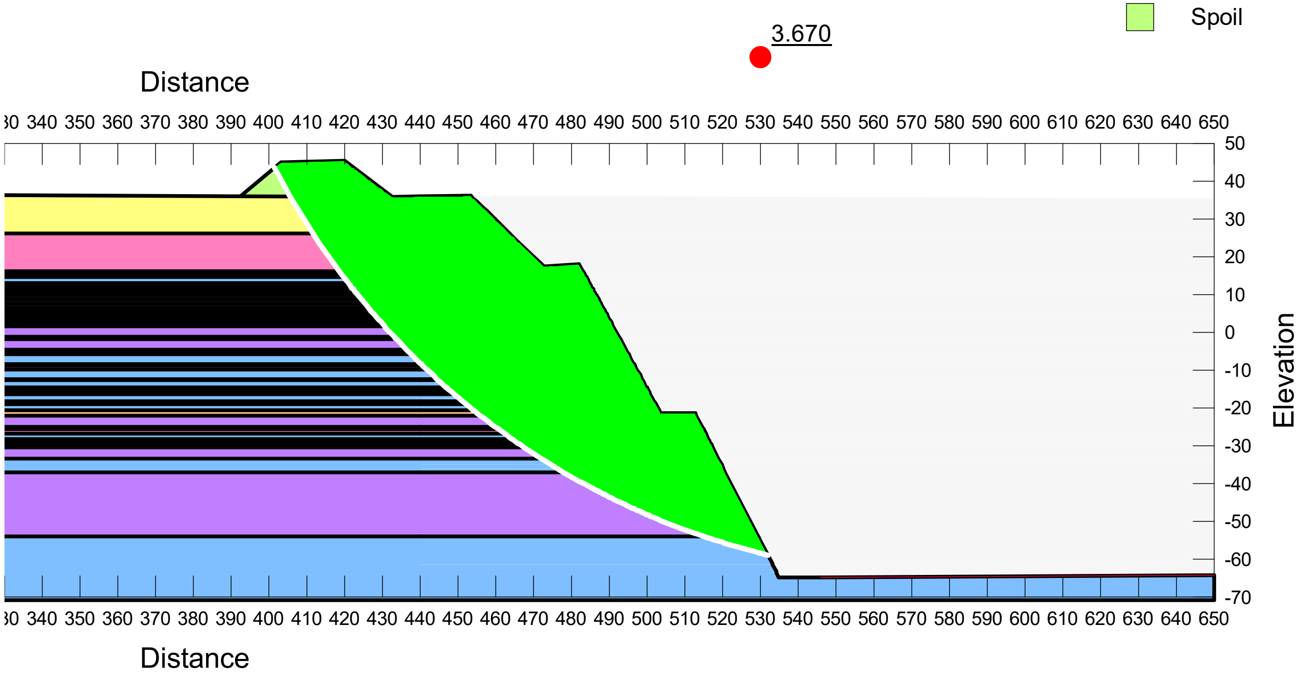
File Name: STX1903V7MeanPropsPlanar.gsz



Kind: SLOPE/WMethod: Morgenstern-PriceName: Cut1a

File Name: STX1904V5 Mean Props.gsz

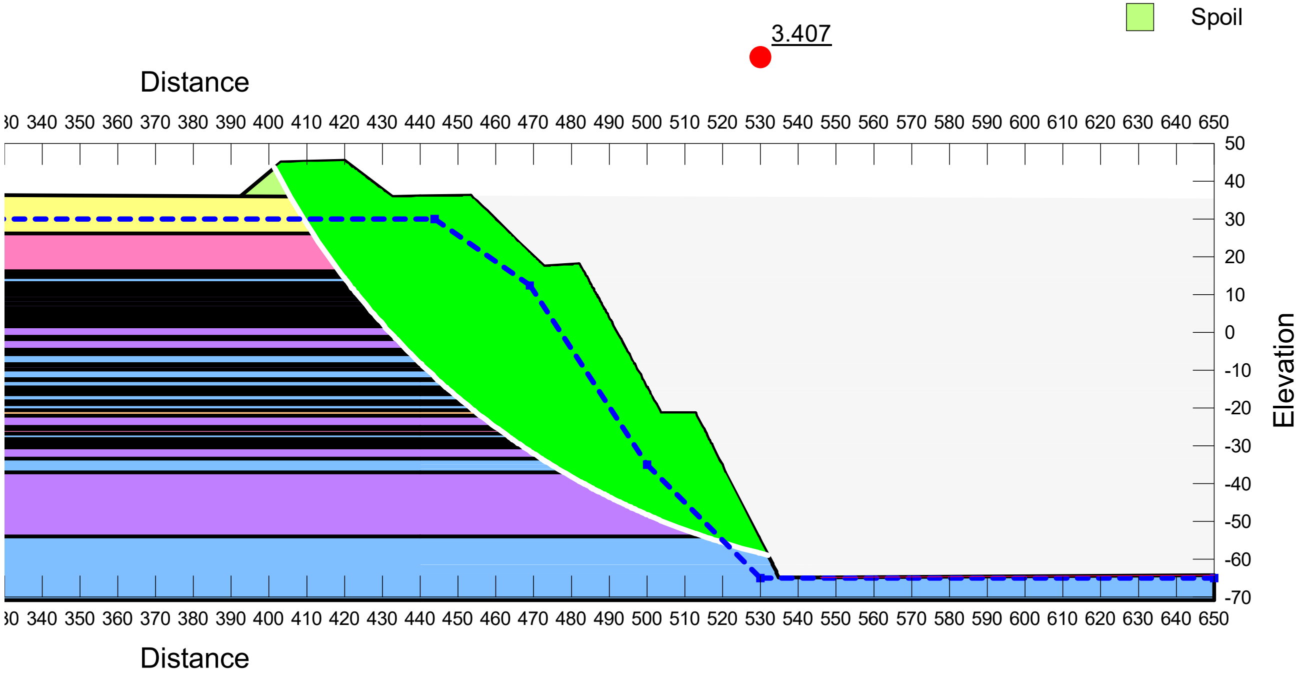
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Ru
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	0.15
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	0.15
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	0.15
🟦	Sandstone FR	Mohr-Coulomb	24.5	1,470	52.1	0	0.15
🟧	Shear Zone	Mohr-Coulomb	18	25	25	0	0.15
🟪	Siltstone Fr	Mohr-Coulomb	24.5	795	44.9	0	0.15
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	0.15



Kind: SLOPE/WMethod: Morgenstern-PriceName: Cut1b

File Name: STX1904V5 Mean Props.gsz

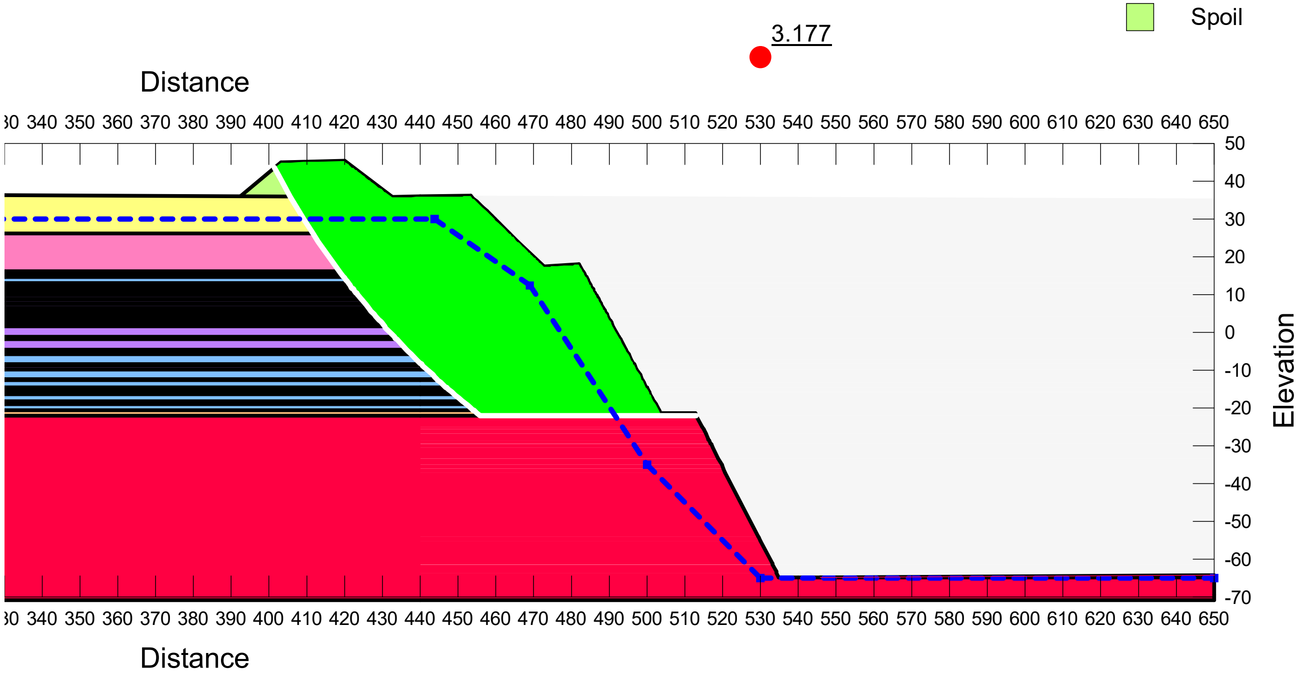
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone FR	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	25	25	0	1
🟪	Siltstone Fr	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1



Kind: SLOPE/WMethod: Morgenstern-PriceName: Cut1c Planar

File Name: STX1904V5 Mean Props.gsz

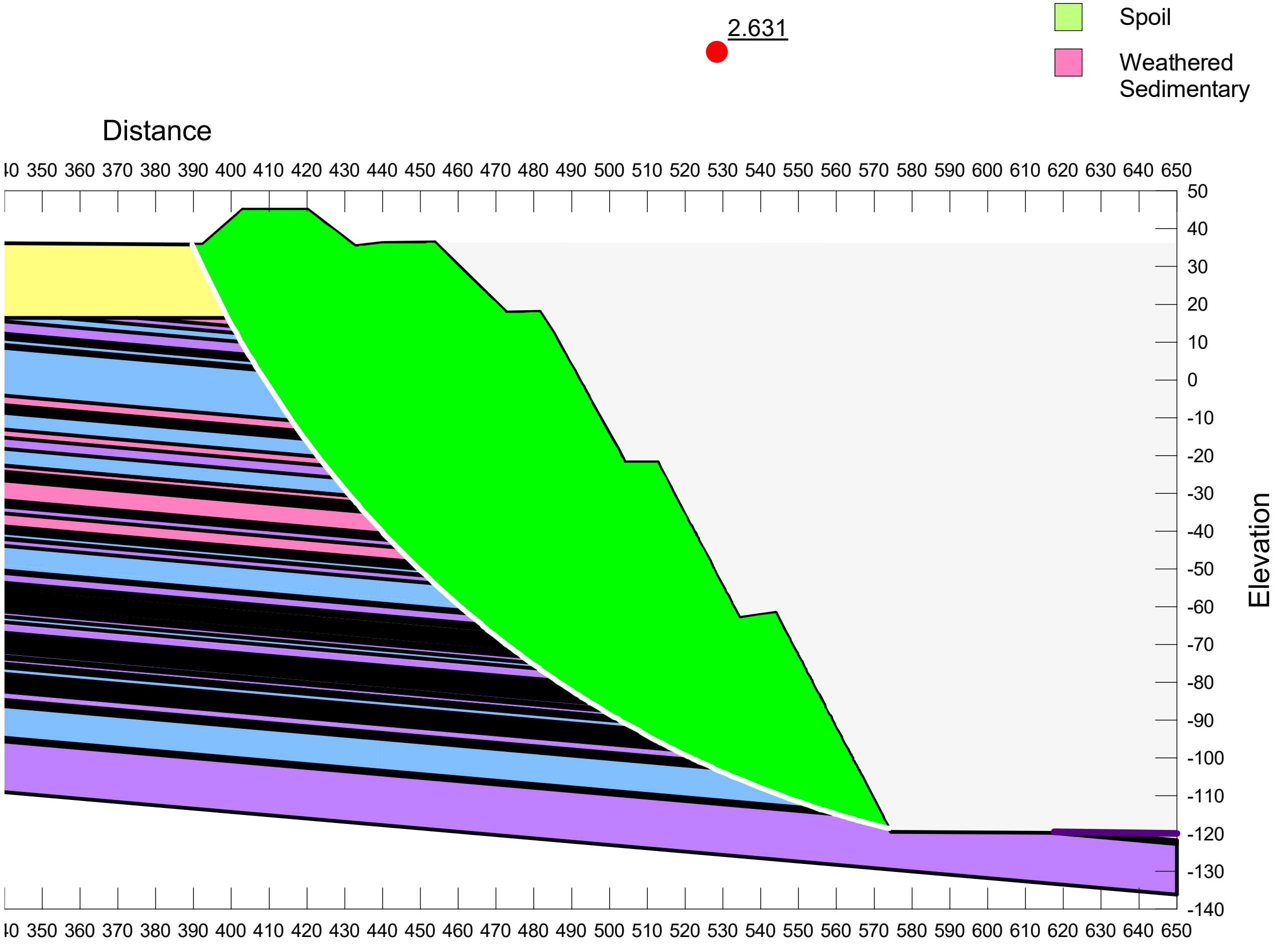
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟥	Impenetrable	Bedrock (Impenetrable)					1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone FR	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	25	25	0	1
🟪	Siltstone Fr	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1



Method: {CurrentAnalysis.MetName: Cut2ahod}Kind: SLOPE/W

File Name: STX1903V7MeanPropsPlanar.gsz

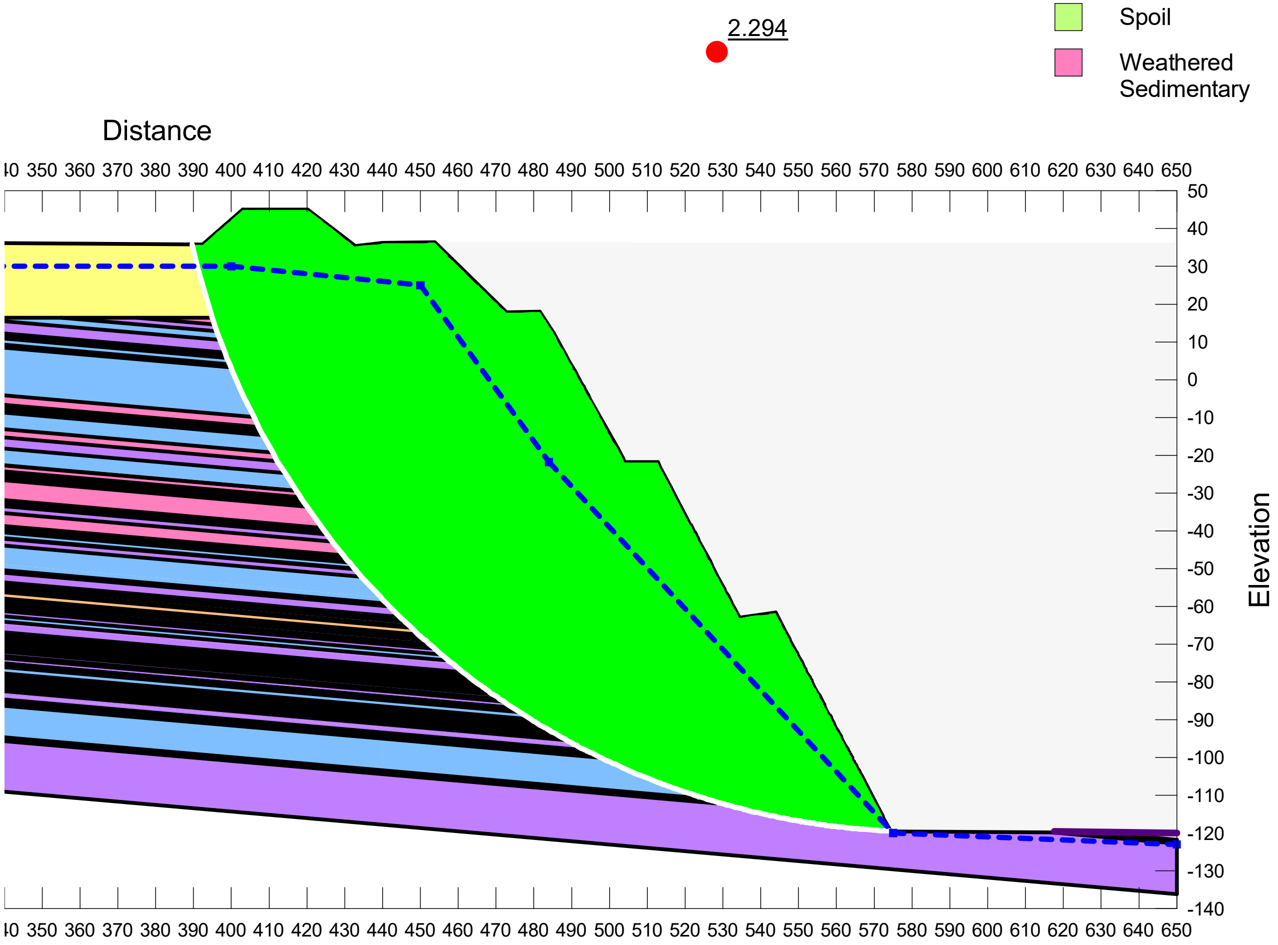
Color	Name	Model	Unit Weight (kN/m^3)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Ru
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	0.15
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	0.15
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	0.15
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	0.15
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	0.15
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	0.15
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	0.15



Method: {CurrentAnalysis.MetName: Cut2bhod}Kind: SLOPE/W

File Name: STX1903V7MeanPropsPlanar.gsz

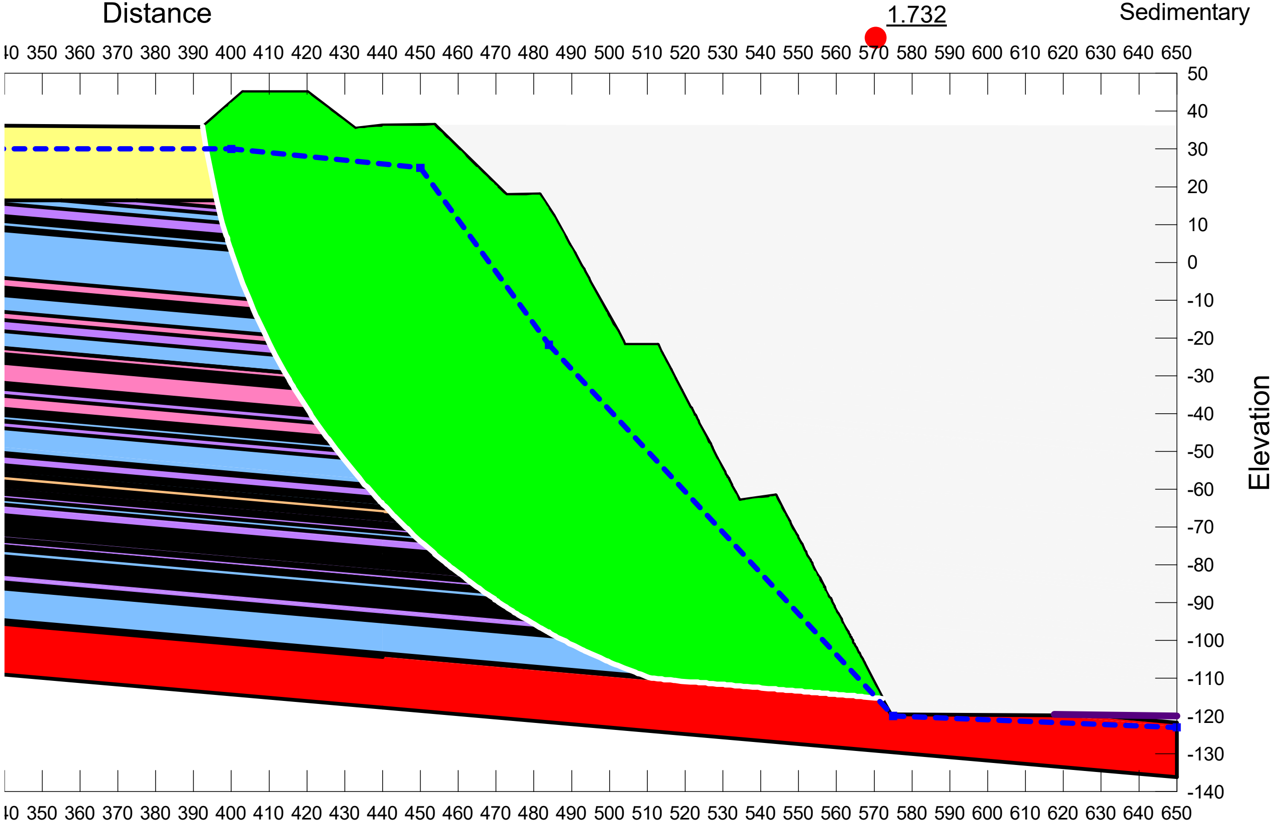
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Method: {CurrentAnalysis.MetName: Cut2c shear zonehod}Kind: SLOPE/W

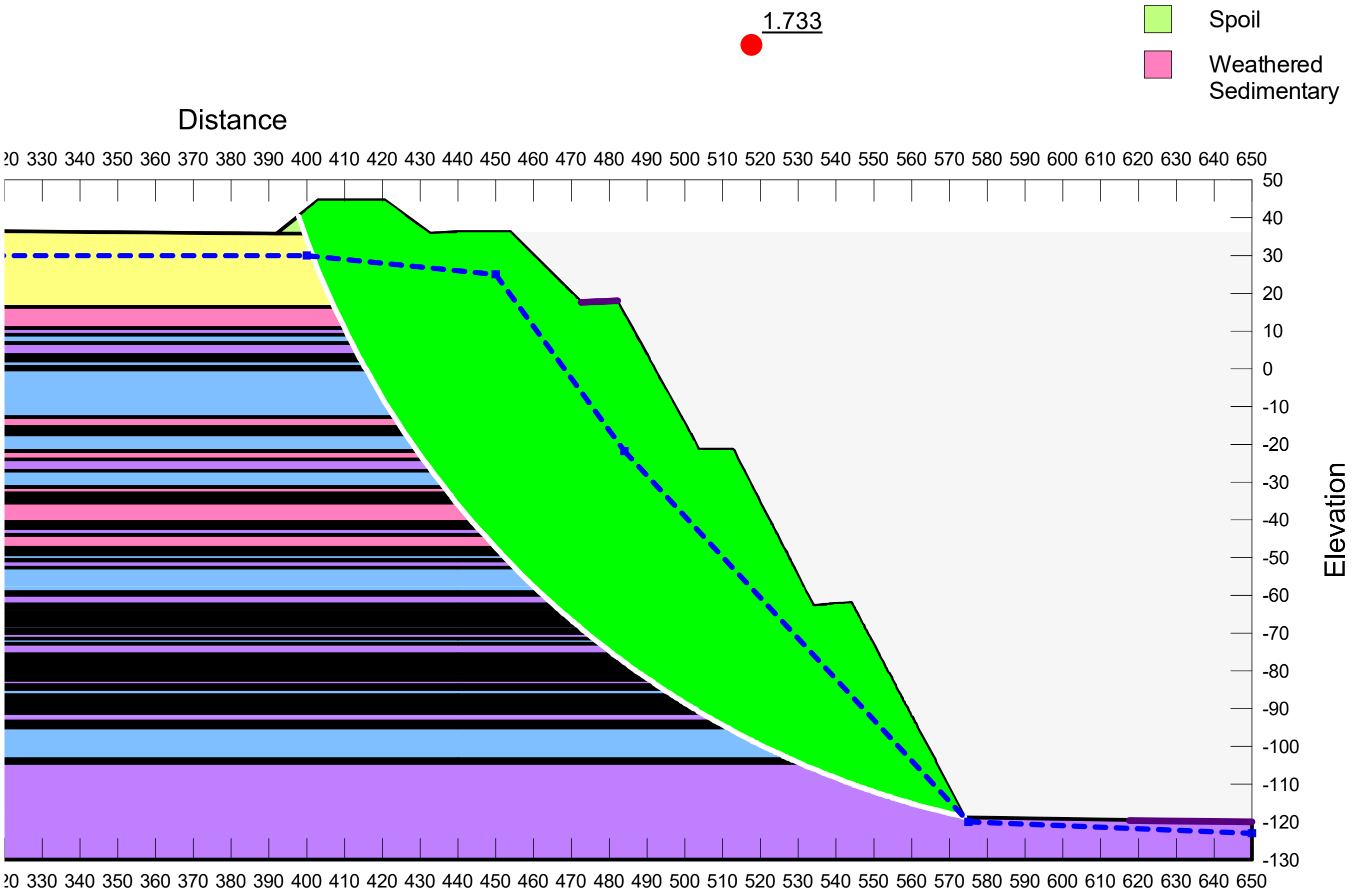
File Name: STX1903V7MeanPropsPlanar.gsz

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
■	Carbonaceous	Mohr-Coulomb	24.5	720	38.7	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟥	Impenetrable	Bedrock (Impenetrable)					
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,470	52.1	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	795	44.9	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
■	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Kind: SLOPE/WFile Name: STX1903V6Low PropsGoodBlasting.gszName: Cut2b

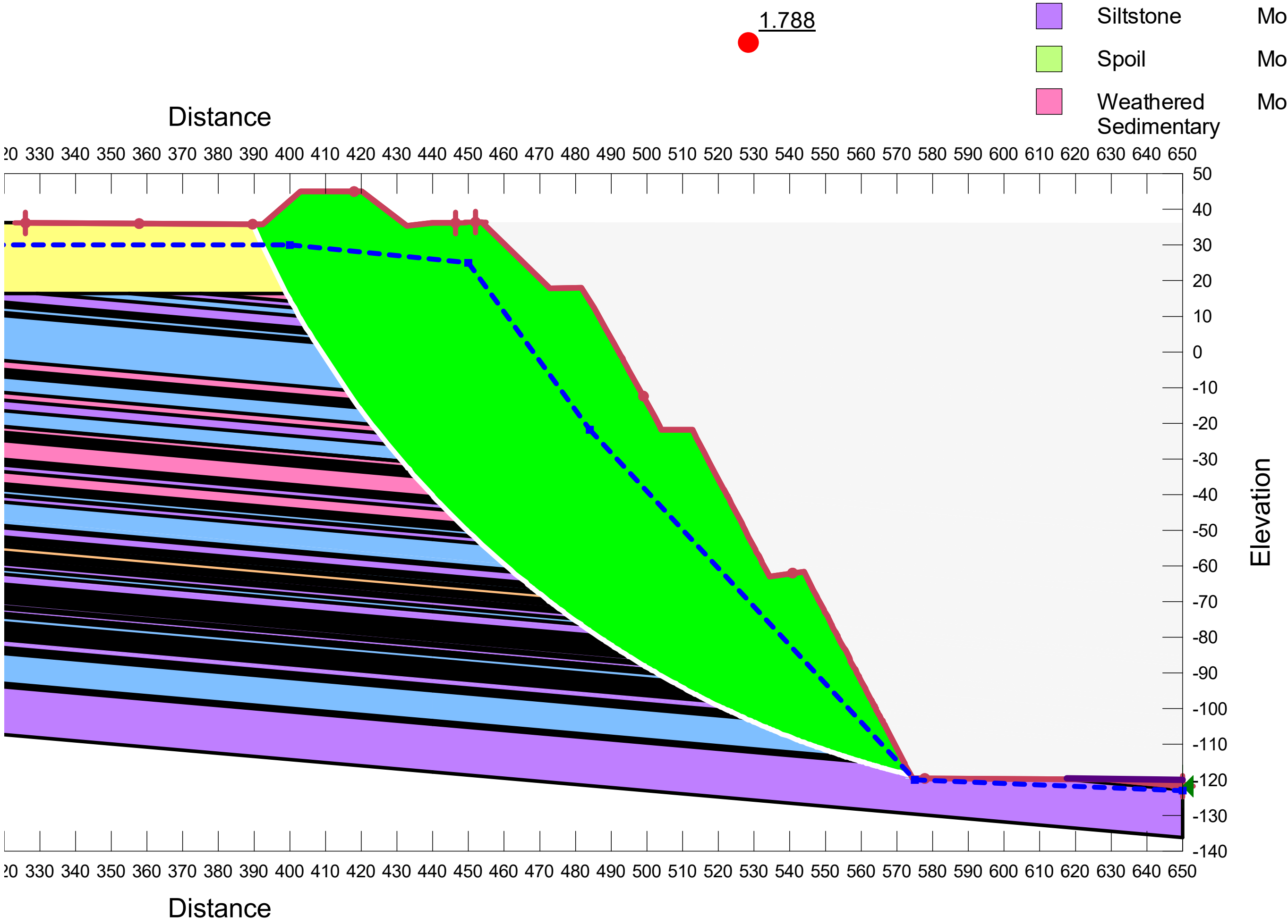
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	590	34.5	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	285	19.8	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,000	45.4	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	660	40.8	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Method: {CurrentAnalysis.MetName: Cut2bhod}Kind: SLOPE/W

File Name: STX1903V7LowPropsGood BlastingPlanar.gsz

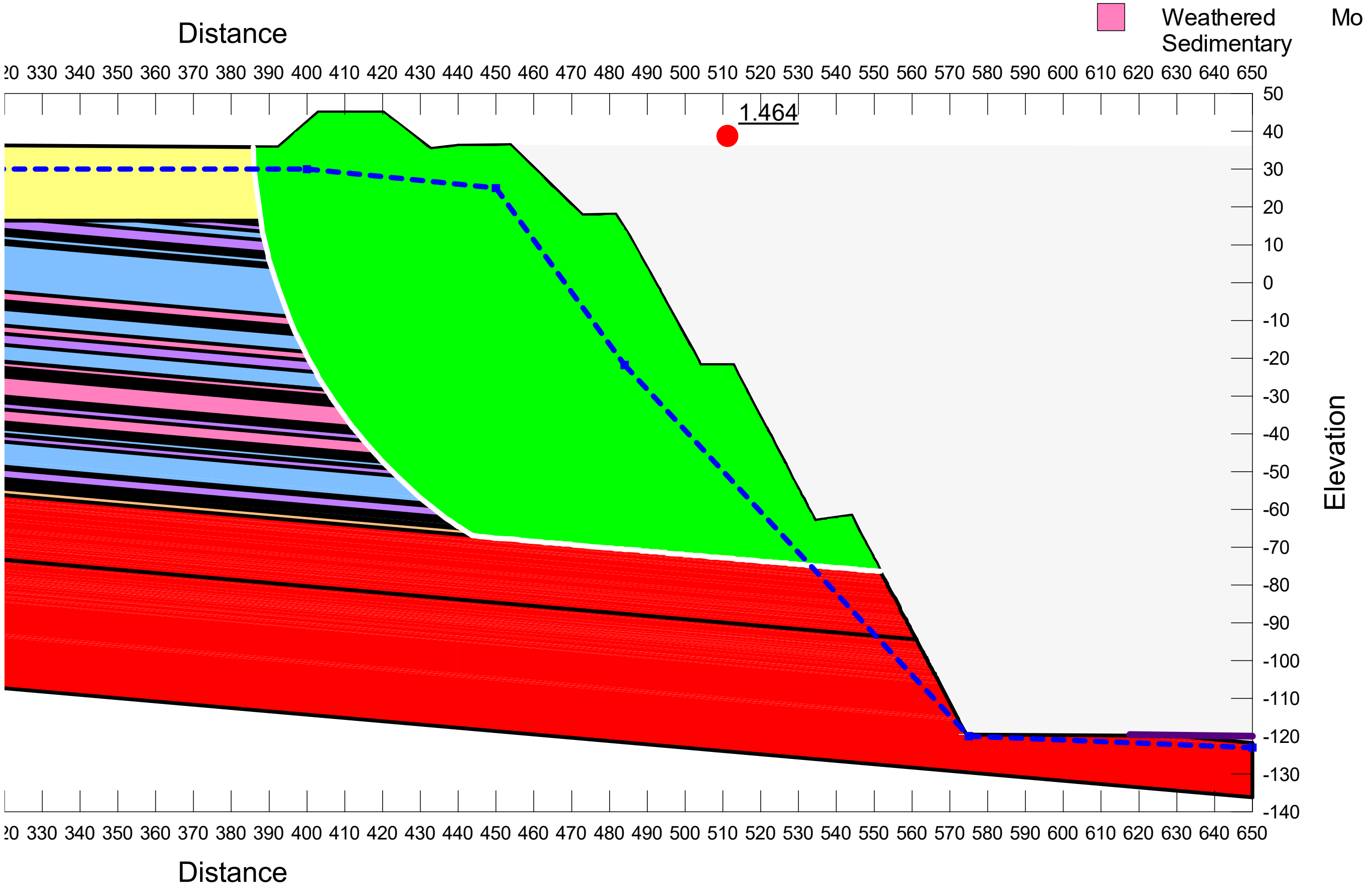
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
🟥	Carbonaceous	Mohr-Coulomb	24.5	590	34.5	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,000	45.4	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	660	40.8	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
🟥	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Method: {CurrentAnalysis.MetName: Cut2d Shear Zonehod}Kind: SLOPE/W

File Name: STX1903V7LowPropsGood BlastingPlanar.gsz

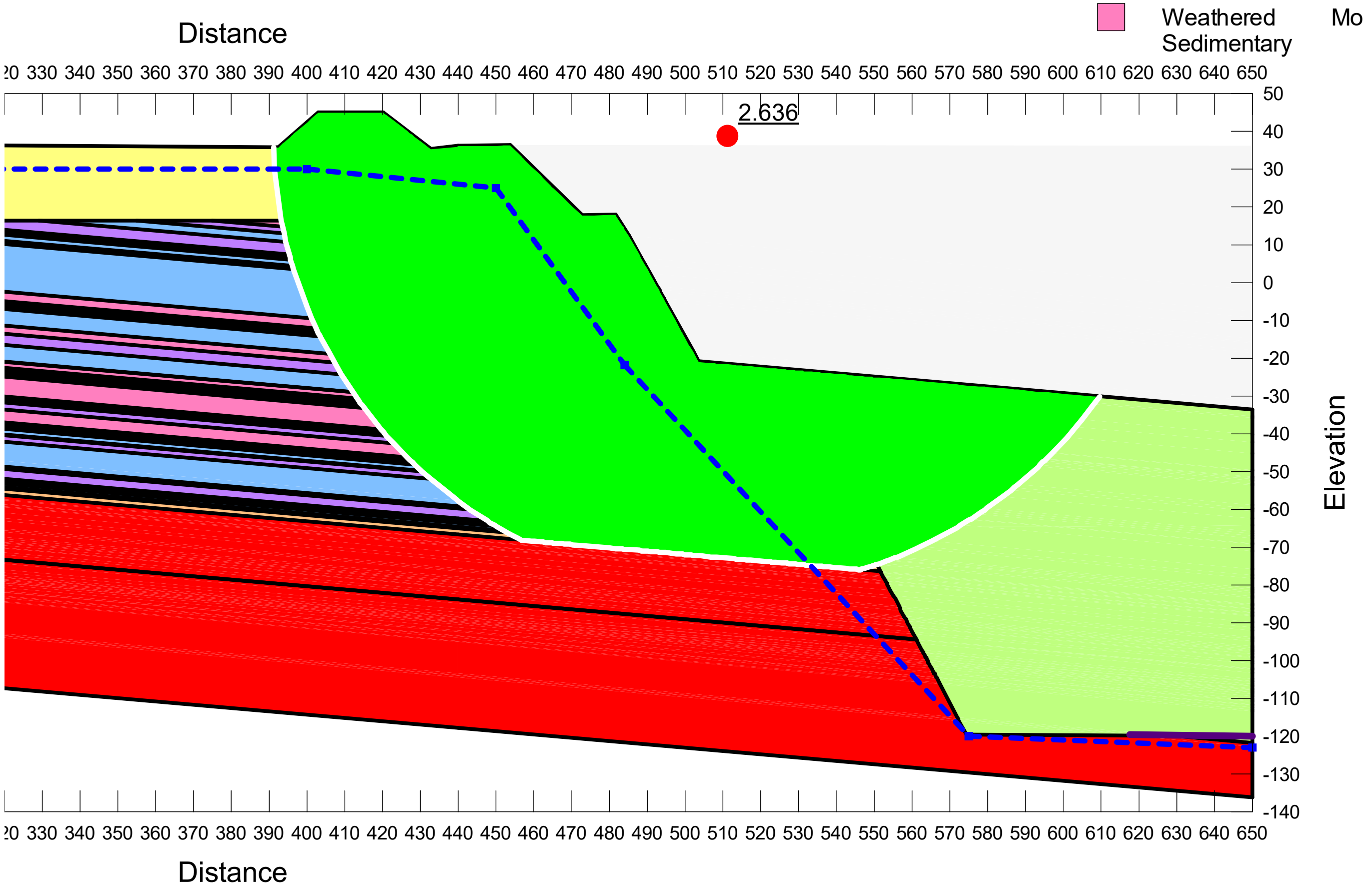
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
■	Carbonaceous	Mohr-Coulomb	24.5	590	34.5	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟥	Impenetrable	Bedrock (Impenetrable)					1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,000	45.4	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	660	40.8	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
■	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



Method: {CurrentAnalysis.MetName: Cut2d Shear Zone Fillhod}Kind: SLOPE/W

File Name: STX1903V7LowPropsGood BlastingPlanar.gsz

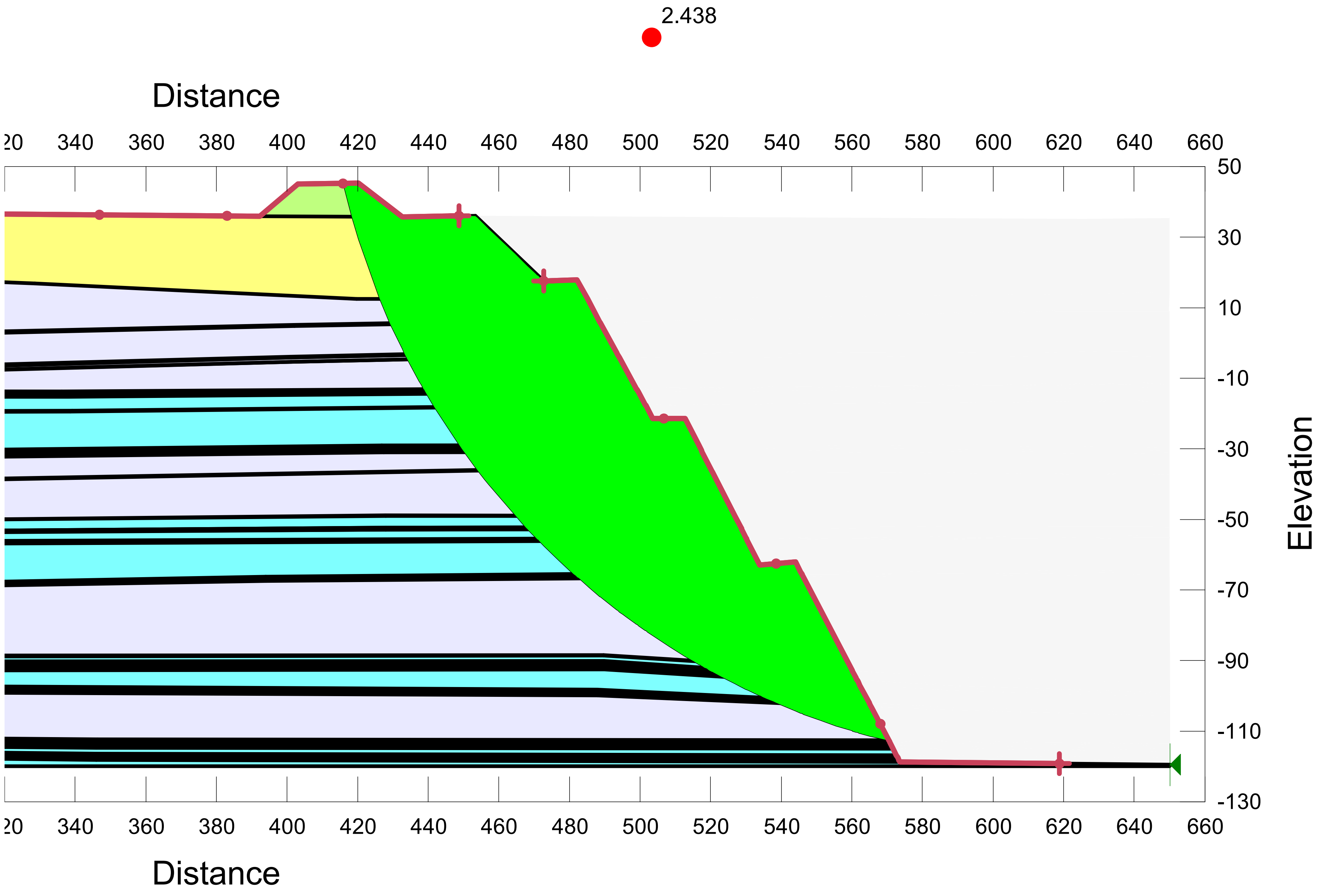
Color	**Name**	**Model**	**Unit Weight (kN/m³)**	**Cohesion' (kPa)**	**Phi' (°)**	**Phi-B (°)**	**Piezometric Line**
▨	Carbonaceous	Mohr-Coulomb	24.5	590	34.5	0	1
⬛	Coal Fr	Mohr-Coulomb	14.7	410	25.4	0	1
🟥	Impenetrable	Bedrock (Impenetrable)					1
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	1
🟦	Sandstone Fr	Mohr-Coulomb	24.5	1,000	45.4	0	1
🟧	Shear Zone	Mohr-Coulomb	18	0	20	0	1
🟪	Siltstone	Mohr-Coulomb	24.5	660	40.8	0	1
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	1
▨	Weathered Sedimentary	Mohr-Coulomb	24.5	500	34	0	1



File Name: CQCoal Sect5d2020a.gsz

Name: Slope Stability (3)

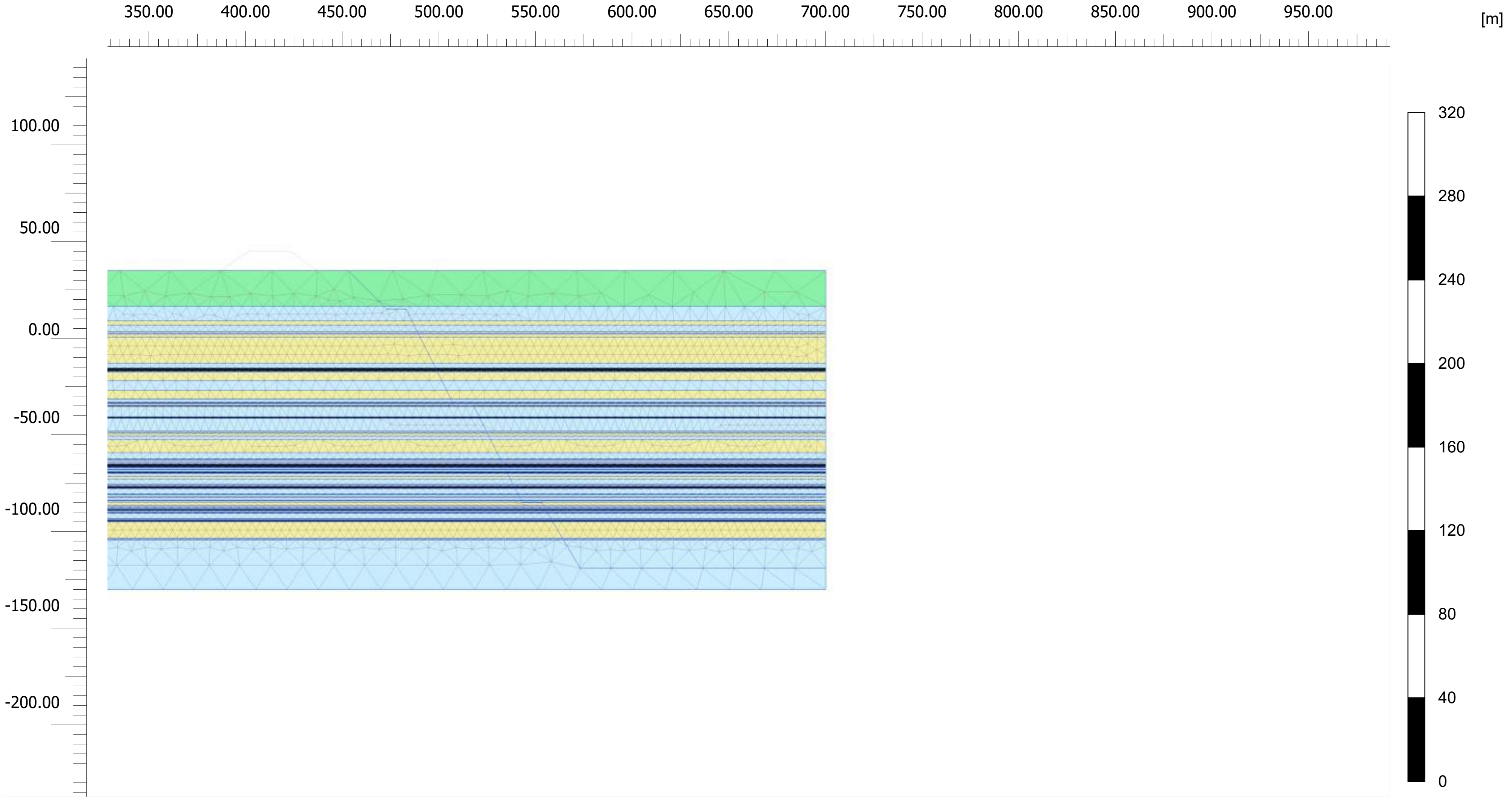
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Ru
⬛	Coal Fr	Mohr-Coulomb	14.7	285	19.9	0	0.15
⬜	Combined Sandstone Siltstone Hi GSI	Mohr-Coulomb	24	1,000	46.45	0	0.15
🟦	Combined Siltstone Carbonaceous	Mohr-Coulomb	24	845	42.3	0	0.15
🟫	Mudstone Fr	Mohr-Coulomb	19.6	410	25.4	0	0.15
🟨	Overburden	Mohr-Coulomb	19.6	40	25	0	0.15
🟩	Spoil	Mohr-Coulomb	18.6	0	34	0	0.15



APPENDIX

H

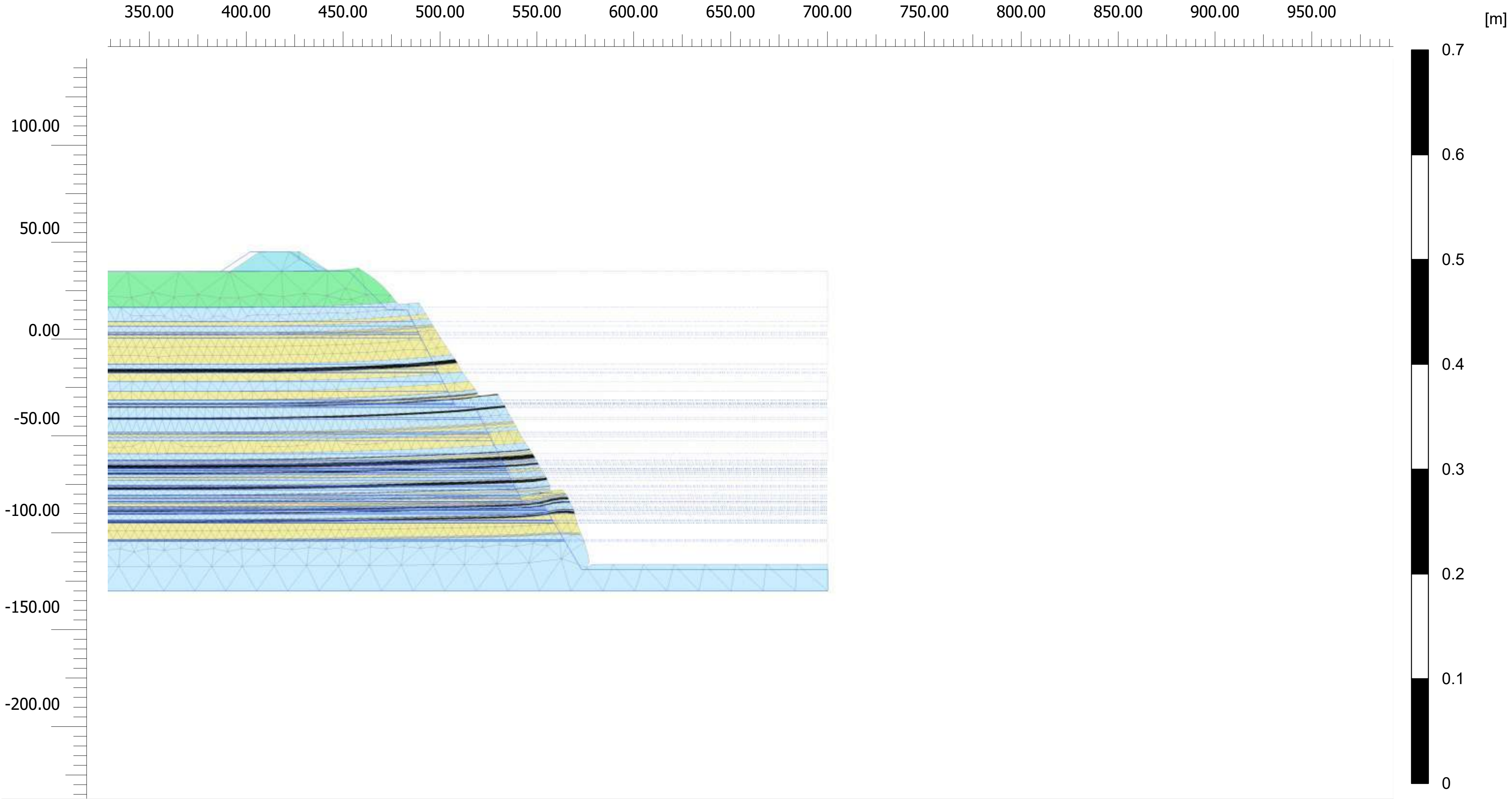
DEFORMATION MODELLING



Deformed mesh |u| (at true scale)

Uniform value of 0.000 m

PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5biso	*Step* 0	*Company* Cardno Pty Limited

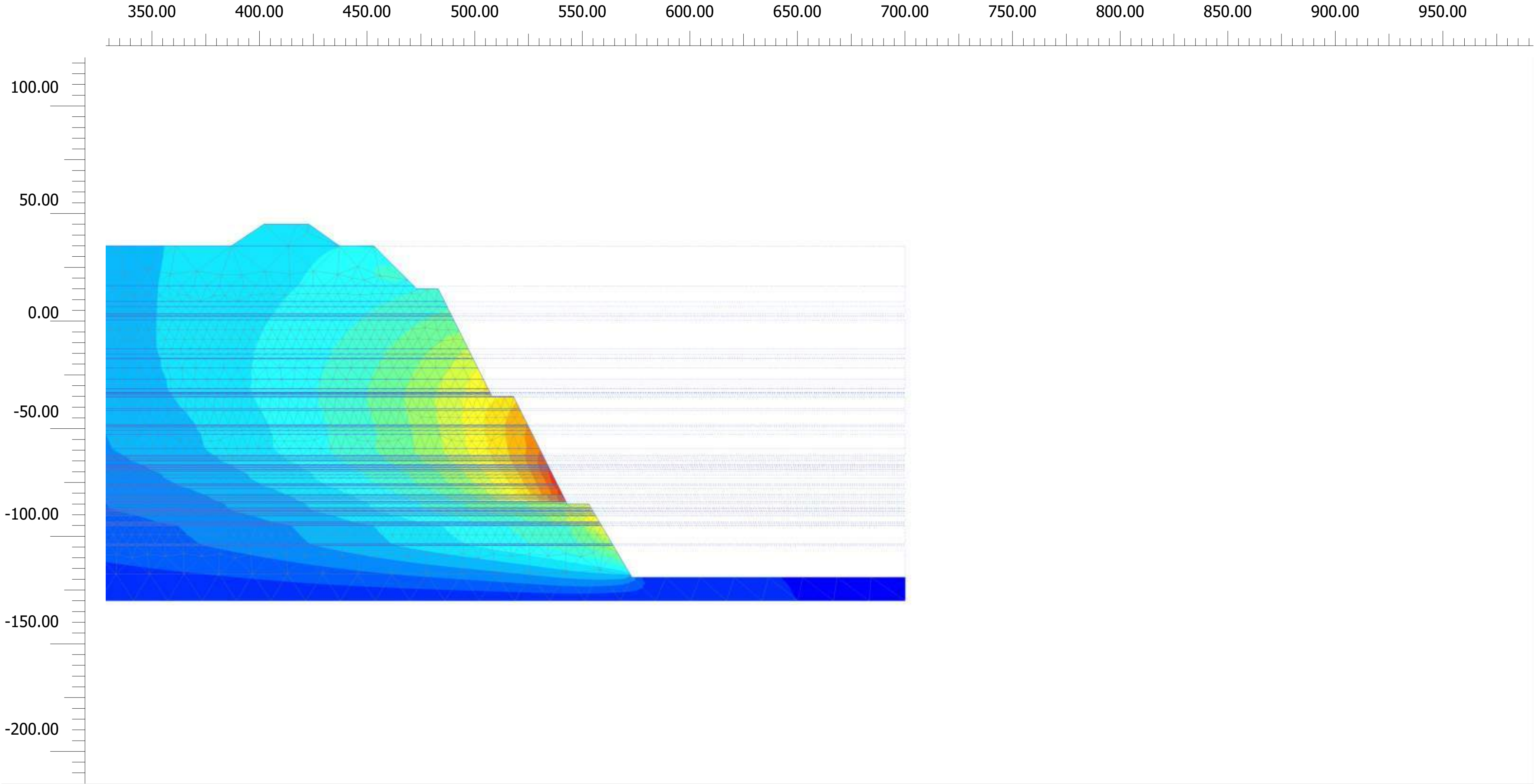


Deformed mesh |u| (scaled up 500 times)

Maximum value = 0.03362 m (Element 16596 at Node 107294)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5biso	*Step* 68	*Company* Cardno Pty Limited	



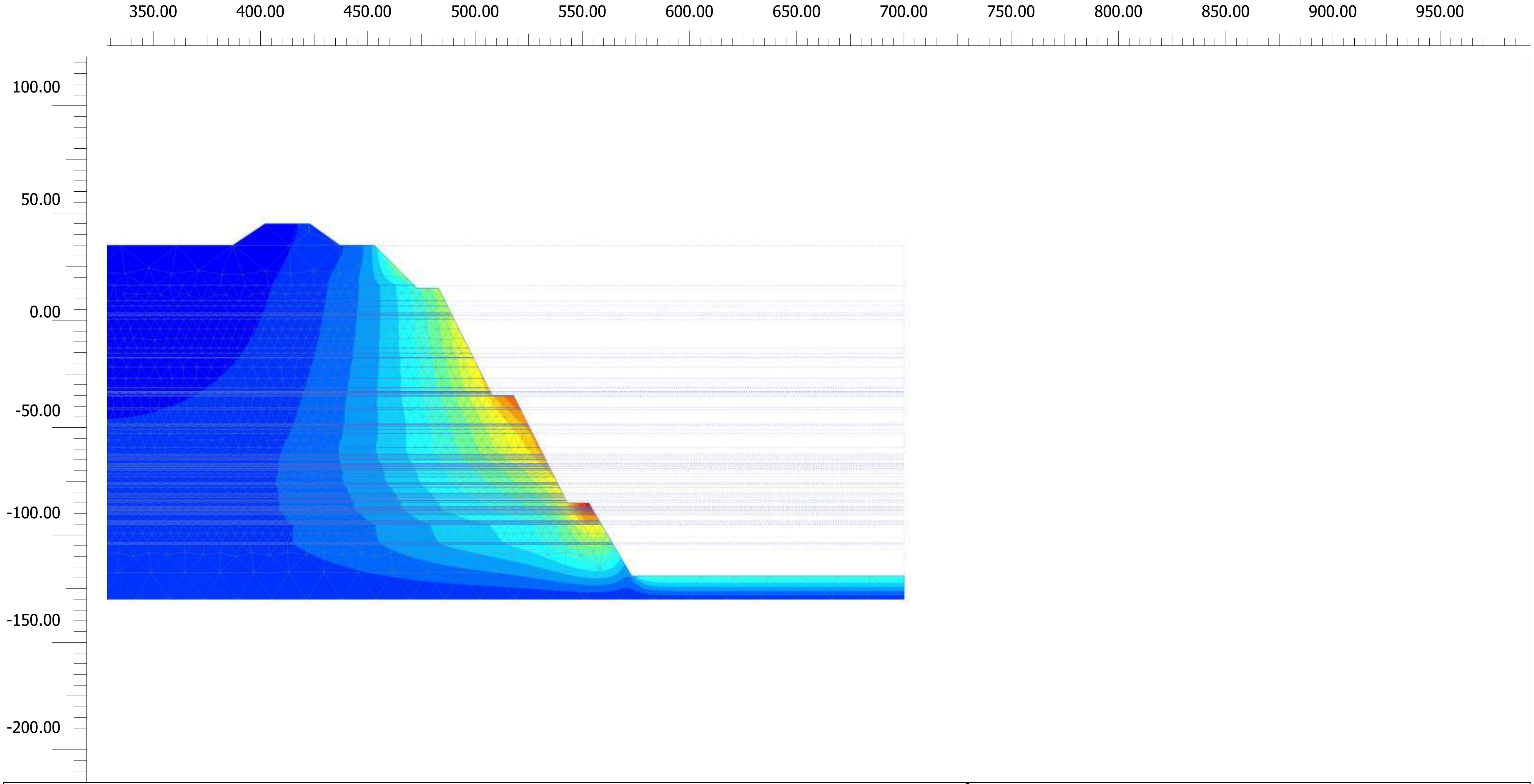
Total displacements u_x (scaled up 500 times)

Maximum value = 0.03206 m (Element 16596 at Node 107294)

Minimum value = $-3.236*10^{-6}$ m (Element 25181 at Node 148852)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5biso	*Step* 68	*Company* Cardno Pty Limited	

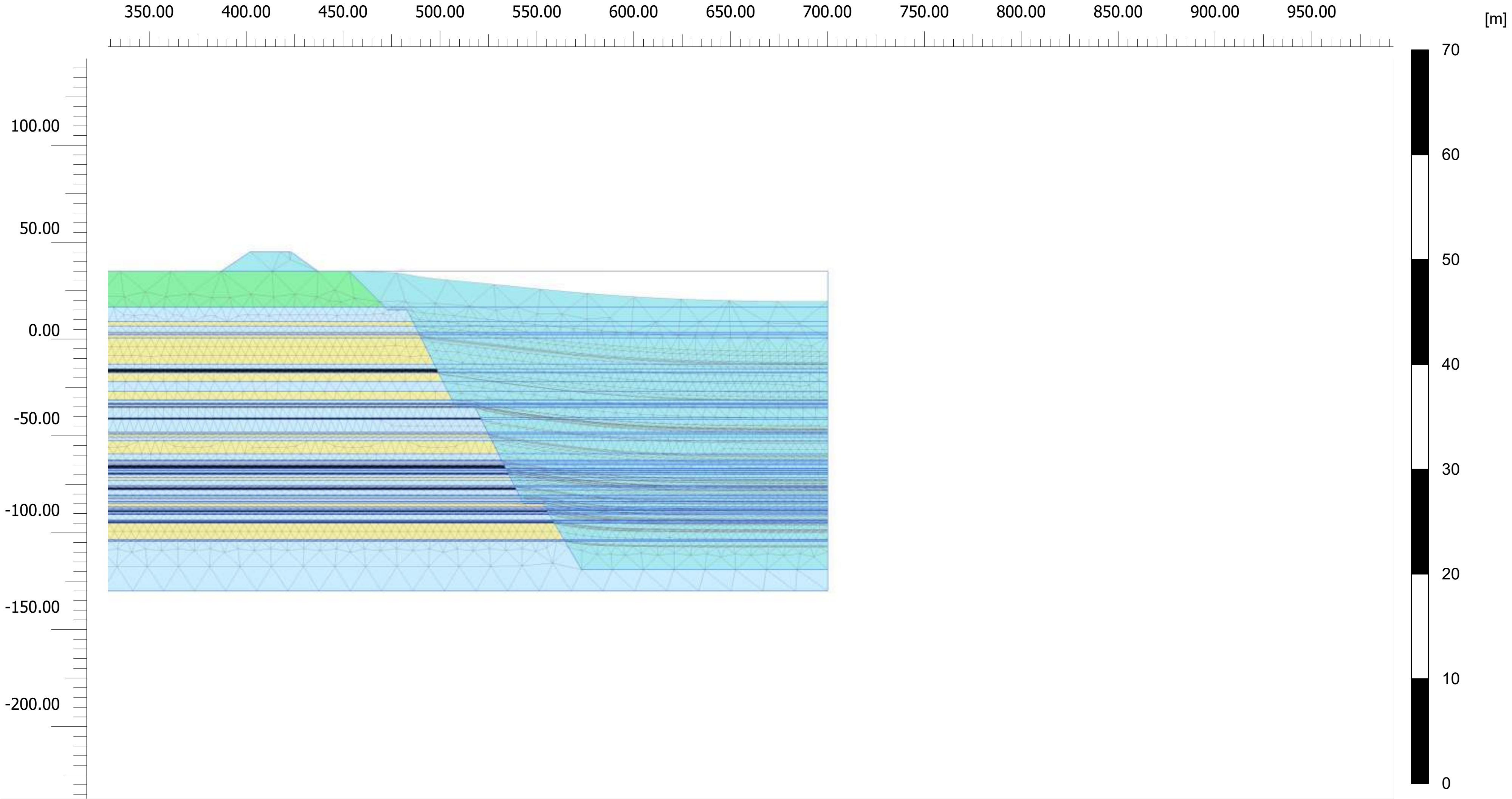


Total displacements u_y (scaled up $1.00*10^3$ times)

Maximum value = 0.01488 m (Element 19845 at Node 129933)

Minimum value = $-0.9234*10^{-3}$ m (Element 135 at Node 15953)

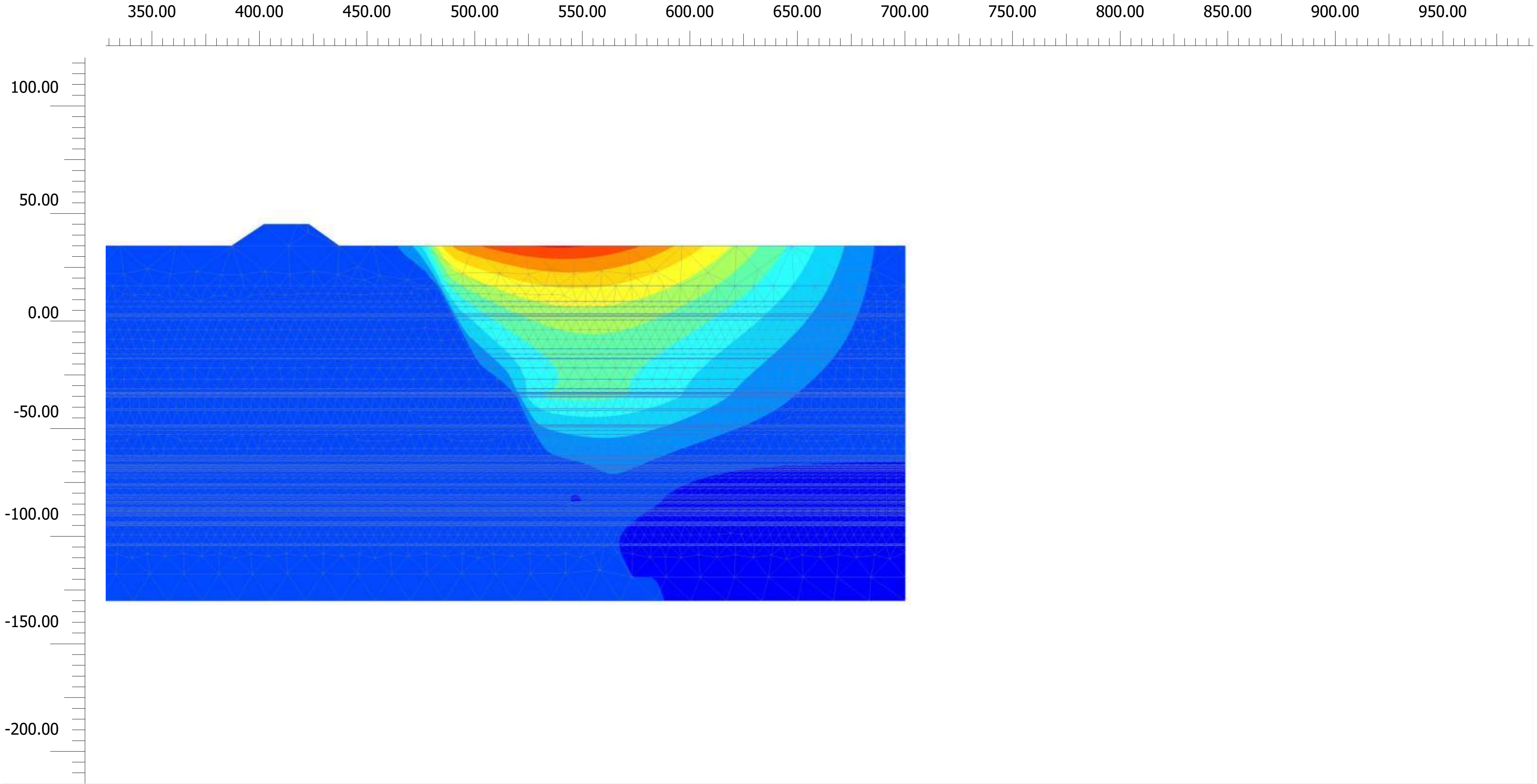
PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5biso	*Step* 68	*Company* Cardno Pty Limited



Deformed mesh |u| (scaled up 5.00 times)

Maximum value = 3.151 m (Element 75 at Node 7)

PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5biso	*Step* 87	*Company* Cardno Pty Limited



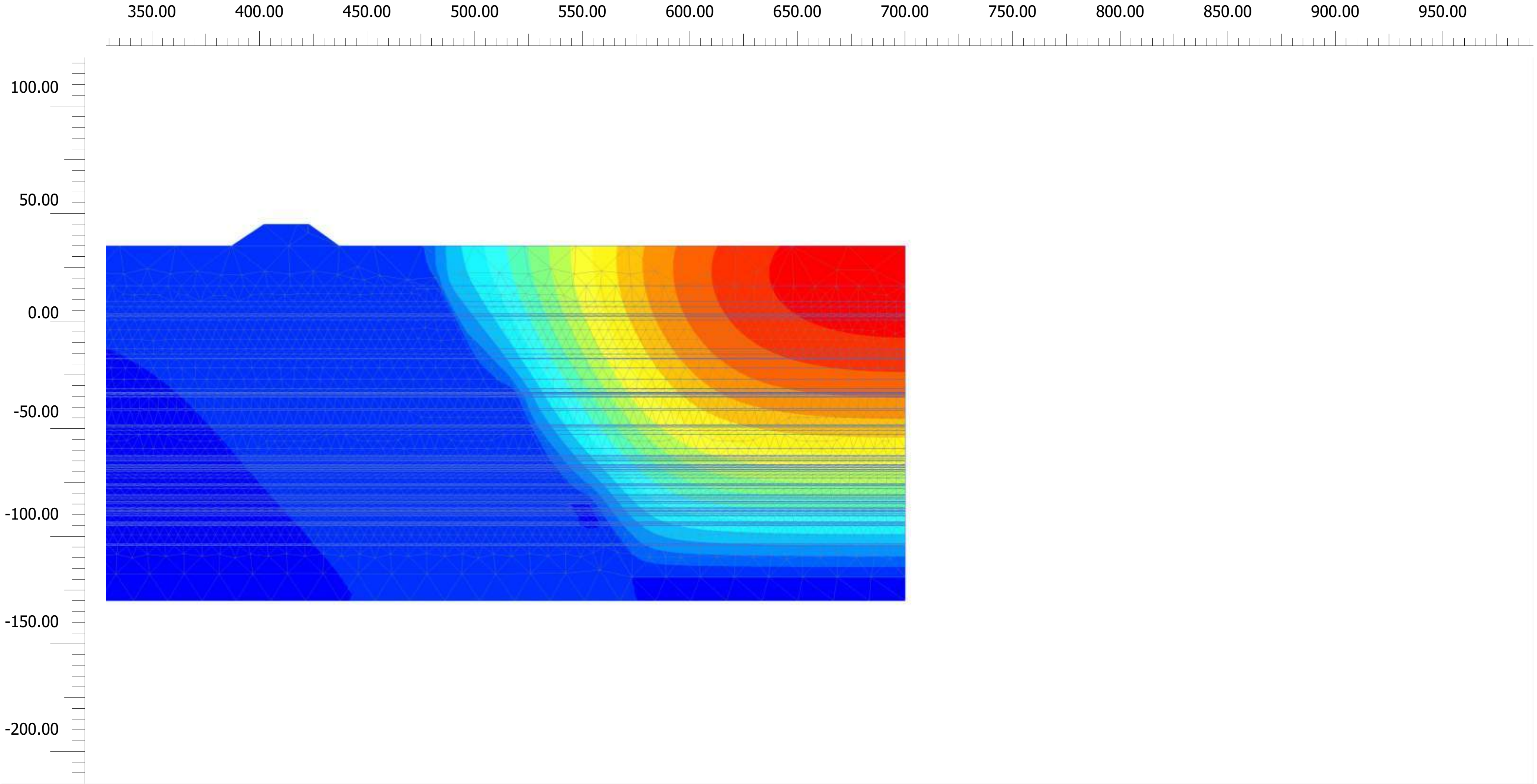
Total displacements u_x (scaled up 20.0 times)

Maximum value = 1.015 m (Element 69 at Node 2784)

Minimum value = -0.07919 m (Element 23752 at Node 153873)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5biso	*Step* 87	*Company* Cardno Pty Limited	

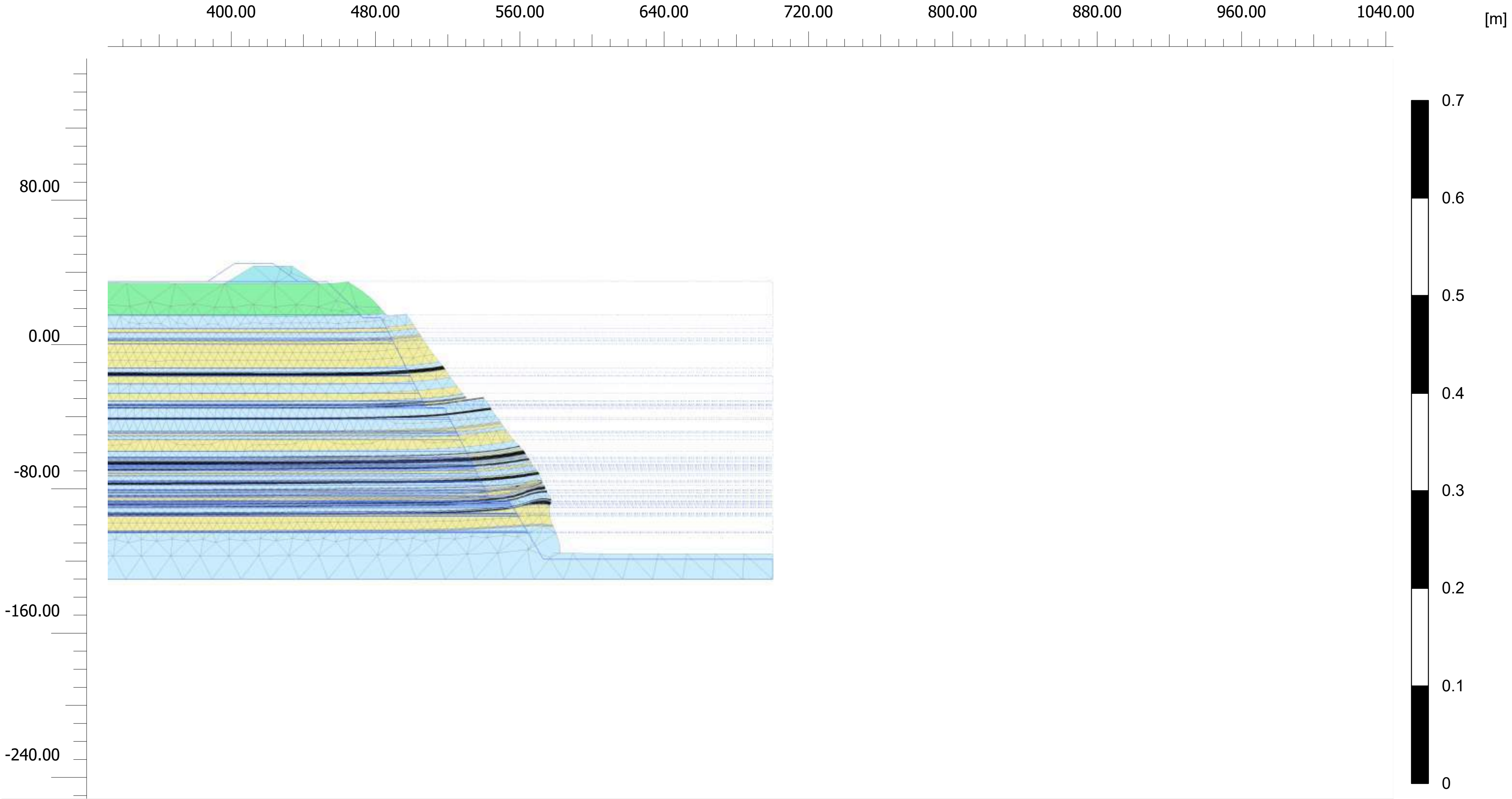


Total displacements u_y (scaled up 5.00 times)

Maximum value = $2.095*10^{-3}$ m (Element 25022 at Node 161465)

Minimum value = -3.151 m (Element 75 at Node 7)

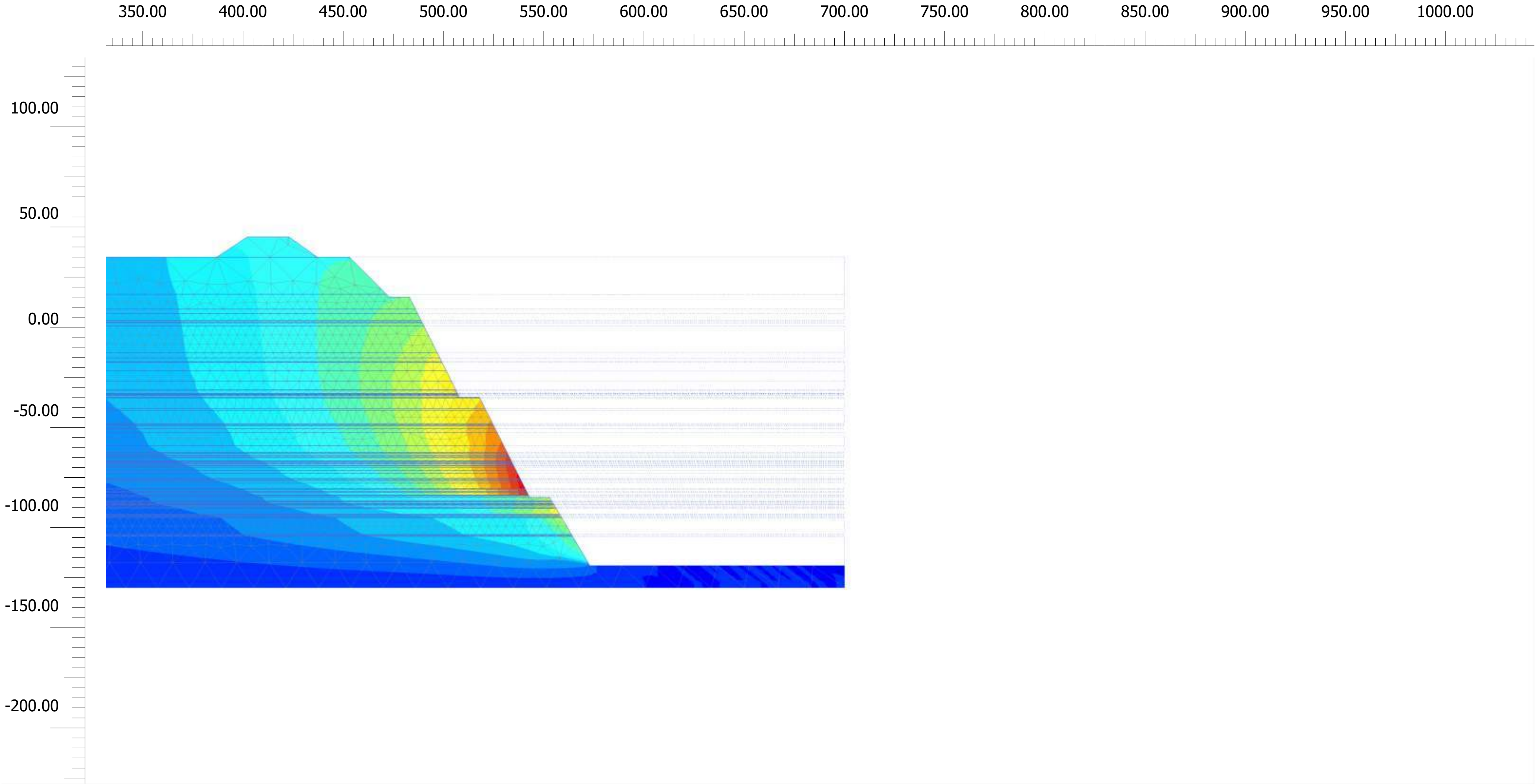
PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5biso	*Step* 87	*Company* Cardno Pty Limited



Deformed mesh |u| (scaled up 500 times)

Maximum value = 0.06397 m (Element 16596 at Node 107296)

PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5a15h	*Step* 39	*Company* Cardno Pty Limited



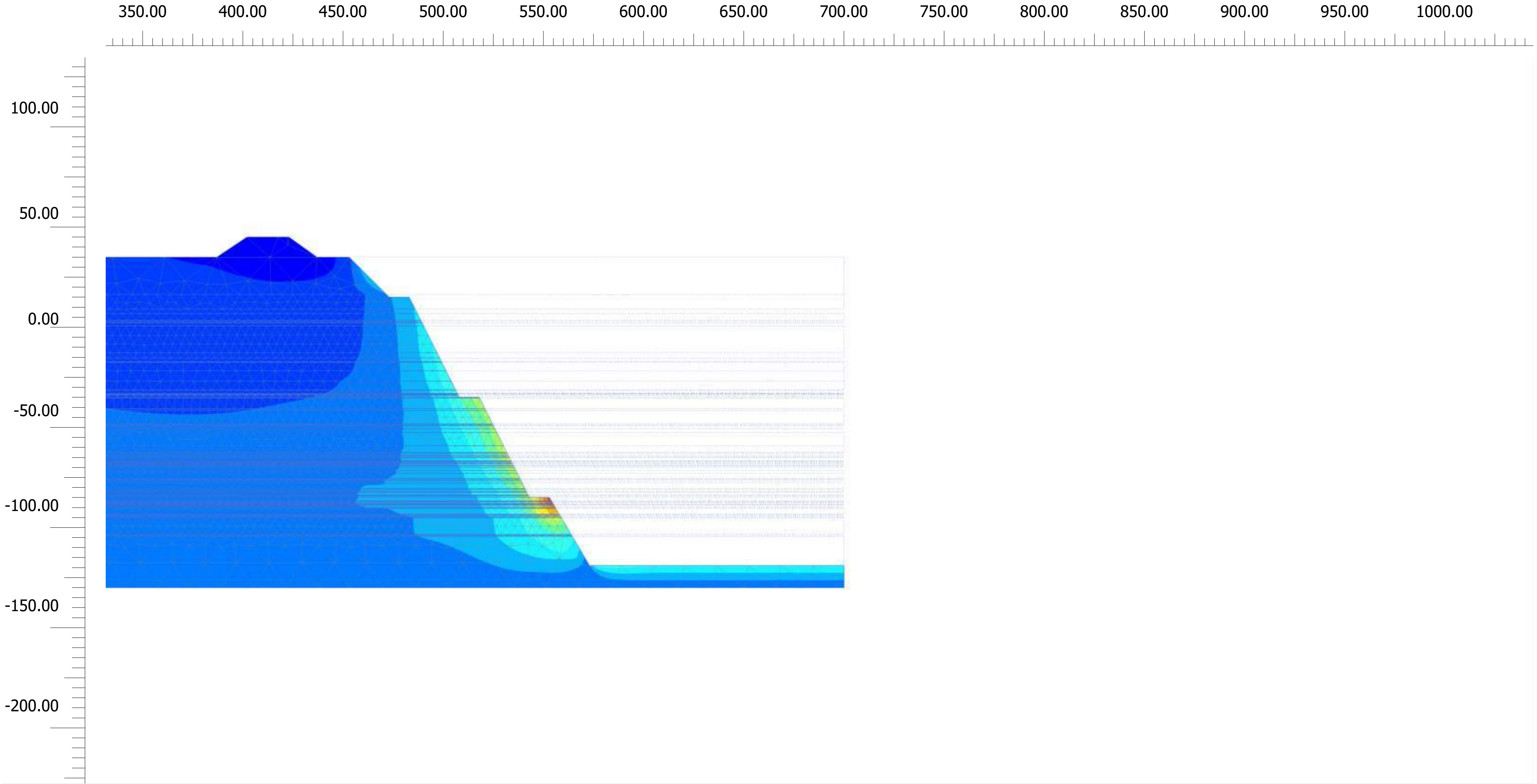
Total displacements u_x (scaled up 500 times)

Maximum value = 0.06286 m (Element 17251 at Node 111664)

Minimum value = $-0.05512*10^{-3}$ m (Element 25179 at Node 146052)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5a15h	*Step* 39	*Company* Cardno Pty Limited	



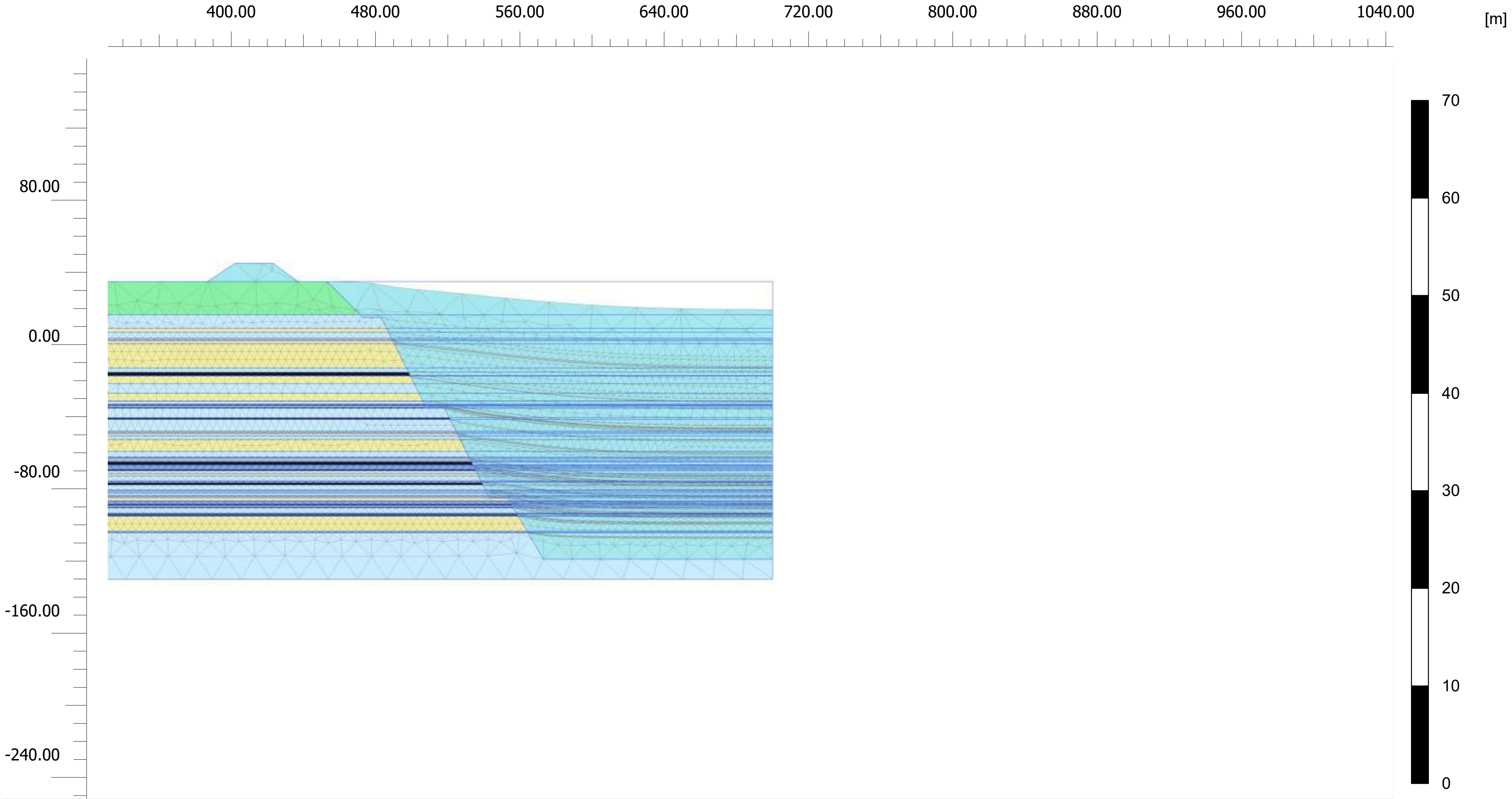
Total displacements u_y (scaled up 500 times)

Maximum value = 0.02263 m (Element 19845 at Node 129933)

Minimum value = $-3.113*10^{-3}$ m (Element 2 at Node 11677)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5a15h	*Step* 39	*Company* Cardno Pty Limited	

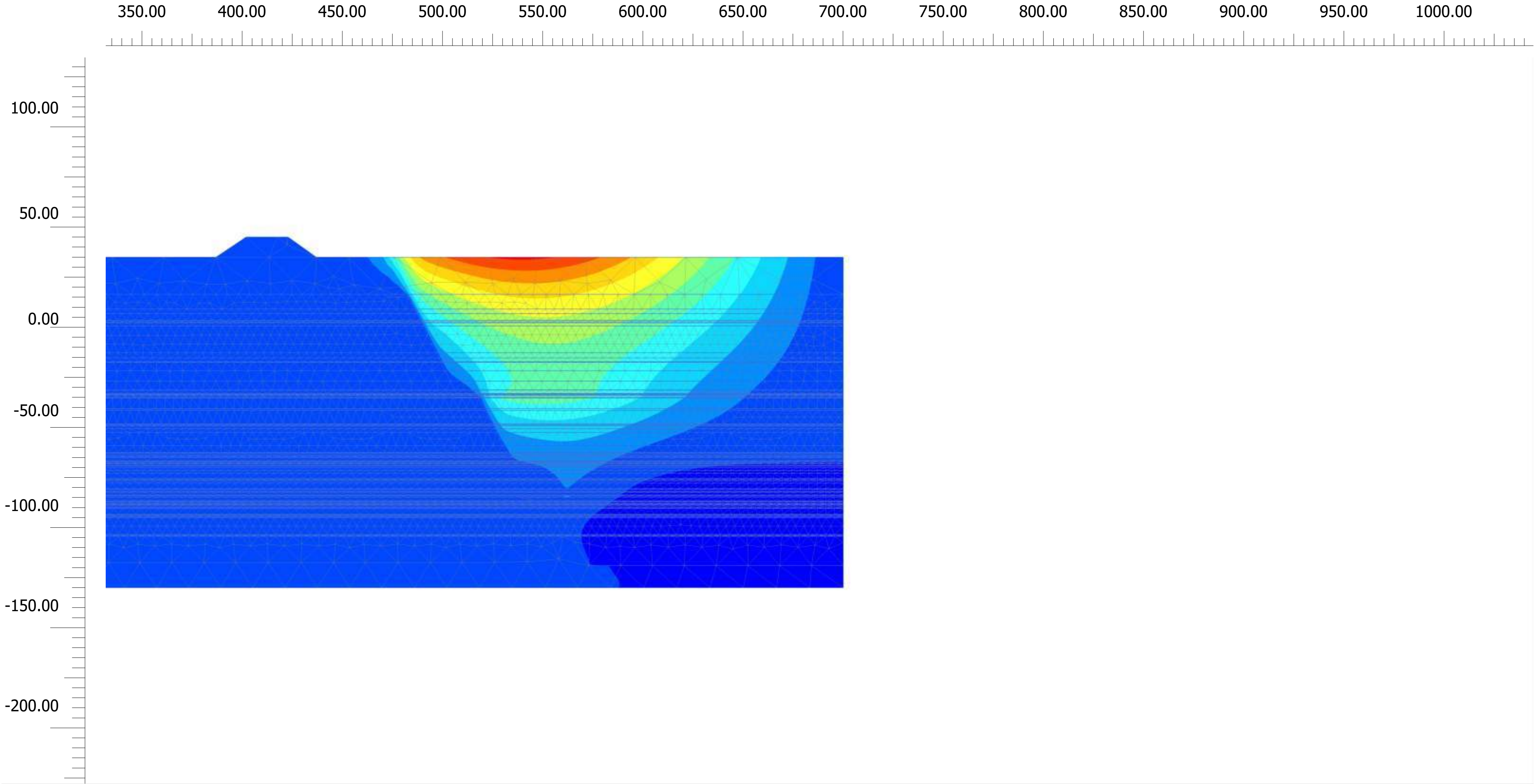


Deformed mesh |u| (scaled up 5.00 times)

Maximum value = 3.144 m (Element 75 at Node 7)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5a15h	*Step* 48	*Company* Cardno Pty Limited	

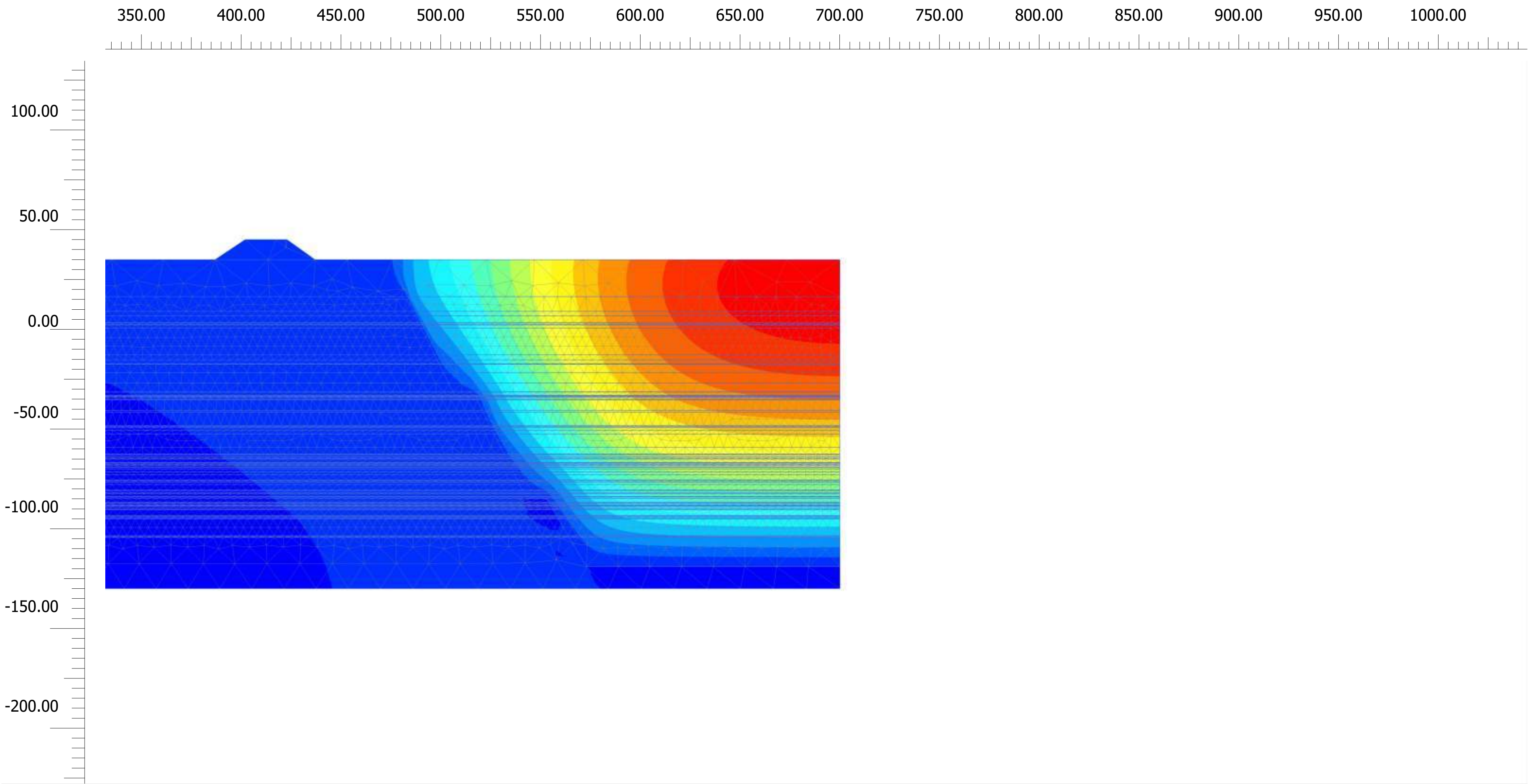


Total displacements u_x (scaled up 20.0 times)

Maximum value = 1.024 m (Element 69 at Node 2784)

Minimum value = -0.07362 m (Element 23757 at Node 152919)

PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5a15h	*Step* 48	*Company* Cardno Pty Limited



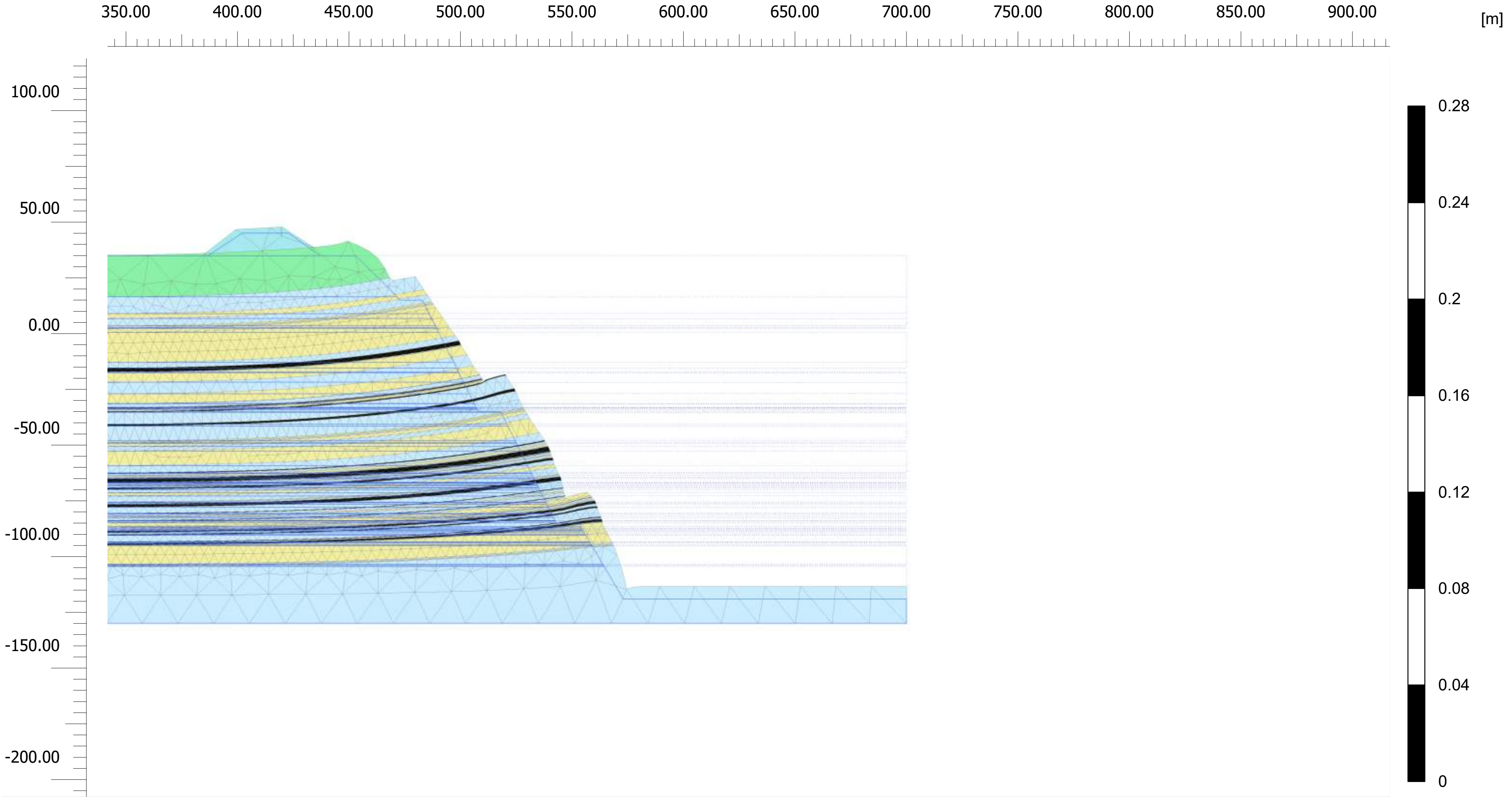
Total displacements u_y (scaled up 5.00 times)

Maximum value = $8.699*10^{-3}$ m (Element 19588 at Node 129933)

Minimum value = -3.144 m (Element 75 at Node 2)

PLAXIS

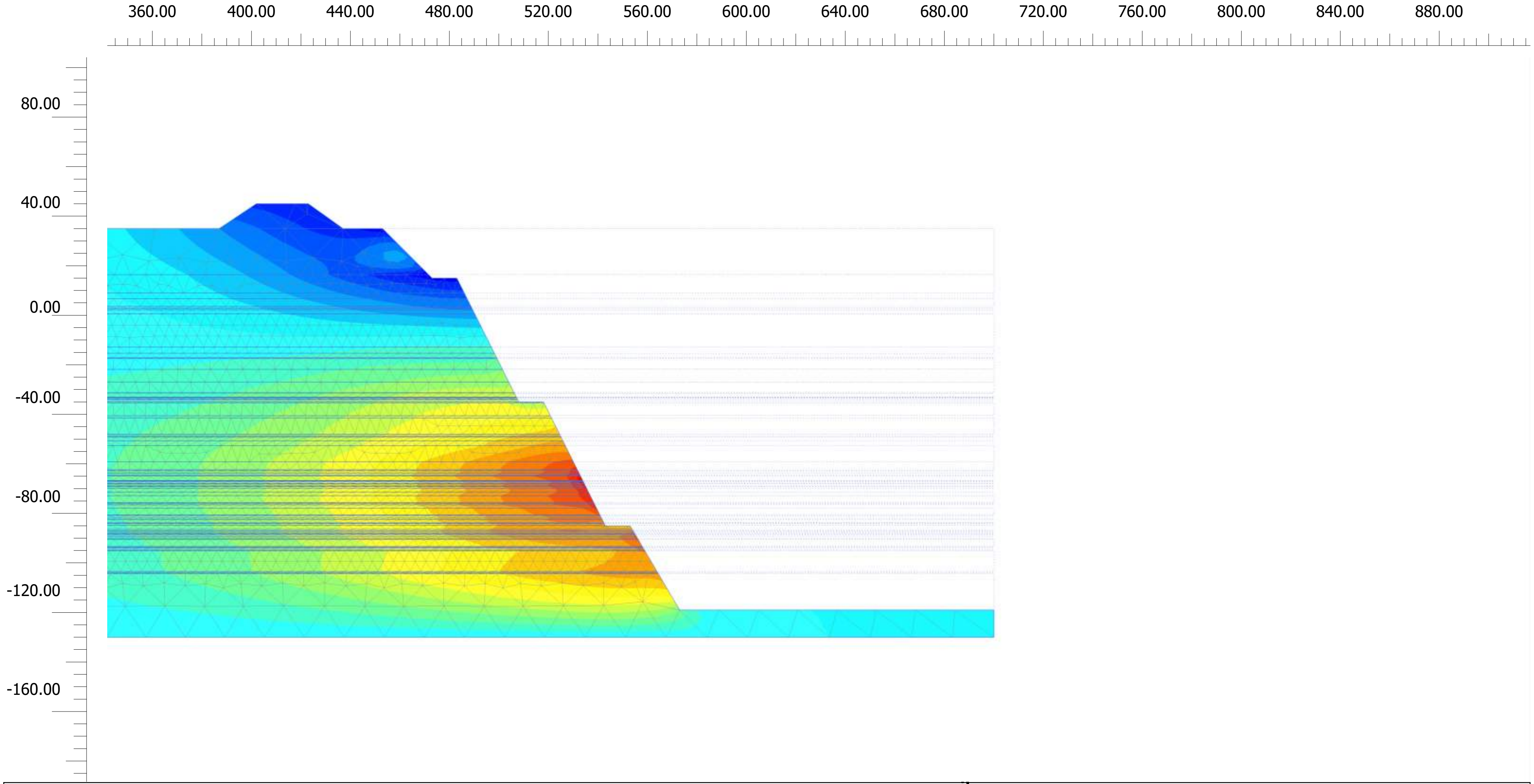
Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5a15h	*Step* 48	*Company* Cardno Pty Limited	



Deformed mesh |u| (scaled up $1.00*10^3$ times)

Maximum value = 0.01684 m (Element 7565 at Node 45119)

PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5cauto	*Step* 11	*Company* Cardno Pty Limited

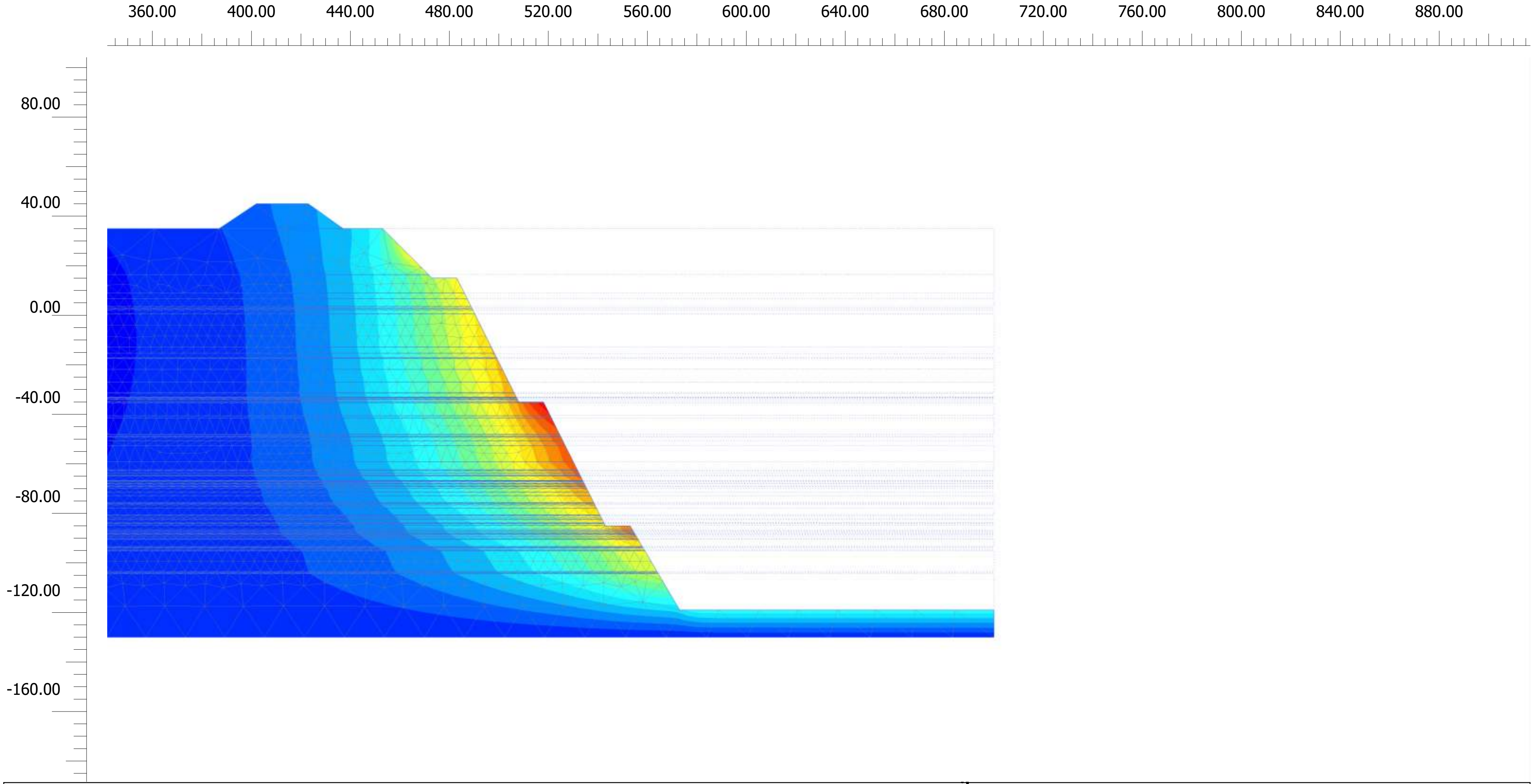


Total displacements u_x (scaled up $2.00*10^3$ times)

Maximum value = $6.358*10^{-3}$ m (Element 12392 at Node 79532)

Minimum value = $-3.409*10^{-3}$ m (Element 139 at Node 8293)

PLAXIS	*Project description* CQCoal XSect5			*Date* 25/08/2020
	Project filename STX1903AV5cauto	*Step* 11	*Company* Cardno Pty Limited	



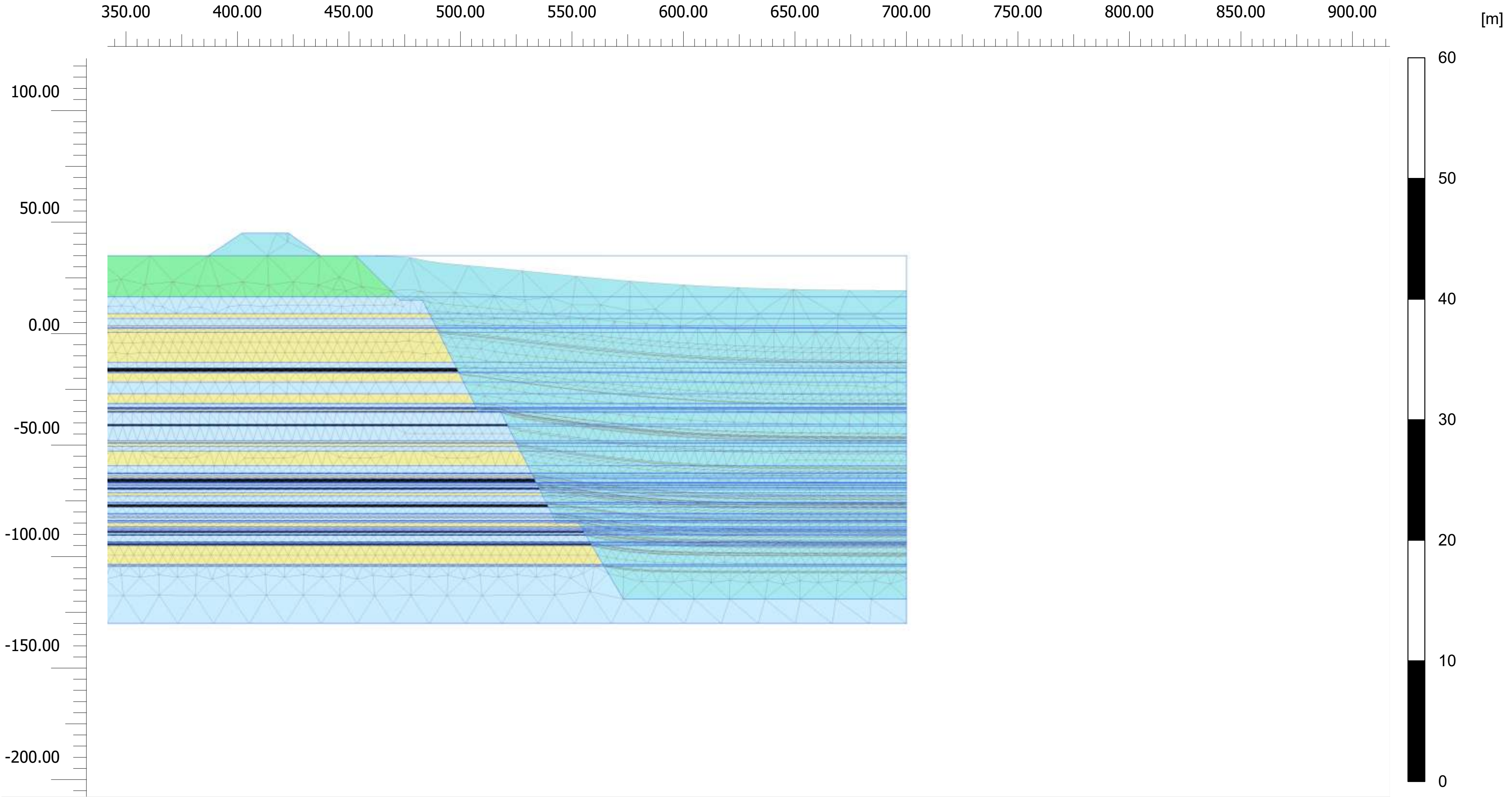
Total displacements u_y (scaled up $1.00*10^3$ times)

Maximum value = 0.01670 m (Element 7565 at Node 45119)

Minimum value = $-0.2397*10^{-3}$ m (Element 3011 at Node 26288)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5cauto	*Step* 11	*Company* Cardno Pty Limited	

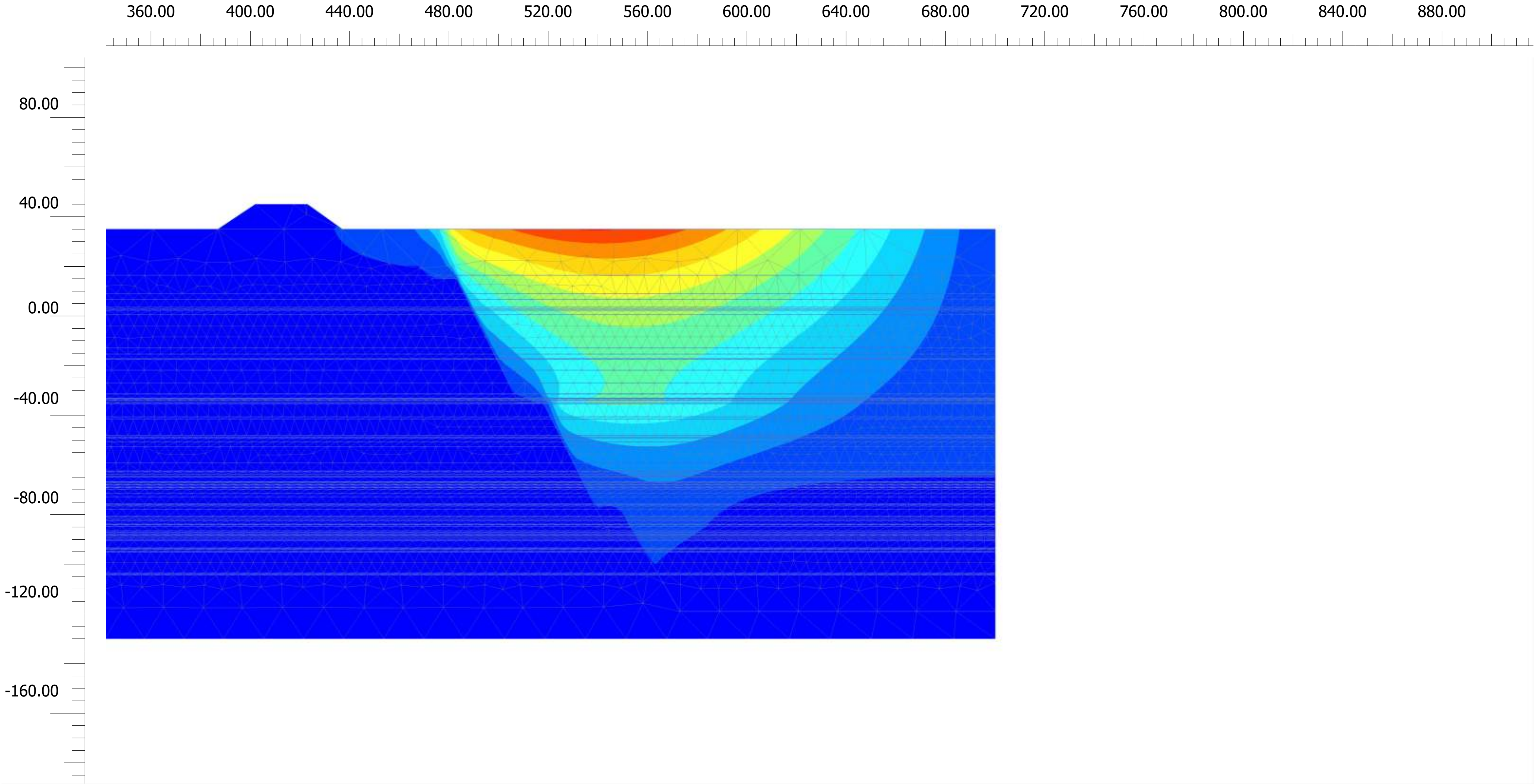


Deformed mesh |u| (scaled up 5.00 times)

Maximum value = 3.156 m (Element 75 at Node 7)

PLAXIS

Project description			*Date*
CQCoal XSect5			25/08/2020
Project filename	*Step*	*Company*	
STX1903AV5cauto	56	Cardno Pty Limited	



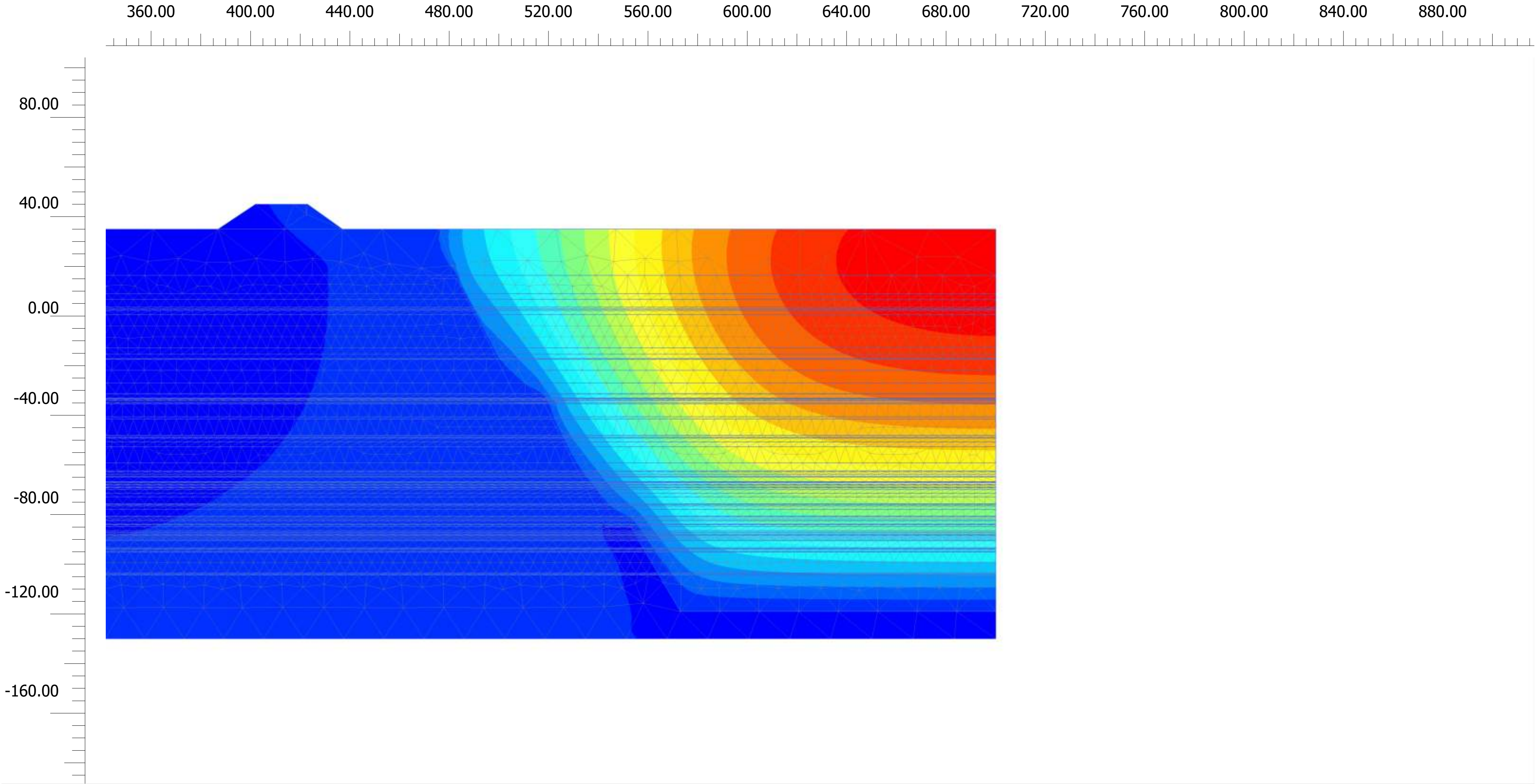
Total displacements u_x (scaled up 20.0 times)

Maximum value = 1.008 m (Element 69 at Node 2784)

Minimum value = -0.08455 m (Element 23752 at Node 153869)

PLAXIS	*Project description* CQCoal XSect5		*Date* 25/08/2020
	Project filename STX1903AV5cauto	*Step* 56	*Company* Cardno Pty Limited

Output Version 20.0.0.119



Total displacements u_y (scaled up 5.00 times)

Maximum value = $2.276*10^{-3}$ m (Element 25022 at Node 163531)

Minimum value = -3.156 m (Element 75 at Node 7)

PLAXIS

Project description CQCoal XSect5			*Date* 25/08/2020
Project filename STX1903AV5cauto	*Step* 56	*Company* Cardno Pty Limited	