Toowoomba Bypass
Summary Analysis of Design/Construction of Batter Protection at Cut 21 and Cut 26

(Version 2.0)

Queensland Government

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Departmental approvals

Refer to the appropriate Risk Assessment Tool for relevant reviewer and approver

Date	Name	Position	Action required *(Review/endorse/approve)*	Due
9/01/2023	Dereck Sanderson	DD(Darling Downs)	Approve	9/01/2023

Risk level

☐ GACC major ☐ GACC minor ☐ High risk (but not GACC) ☐ Medium risk

Prepared by	Bruce Ollason
Title	Project Director (Toowoomba Second Range Crossing)
District & Region	Darling Downs District
Branch & Division	Infrastructure Management Division
Project/program	
Project number	
Project location	
Status	
DMS ref. no.	

Contents

1. Overview

On 5 January 2023 the department received a media enquiry regarding the length and spacing of "stabilisation rods" in Cut 21 and Cut 26 which both have experienced geotechnical failures post-construction and are currently subject to significant repair works.

The purpose of this report is to give a high-level summary of the design and construction process related to cut batter treatments with particular reference to Cut 21 RHS and Cut 26 RHS.

(Note RHS is "right hand side " in the direction of chainage which is the northern side of the bypass where its alignment is running east-west.)

The two cuttings are both within the eastern section of the project which extends from the interchange with the Warrego Highway at Helidon in the east to the top of the range at the New England Highway.

This section is characterised by the steepest grades on the project, large cuts and large fills and a varied geology ranging from sections of strong and highly uniform basalt or sandstone to volcanically influenced sections with high variability of material types and strengths.

See locality map attached at Appendix 1.

This analysis has been carried out based on a review of the Issued for Construction (IFC) drawings and the As-built drawings which were produced by Nexus and reviewed and certified by the Independent Reviewer.

2. Roles under a Public Private Partnership

The Toowoomba Second Range Crossing (TSRC) project is a Public Private Partnership (PPP) contract (between the State and Nexus Infrastructure) underpinned by a Design and Construct sub-contract (Nexus Delivery) and an Operate and Maintain sub-contract (Nexus Operations and Maintenance).

One of the key elements of the PPP contract model is the role of the Independent Reviewer in key technical processes for the Design and Construct phase.

This role is considered a necessary mechanism to give confidence to lenders and equity investors that their interests are protected.

As a result, the role of TMR under these arrangements is different to the role it normally adopts on the majority of its contracts.

In the context of this report, the key difference of significance is that TMR does not have an approval role in the design and construction activities.

The Independent Reviewer is tasked with reviewing and certifying the design and construction activities.

3. Design Process

Nexus have been contracted to design and construct the TSRC in accordance with the project-specific Performance Specification which calls up TMR's various design guidelines and specifications and other design guidelines and codes, for example Austroads design guidelines.

The Performance Specification defines the design process that should be followed for the project.

The design process is an iterative one where a design at a designated level of maturity is submitted to the Independent Reviewer for review and comment.

The comments are fed back to Nexus and incorporated into the design work to take the design to the next level of maturity.

This process continues until the Issue for Construction (IFC) drawings are completed and certified by the Independent Reviewer.

During each iteration of the design the Independent Reviewer provides the design to TMR for comment.

The Independent Reviewer then includes the TMR comments it considers relevant in its list of comments and returns them to Nexus.

TMR has input to the design through its review role but is not the approver of the design.

4. Summary of Approach to Batter Treatments

The term "stabilisation rods" used in the media enquiry is not a term used on the project.

It is assumed the reference is to soil nails or bolts which is the terminology adopted in the TSRC design. These will be referred to simply as bolts for the purposes of this report.

Bolts used on cut faces were an integral part of the design elements used to protect the cut batter faces from the elements.

It should be noted these treatments are "local level" and designed to protect the cut face. They are not part of the geotechnical design to deliver large scale geotechnical stability across the cuttings.

These design elements fall into two broad categories:

i. Slope protection where the bolts are used to essentially hold erosion control matting on the face of the cut. The matting is a plastic filament matrix that is filled with a topsoil / hydromulch mix that will facilitate vegetation growth over time.

   This was the predominant treatment at Cut 21. (See details at Appendix 2)

ii. Slope reinforcement where the bolts hold steel mesh reinforcement in place to facilitate installation of a layer shotcrete facing to the batter.

   This was the predominant treatment at Cut 26. (See details at Appendix 3).

The designers had a broad understanding of the geology at each of the cuttings based on pre-tender site investigation reports which were supplemented with additional site investigations during the design phase.

Notwithstanding the availability of this information the designers recognised that the actual location and extent of the various materials can only be fully known once the cut face is excavated.

As a result, the design contains numerous references to determining final treatments on site based on either specific testing or geotechnical expert advice.

In other words, the design itself contemplated that there would be changes during the construction phase to reflect the actual site conditions encountered.

Of particular note is the schedule of "J bolts" which are designated as "to be determined on site" in the original drawings. In the case of Cut 21 the drawings advise "Spot bolting and ancillary support may be required on zones of increased weathering and fracturing.

During construction they were not required at Cut 21 and so the As-built schedule shows no "j bolts".

5. IFC Drawings and Requirements

The IFC drawings are the version that is approved at the end of the design cycle and are therefore the initial set of drawings for construction.

Relevant excerpts from the IFC drawings are attached at Appendix 4.

The bolt requirements as outlined in the IFC drawings are as follows:

i. Cut 21

Depending on batter slope and the type of material encountered the bolt requirements were 2.5 x 3 m spacing with 2 m length, 3 x 3 m spacing with 2 m length or 2.5 x 2.5 m spacing with 2.5 m length.

ii. Cut 26

The bolt requirements were 2.0 x 2.5 m with 3 m length.

6. Updated IFC Drawings

During construction in 2017 there was a significant geotechnical failure of Embankment 24.

This required a re-design which resulted in the motorway alignment pushing to the north from the original alignment.

Cut 26 is adjacent to Embankment 24 and so the shift in alignment made it necessary to re-design Cut 26.

The IFC drawings were updated to incorporate the changes from the re-alignment and these were then issued for construction.

Relevant excerpts from the re-issued IFC drawings are attached at Appendix 5.

The bolt requirements as outlined in the updated IFC drawings are as follows:

ii. Cut 21

The requirements for Cut 21 remained unchanged from the original IFC drawings

iii. Cut 26

The bolt requirements were 2.5 x 2.5 m staggered spacing with 3 m length except at Batter 1 which required 5 m length.

7. As-built Drawings

The As-built drawings are the documented record of what was constructed.

Relevant excerpts from the As-built drawings are attached at Appendix 6.

The actual spacings and lengths of bolts constructed were as follows:

iii. Cut 21

Depending on batter slope and the type of material encountered the bolt parameters of 2.5 x 3 m spacing with 2 m length, 3 x 3 m spacing with 2 m length or 2.5 x 2.5 m spacing with 2.5 m length were adopted in line with the IFC drawings.

iv. Cut 26

The bolt parameters adopted were all at 2.5 x 2.5 m staggered spacings but depending on location in the cutting the lengths were either 3m or 6 m.

8. Likely Geotechnical Failure Mechanisms

As mentioned in Section 4 the bolting that has been carried out on the project is part of "local level" treatments that are designed to protect the face of the cut batters from the elements over time.

Although protecting the faces of cuttings is critically important for the general stability and durability of the cuttings these protection treatments are not part of the geotechnical design to provide the large-scale stability of the cuttings.

The inference that changes in bolt spacing and lengths has led to the failures in Cut 21 and Cut 26 is misplaced.

In general terms the large-scale stability problems being encountered at these cuttings has resulted from deep seated thin lenses of poor material being weakened by the ingress of water resulting in a loss of resistance and an inability to support the material above them.

A cross-section from Cut 26 showing the geological layering and likely failure planes is attached at Appendix 7.

9. Conclusion

The original design contemplated adjustments to the design during construction to reflect the ground conditions exposed during excavation.

The constructed works are generally in accordance with the original design (or re-design for Cut 26) and the variations to the design have not resulted in shortening any bolts and in fact has resulted in longer bolts than originally scheduled in some sections of the design.

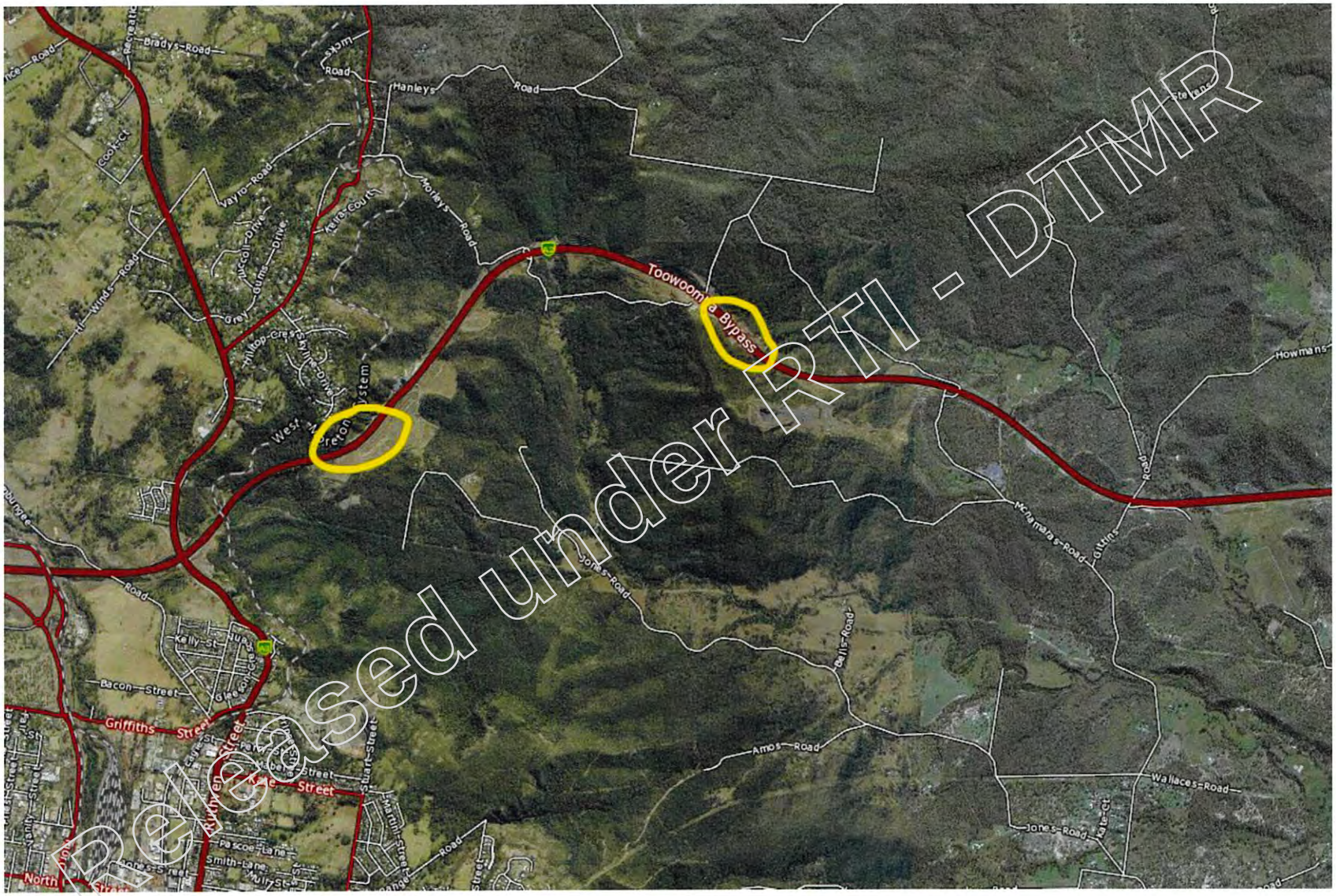
NR

Bruce Ollason
Project Director (Toowoomba Second Range Crossing)

9 January 2023

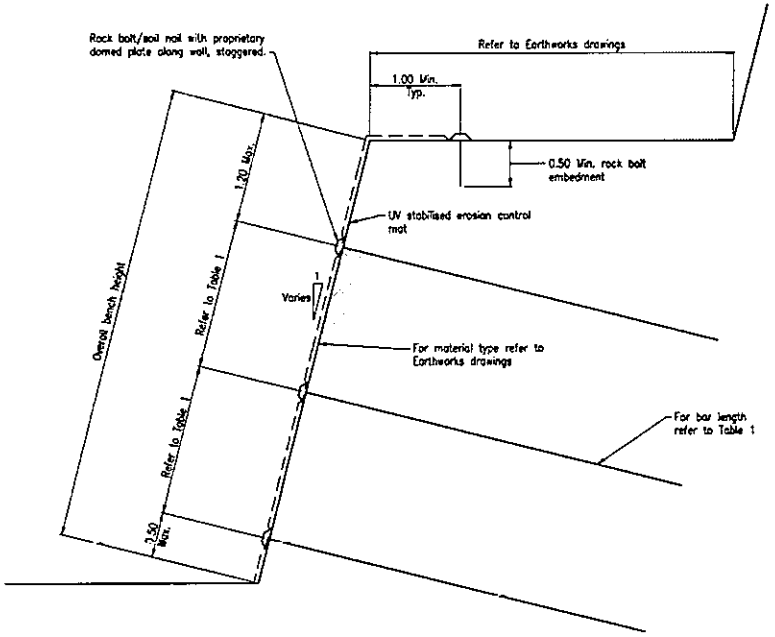
Appendix 1

Locality Map

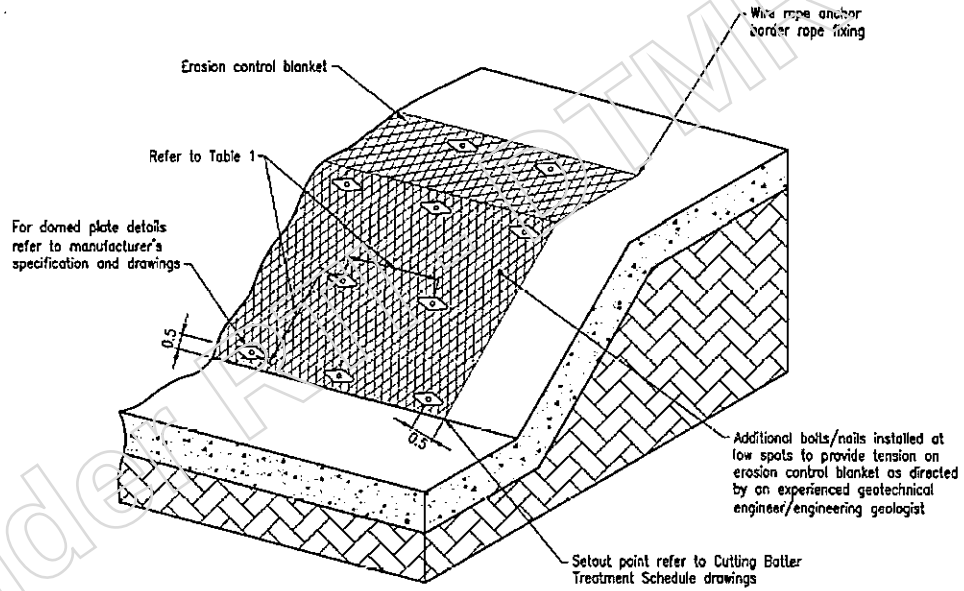


Appendix 2

Details of Slope Protection

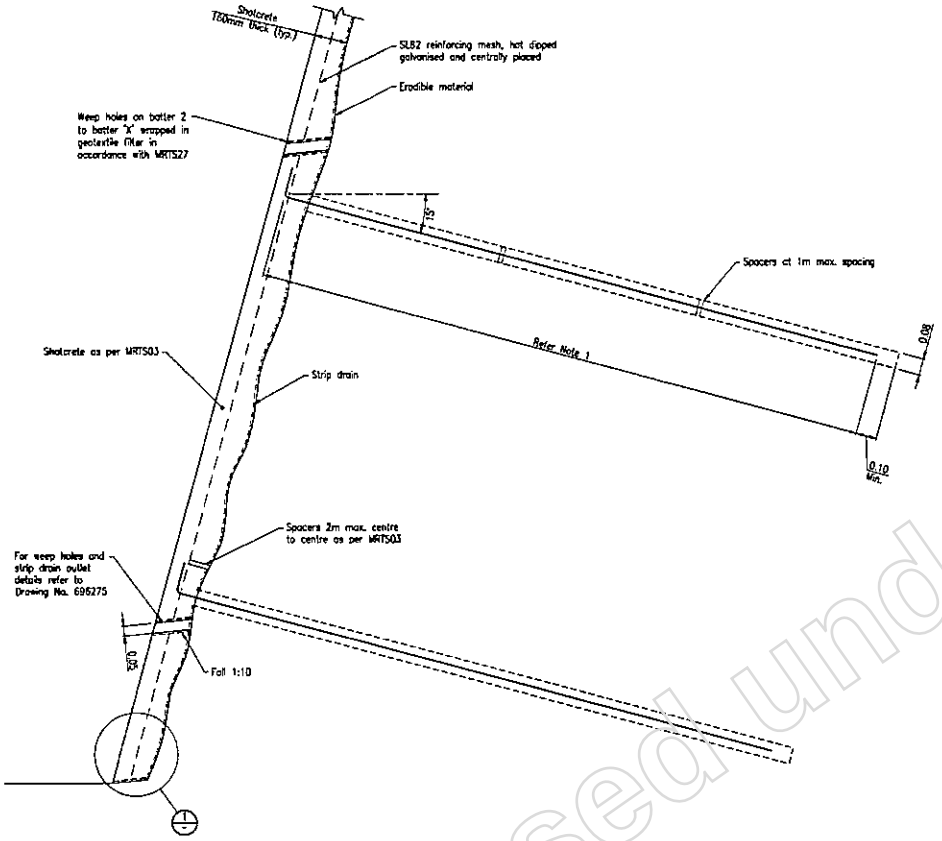


GENERAL LAYOUT OF EROSION CONTROL BLANKET
Scale A

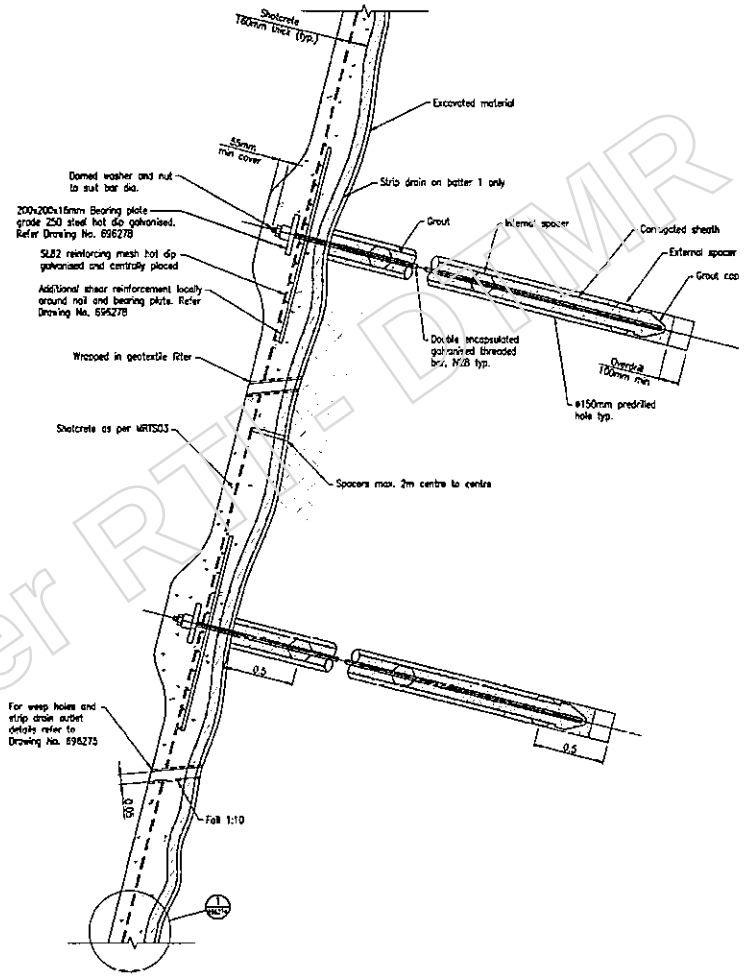


Appendix 3

Details of Slope Reinforcement



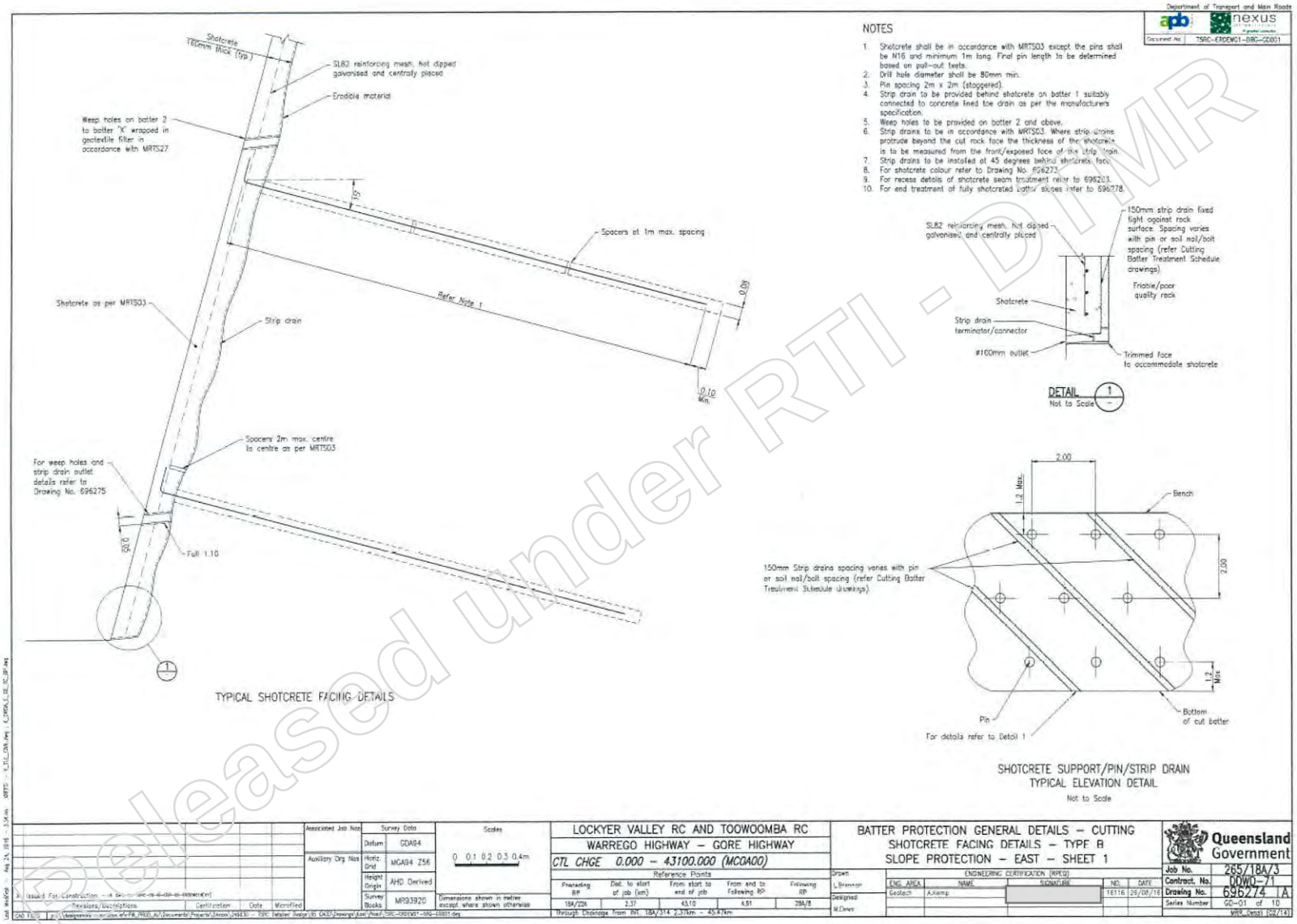
TYPICAL SHOTCRETE FACING DETAILS

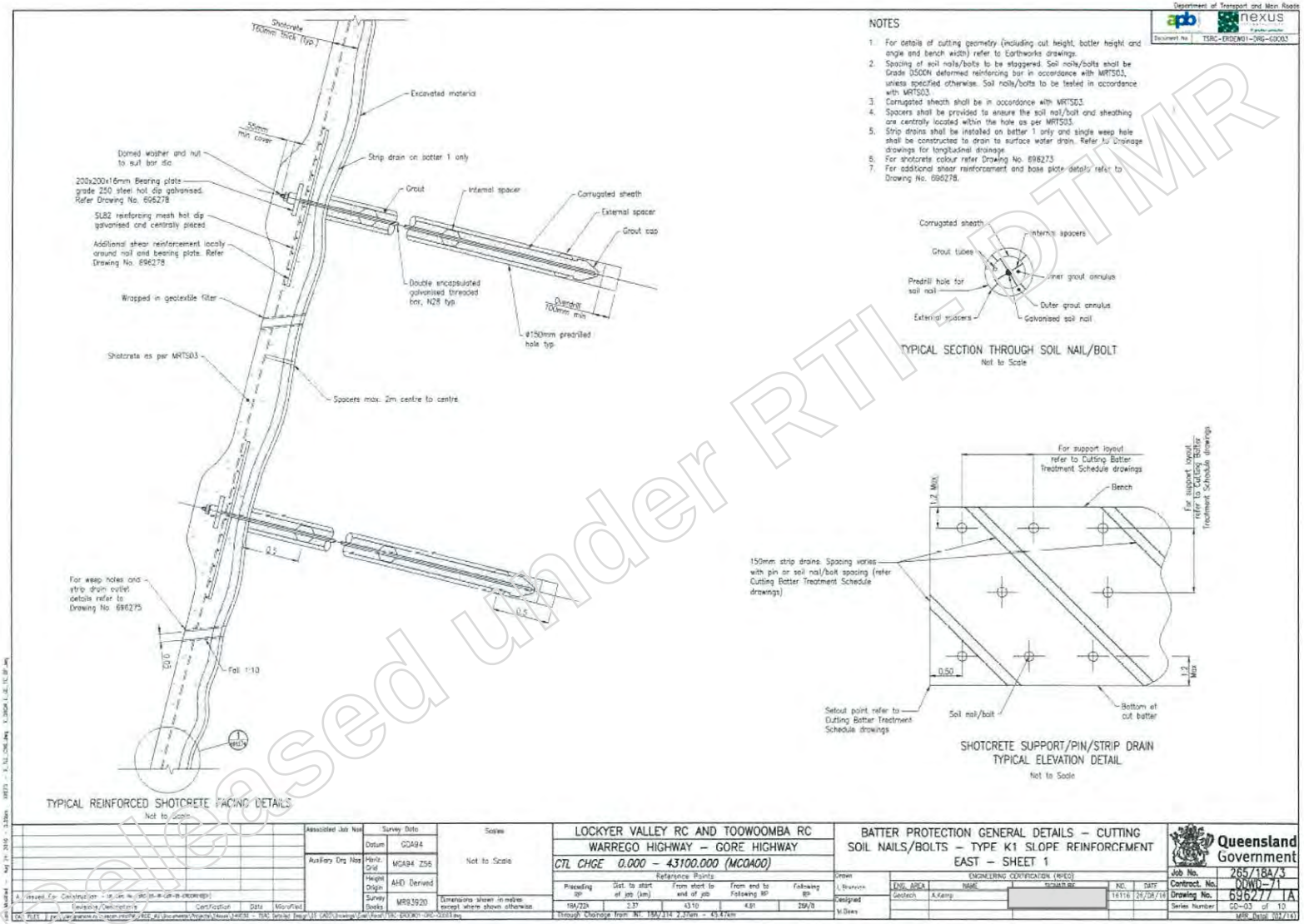


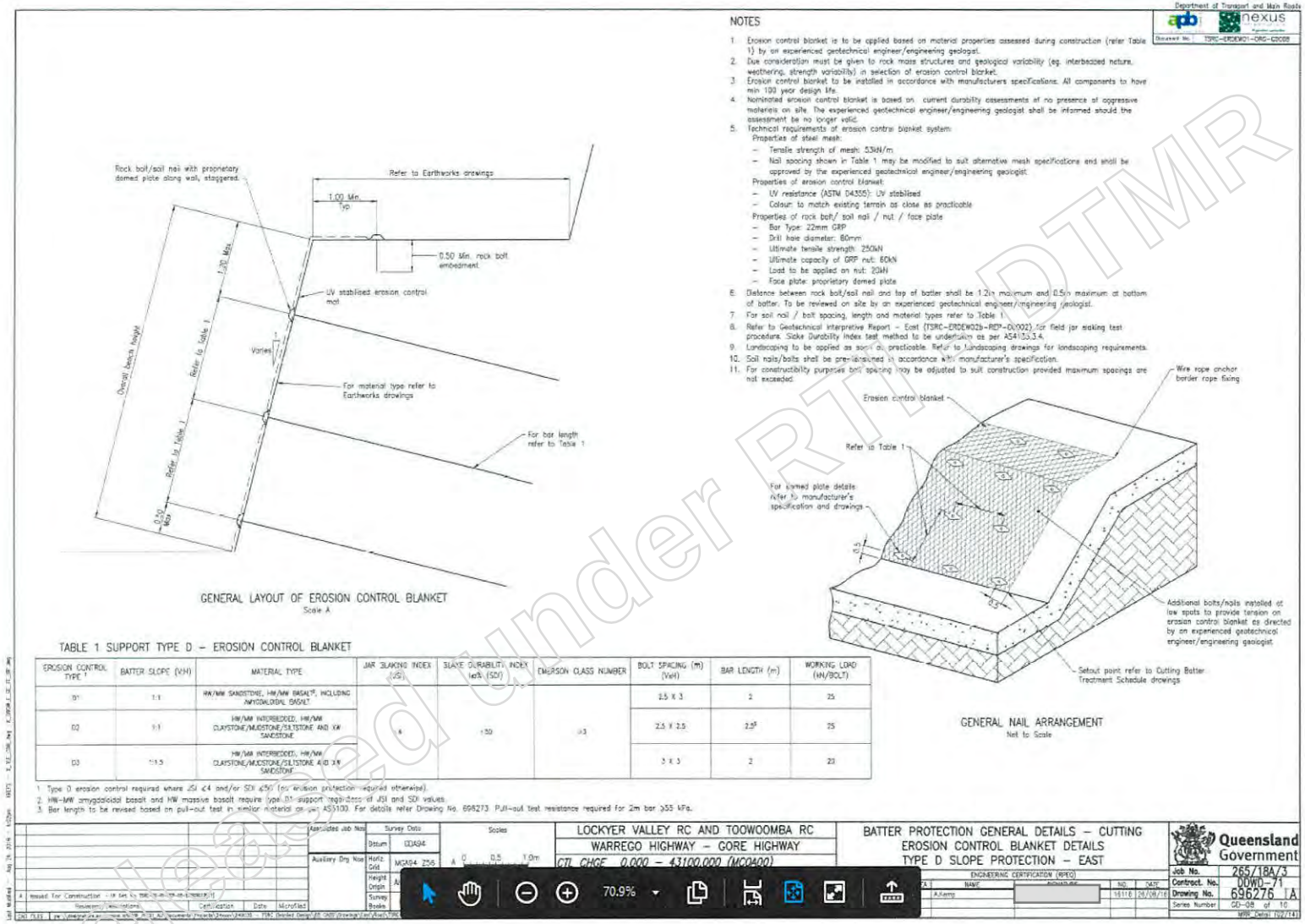
TYPICAL REINFORCED SHOTCRETE FACING DETAILS
Not to Scale

Appendix 4

IFC Drawings







NOTES

1. For detailed cross sections of cuts refer to Earthworks Drawings.
2. For typical cutting layout and geometry refer to Earthworks drawings.
3. Landslide/colluvium/scree/talus deposits identified. For excavation sequence details refer to Earthworks drawings.
4. For batter protection extents refer to Batter Protection Plan and Longitudinal Section drawings.
5. Extent of rock fall protection is based on geotechnical requirements only and does not consider general road design requirements. For full extent of rock fall fence refer to Road Alignment drawings

apb nexus — Document No. TSRC-ERDEW01-DRG-SH101

ID	CHAINAGE		TYPE (BOX / SIDE LONG)	CUT HEIGHT		EXPECTED GEOLOGICAL CONDITIONS	EXPECTED GROUNDWATER CONDITIONS	SLOPE PROTECTION COVERAGE OF TOTAL CUT FACE AREA (%) — EROSION PROTECTION				SLOPE REINFORCEMENT (REFER NOTE 4) TYPE K – PATTERN BOLTING (K1 WITH SHOTCRETE, K2 WITH HIGH TENSILE STEEL MESH) TYPE J – SPOT BOLTING WITH SHOTCRETE				SUB-SURFACE DRAINAGE — TYPE I SUB-HORIZONTAL DRAINAGE			ROCKFALL PROTECTION LENGTH (M)		REMARKS
	FROM	TO		LHS	RHS			TYPE B – SHOTCRETE	TYPE D1 (1V:1H HW/MW SANDSTONE, BASALT)	TYPE D2 (1V:1H HW/MW INTERBEDDED, CLAYSTONE/ MUDSTONE AND XW SANDSTONE)	TYPE D3 (1V:1.5H HW/MW CLAYSTONE/MUDSTONE AND HW/MW INTERBEDDED CLAYSTONE/MUDSTONE /SILTSTONE	TYPE	SPACING V x H (m)	SOIL NAIL/ROCK ANCHOR LENGTH (m)	COVERAGE OF TOTAL CUT FACE AREA %	SPACING (m)	DRAIN HOLE LENGTH (m)	TOTAL DRAIN HOLES	LHS	RHS	
CUT 20	12500	12710	Side Long	12.8	2.5	Residual: Sandstone – XW to MW	EB145 – 30.43m bgl – RL393.85m – 24/02/2016 EB146 – 33.45m bgl – RL426.95m – 24/02/2016 EB141 – 31.37m bgl – RL421.68m – 24/02/2016					K2	2.0 x 2.5 Staggered	8	LHS – 100						
[redacted]	12710	12950	Box	45.1	24.0	Minor colluvium; Residual; Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – XW to MW; Mudstone – XW to SW; Coal seams and Ferricrete; Basalt (massive) – XW to SW	BH115 – Moist at base 65.03m bgl – RL438.95m – 12/01/2016 BH115 – 65.58m bgl – RL438.40m – 01/02/2016 BH116 – 70.04m bgl – RL412.49m – 14/01/2015 BH116 – 69.97m bgl – RL412.56m – 01/02/2015 EB045 – 33.92m bgl – RL454.92m – 26/11/2015 EB045 – 33.92m bgl – RL454.92m – 13/01/2016 EB045 – 33.42m bgl – RL455.42m – 13/01/2016 to 01/02/2016 EB045 – 33.92m bgl – RL454.92m – 01/02/2016 EB045 – 33.95m bgl – RL454.89m – 24/2/2016 EB045 – 33.96m bgl – RL454.88m – 22/03/2016 EB048 – 29.25m bgl – RL461.70m – 25/11/2015 EB149 – 12.90m bgl – RL448.24m – 24/02/2016 EB149 – 15.14m bgl – RL446.00m – 22/03/2016		LHS – 15 RHS – 20	LHS – 35 RHS – 40	LHS – 25	[redacted]									Spot bolting and ancillary support may be required on zones of increased weathering and fracturing. Drainage holes required at basalt-claystone interface.
	12950	13240	Box	50.3	57.2											2	5	175			
	13240	13340	Box	6.0	23.2	Colluvium (slope instability area); Basalt – MW to SW (with some extremely weathered seams and infill joints); Interbedded Sandstone/Siltstone/Mudstone – HW															
CUT 24	14380	14770	Box	34.2	31.3	Residual; Interbedded Sandstone/Siltstone/Mudstone – XW to SW; Coal Seams; Basalt – HW	BH119 – 29.445m bgl – RL412.46m – 12/01/16 BH119 – 30.44m bgl – RL411.46m – 01/02/16 EB060 – 29.25m bgl – RL413.677m – 27/11/2015 EB061 – 26.24m bgl – RL414.894m – 26/11/2015 EB061 – 31.93m bgl – RL409.20m – 14/1/2016 EB061 – 31.93m bgl – RL409.20m – 1/2/2016 EB061 – 31.95m bgl – RL409.18m – 24//02/2016 EB061 – 31.97m bgl – RL409.16m – 23/03/2016				RHS – 60	J	To be determined on site						295	0	Spot bolting and ancillary support may be required where coal seams are intersected.
CUT 25	15100	15200	Box	8.3	26.5	Colluvium (slope instability area); Residual; Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – HW to MW	BH043 – 30.765 m bgl – RL433.035m – 04/01/16 BH043 – 30.72 m bgl – RL433.08m – 12/01/16 & 02/02/16 EB064 – 17.54 m bgl – RL449.987m – 14/01/16 EB064 – 18.44 m bgl – RL449.087m – 02/02/16 EB065 – Dry @ 19.50 m bgl – RL451.05m – 04/01/16 EB065 – Dry @ 19.65 m bgl – RL450.909m – 14/01/16 EB065 – Dry @ 19.69 m bgl – RL450.869m – 02/02/16		RHS – 15			J	To be determined on site								Spot bolting may be required fractured basalt. Drainage holes may be required in colluvium and at basalt-sandstone interface.
	15200	15340	Box	12.1	26.1											To be determined on site			230	220	
[redacted]	15480	15600	Box	12.3	44.3	Colluvium (near surface); Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – XW to SW	EB066 – 31.40m bgl – RL468.77m – 02/02/2016 EB067 – 33.46m bgl – RL475.01m – 02/02/2016		RHS – 40			J	To be determined on site								Spot bolting may be required on the fractured basalt, tuff bands and zones of weakness. 20mm diameter bars.
	15600	15750	Box	7.2	45.8							[redacted]	[redacted]	[redacted]	RHS – 35 To be determined on site						
CUT 27	16280	16380	Box	14.7	41.7	Colluvium (near surface); Basalt (Amygdaloidal) – XW to MW; some tuff and paleosol bands	BH049 (off alignment 50m) – Dry at 39.5m bgl – RL524.24m BH050 (off alignment 50m) – Dry at 33.5m bgl – RL518.64m		LHS – 25 RHS – 35			K1 J	2.8 x 2.8 Staggered for Batters 1 and 3 2.0 x 2.0 Staggered for Batter 2 To be determined on site	4 To be determined on site	RHS – 65 To be determined on site	To be determined on site					Additional spot bolting may be required on the shear zone identified on the bottom batter. Drainage holes may also be required in this area. No additional shear reinforcement required.
EMBANKMENT 25	16380	16630	Side Long	11.7	10.3	Residual (near surface); Basalt (Amygdaloidal) – XW to SW	EB073 – 10.12 m bgl – 516.01 RL – 2/2/2016		RHS – 75			K1 J	2.8 x 2.8 Staggered To be determined on site	4 To be determined on site	RHS – 25 To be determined on site	To be determined on site					Additional spot bolting may be required in zones of increased weathering and fracturing. Drainage holes may also be required in this area. No additional shear reinforcement required.

A	Issued For Construction
Revisions/Descriptions	Certification / Date / Microfiled

Associated Job Nos | Auxiliary Drg Nos

Survey Data: Datum GDA94; Horiz. Grid MGA94 Z56; Height Origin AHD Derived; Survey Books MR93920

Scales

LOCKYER VALLEY RC AND TOOWOOMBA RC
WARREGO HIGHWAY – GORE HIGHWAY
CTL CHGE 0.000 – 43100.000 (MC0A00)
Reference Points

BATTER PROTECTION
CUTTING BATTER TREATMENT SCHEDULE
EAST – SHEET 2

Drawn Brannon | Designed Dews

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
Geotech	A.Kemp	[redacted]	15116	26/08/16

Queensland Government

Job No. 265/18A/3
Contract. No. DDWD-71
Drawing No. 696285 A
Series Number SH-101 of 04
MRR_Detail (02/14)

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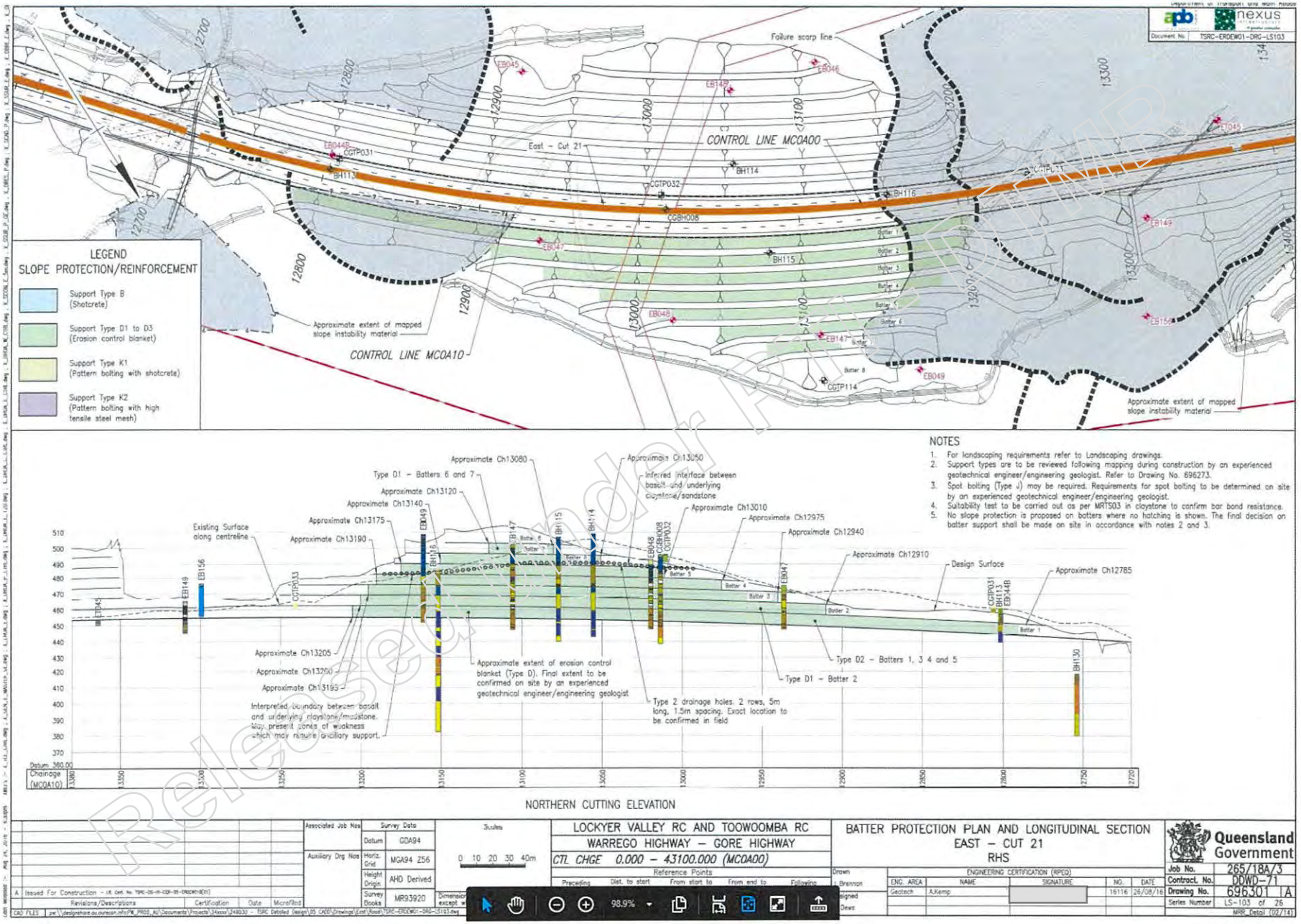
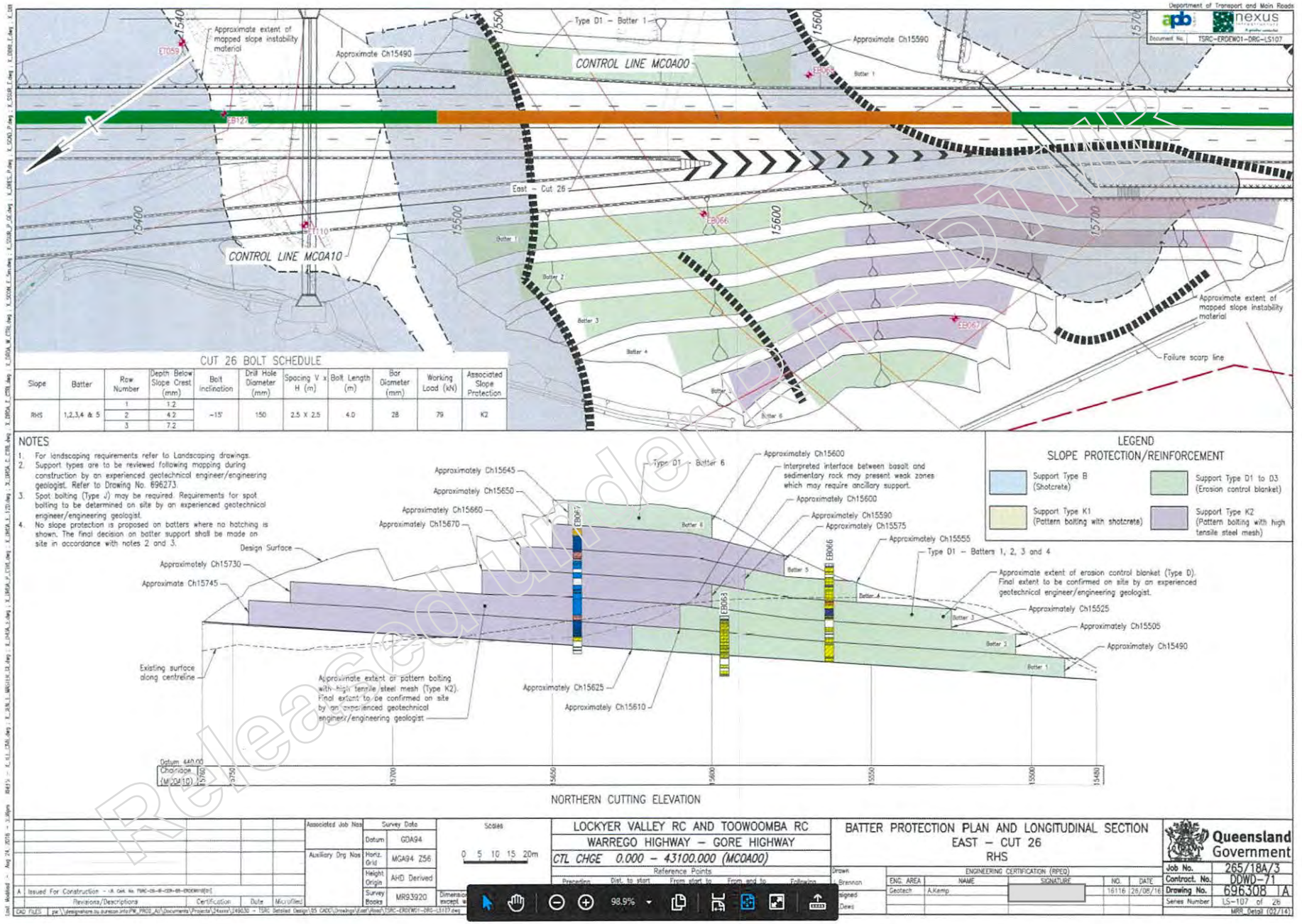

LEGEND
SLOPE PROTECTION/REINFORCEMENT
Support Type B (Shotcrete)
Support Type D1 to D3 (Erosion control blanket)
Support Type K1 (Pattern bolting with shotcrete)
Support Type K2 (Pattern bolting with high tensile steel mesh)
CONTROL LINE MCOA00
CONTROL LINE MCOA10
East – Cut 21
Failure scarp line
Approximate extent of mapped slope instability material
Approximate extent of mapped slope instability material
NOTES
1. For landscaping requirements refer to Landscaping drawings.
2. Support types are to be reviewed following mapping during construction by an experienced geotechnical engineer/engineering geologist. Refer to Drawing No. 696273.
3. Spot bolting (Type J) may be required. Requirements for spot bolting to be determined on site by an experienced geotechnical engineer/engineering geologist.
4. Suitability test to be carried out as per MRTS03 in claystone to confirm bar bond resistance.
5. No slope protection is proposed on batters where no hatching is shown. The final decision on batter support shall be made on site in accordance with notes 2 and 3.
Approximate Ch13080
Approximate Ch13050
Inferred interface between basalt and underlying claystone/sandstone
Type D1 – Batters 6 and 7
Approximate Ch13120
Approximate Ch13140
Approximate Ch13175
Approximate Ch13190
Approximate Ch13010
Approximate Ch12975
Approximate Ch12940
Approximate Ch12910
Design Surface
Approximate Ch12785
Existing Surface along centreline
Approximate Ch13205
Approximate Ch13250
Approximate Ch13195
Interpreted boundary between basalt and underlying claystone/mudstone. May present zones of weakness which may require ancillary support.
Approximate extent of erosion control blanket (Type D). Final extent to be confirmed on site by an experienced geotechnical engineer/engineering geologist
Type 2 drainage holes: 2 rows, 5m long, 1.5m spacing. Exact location to be confirmed in field
Type D2 – Batters 1, 3 4 and 5
Type D1 – Batter 2
Datum 360.00
Chainage (MCOA10)
NORTHERN CUTTING ELEVATION
LOCKYER VALLEY RC AND TOOWOOMBA RC
WARREGO HIGHWAY – GORE HIGHWAY
CTL CHGE 0.000 – 43100.000 (MCOA00)
BATTER PROTECTION PLAN AND LONGITUDINAL SECTION
EAST – CUT 21
RHS
Queensland Government
Job No. 265/18A/3
Contract No. DDWD-71
Drawing No. 696301 1A
Series Number LS-103 of 25



Appendix 5

Updated IFC Drawings

NOTES
1. For notes refer to Drawing No. 696284

ID	CHAINAGE FROM	CHAINAGE TO	TYPE (BOX / SIDE LONG)	CUT HEIGHT LHS	CUT HEIGHT RHS	EXPECTED GEOLOGICAL CONDITIONS	EXPECTED GROUNDWATER CONDITIONS	SLOPE PROTECTION – COVERAGE OF TOTAL CUT FACE AREA (%) – EROSION PROTECTION: TYPE B/B+ – SHOTCRETE	TYPE D1 (1V:1H HW/MW SANDSTONE, BASALT)	TYPE D2 (1V:1H HW/MW INTERBEDDED, CLAYSTONE/ MUDSTONE AND XW SANDSTONE)	TYPE D3 (1V:1.5H HW/MW CLAYSTONE/MUDSTONE AND HW/MW INTERBEDDED CLAYSTONE/MUDSTONE /SILTSTONE	SLOPE REINFORCEMENT (REFER NOTE 4) TYPE K – PATTERN BOLTING (K1 WITH SHOTCRETE, K2 WITH HIGH TENSILE STEEL MESH) TYPE J – SPOT BOLTING WITH SHOTCRETE: TYPE	SPACING V x H (m)	SOIL NAIL/ROCK ANCHOR LENGTH (m)	COVERAGE OF TOTAL CUT FACE AREA %	SUB-SURFACE DRAINAGE – TYPE I SUB-HORIZONTAL DRAINAGE: SPACING (m)	DRAIN HOLE LENGTH (m)	TOTAL DRAIN HOLES	ROCKFALL PROTECTION LENGTH (M) LHS	RHS	REMARKS
CUT 20	12500	12710	Side Long	12.8	2.5	Residual; Sandstone – XW to MW	EB145 – 30.43m bgl – RL393.85m – 24/02/2016 EB146 – 33.45m bgl – RL426.95m – 24/02/2016 EB141 – 31.37m bgl – RL421.66m – 24/02/2016	△B													
CUT 21	12710	12950	Box	45.1	24.0	Minor colluvium; Residual, Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – XW to MW; Mudstone – XW to SW; Coal seams and Ferricrete; Basalt (massive) – XW to SW	BH115 – Moist at base 65.03m bgl – RL438.95m – 12/01/2016 BH115 – 65.58m bgl – RL438.40m – 01/02/2016 BH116 – 70.04m bgl – RL412.49m – 14/01/2015 BH116 – 69.97m bgl – RL412.56m – 01/02/2015 EB045 – 33.92m bgl – RL454.92m – 26/11/2015 EB045 – 33.92m bgl – RL454.92m – 13/01/2016 EB045 – 33.42m bgl – RL455.42m – 13/01/2016 to 01/02/2016 EB045 – 33.92m bgl – RL454.92m – 01/02/2016 EB045 – 33.95m bgl – RL454.89m – 24/2/2016 EB045 – 33.96m bgl – RL454.88m – 22/03/2016 EB048 – 29.25m bgl – RL481.70m – 25/11/2015 EB149 – 12.90m bgl – RL448.24m – 24/02/2016 EB149 – 15.14m bgl – RL446.00m – 22/03/2016		LHS – 15 RHS – 20	LHS – 35 RHS – 40	LHS – 25	J	To be determined on site								Spot bolting and ancillary support may be required on zones of increased weathering and fracturing. Drainage holes required at basalt-claystone interface.
	12950	13240	Box	50.3	57.2											2	5	175			
	13240	13340	Box	6.0	23.2	Colluvium (slope instability area); Basalt – MW to SW (with some extremely weathered seams and infill joints); Interbedded Sandstone/Siltstone/Mudstone – HW															
CUT 24	14380	14770	Box	34.2	31.3	Residual: Interbedded Sandstone/Siltstone/Mudstone – XW to SW; Coal Seams; Basalt – HW	BH119 – 29.445m bgl – RL412.48m – 12/01/16 BH119 – 30.44m bgl – RL411.46m – 01/02/16 EB060 – 29.25m bgl – RL413.677m – 27/11/2015 EB061 – 26.24m bgl – RL414.894m – 26/11/2015 EB061 – 31.93m bgl – RL409.20m – 14/1/2016 EB061 – 31.93m bgl – RL409.20m – 1/2/2016 EB061 – 31.95m bgl – RL409.18m – 24//02/2016 EB061 – 31.97m bgl – RL409.16m – 23/03/2016			RHS – 55	RHS – 5	J	To be determined on site						295	0	Spot bolting and ancillary support may be required where coal seams are intersected.
CUT 25	15100	15200	Box	8.3	26.5	Colluvium (slope instability area); Residual: Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – HW to MW	BH043 – 30.765 m bgl – RL433.035m – 04/01/16 BH043 – 30.72 m bgl – RL433.08m – 12/01/16 & 02/02/16 EB064 – 17.54 m bgl – RL449.987m – 14/01/16 EB064 – 18.44 m bgl – RL449.087m – 02/02/16 EB065 – Dry @ 19.50 m bgl – RL451.059m – 04/01/16 EB065 – Dry @ 19.65 m bgl – RL450.909m – 14/01/16 EB065 – Dry @ 19.69 m bgl – RL450.869m – 02/02/16		RHS – 25		△B	J	To be determined on site								Spot bolting may be required fractured basalt. Drainage holes may be required in colluvium and at basalt-sandstone interface.
	15200	15340	Box	12.1	26.1											To be determined on site			230	220	
CUT 26	15450	15600	Box	11.1	33.1	Colluvium; Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – XW to SW			RHS – 40			J	To be determined on site								
	15600	15680	Box	11.1	53.6		EB066 – 31.40m bgl – RL463.77m – 02/02/2016 EB067a – 38.46m bgl – RL475.11m – 02/02/2016		RHS – 30			K1 J	[illegible] To be determined on site	[illegible] To be determined on site	RHS – 15 To be determined on site						Spot bolting may be required on the fractured basalt, tuff bands and zones of weakness. 20mm diameter bars.
	15680	15850	Side Long	0.0	59.3			RHS – 25	RHS – 20	△B		K1 J	[illegible] To be determined on site	[illegible] To be determined on site	RHS – 40 To be determined on site						Type B/B+ to be applied where MW Basalt or better is encountered, Type K1 to be applied where XW and HW are encountered. Additional spot bolting may be required in areas of tuff and palaeosols.
EMBANKMENT 24	15710	16230	Side Long	0.0	10.2	Colluvium Amygdaloidal Basalt – XW to SW			RHS – 100			J	To be determined on site								Spot bolting may be required in fractured basalt. Upslope cutting corresponds to CH15940 – CH15985.
CUT 27	16230	16380	Box	12.9	42.0	Colluvium: Basalt (Amygdaloidal) – XW to MW; some tuff and palaeosol bands	BH049 (off alignment 50m) – Dry at 39.5m bgl – RL524.24m BH050 (off alignment 50m) – Dry at 33.5m bgl – RL518.64m		RHS – 50			K1 K1 J	2.3 x 2.3 Staggered for Batter 1 & 2 2.8 x 2.8 Staggered for Batter 2 To be determined on site	4 4 To be determined on site	RHS – 50 To be determined on site	To be determined on site					Additional spot bolting may be required on the shear zone identified on the bottom batter. Drainage holes may also be required in this area. No additional shear reinforcement required. Type K1 bolt spacing for Batter 2 to be revised to match Batter 1 configuration should shear zone 2 (refer to Drawing No. 656206) be encountered.
EMBANKMENT 25	16380	16592	Side Long	11.7	20.2	Residual (near surface); Basalt (Amygdaloidal) – XW to SW	EB073 – 10.12 m bgl – 515.61 RL – 2/2/2016	RHS – 15	RHS – 50			K1 J	2.3 x 2.3 Staggered for Batter 1 To be determined on site	4 To be determined on site	RHS – 25 To be determined on site	To be determined on site					Additional spot bolting may be required in zones of increased weathering and fracturing. Drainage holes may also be required in this area. No additional shear reinforcement required.

Department of Transport and Main Roads

Document No. TSRC-ERDEW01-DRG-SH101

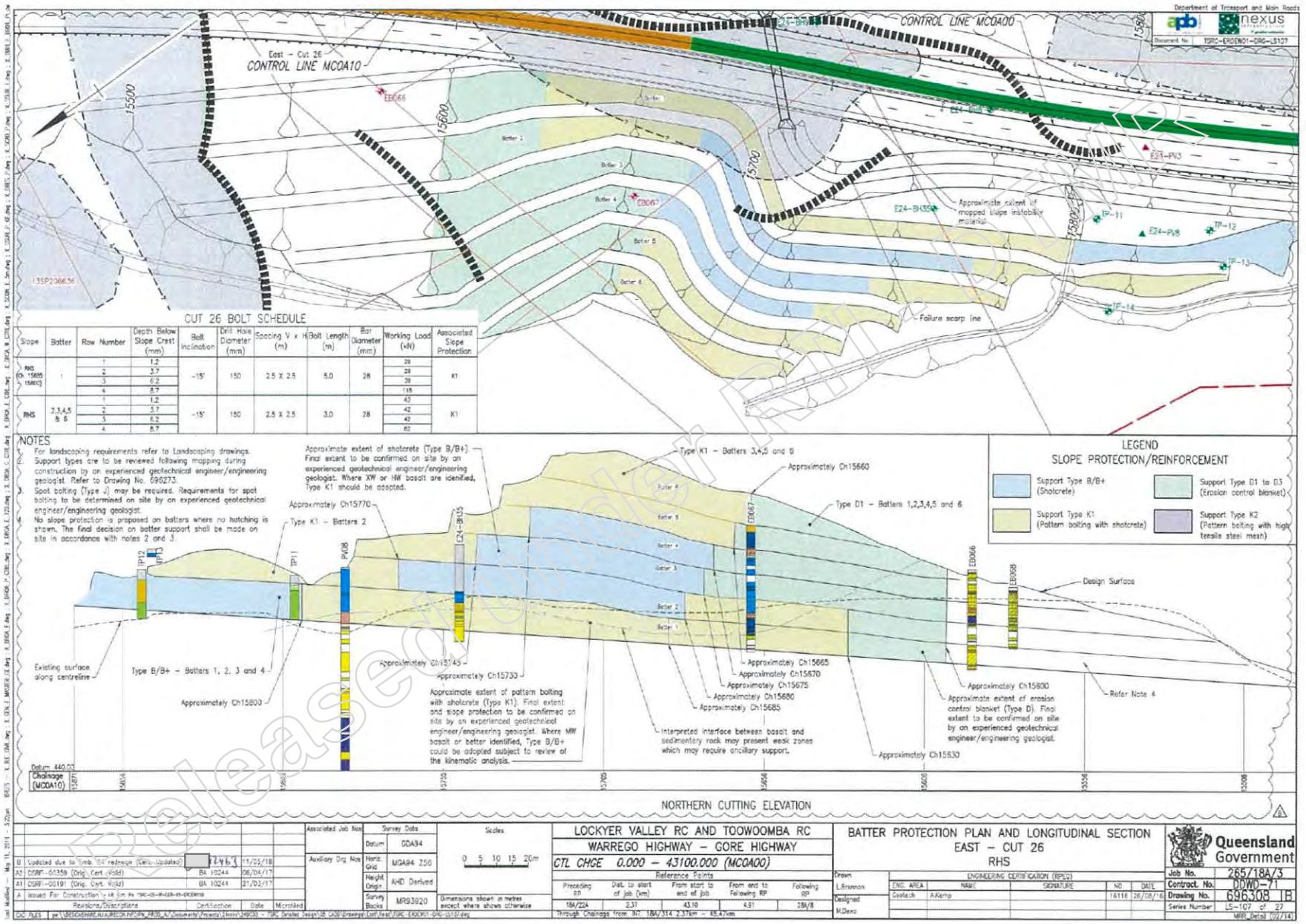
B Updated due to Emb. 24 redesign (Cert. Updated) 11/05/18
A2 DSRFI-00455 (Orig. Cert. Void) MS 18732 22/08/17
A1 DSRFI-00413 (Orig. Cert. Void) BA 10244 13/04/17
A Issued For Construction
Revisions/Descriptions | Certification | Date | Microfilm

Survey Data: Datum GDA94; Horiz. Grid MGA94 Z56; Height Origin AHD Derived; Survey Books MRS3920

LOCKYER VALLEY RC AND TOOWOOMBA RC
WARREGO HIGHWAY – GORE HIGHWAY
CTL CHGE 0.000 – 43100.000 (MC0A00)

BATTER PROTECTION
CUTTING BATTER TREATMENT SCHEDULE
EAST – SHEET 2

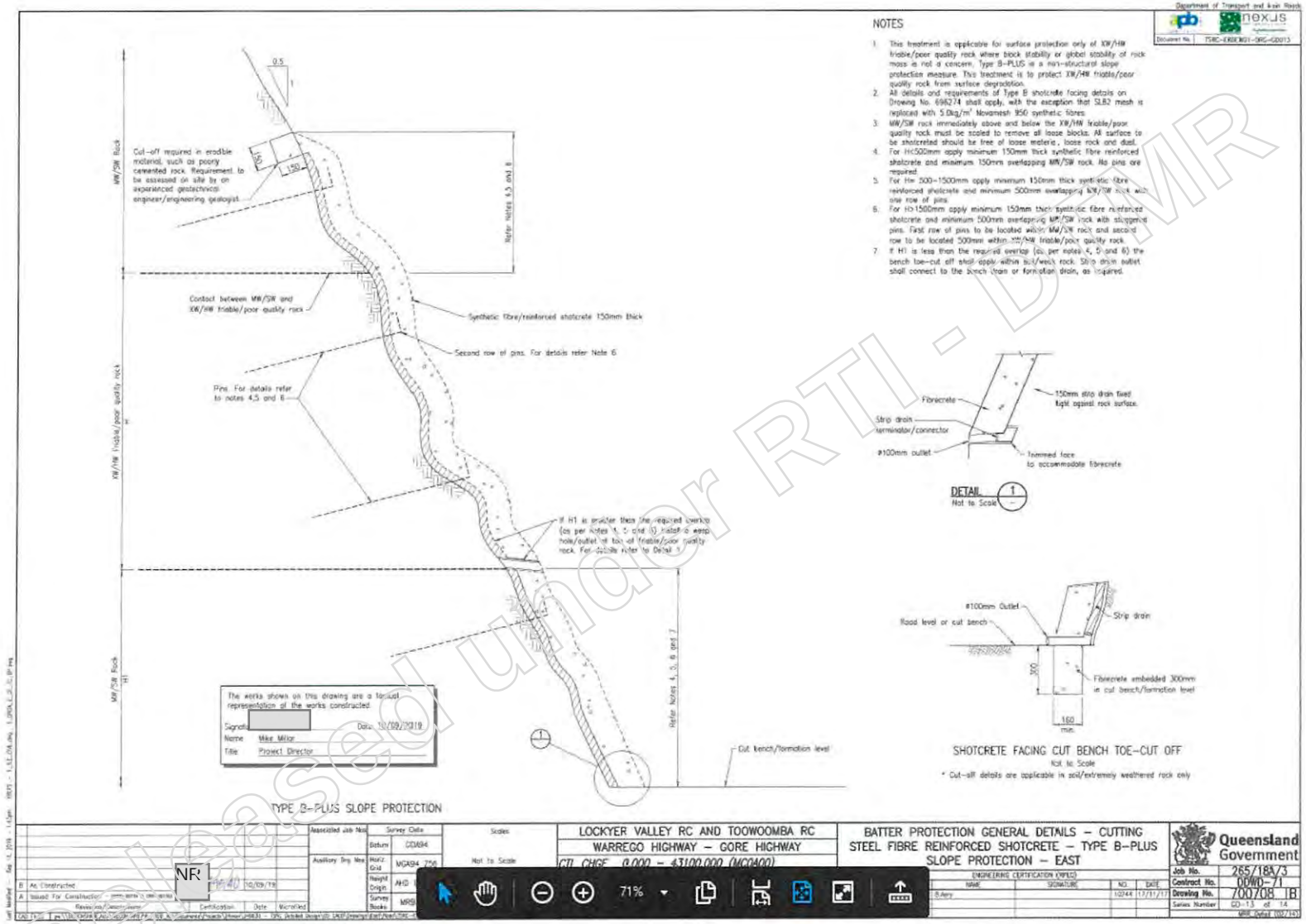
Queensland Government
Job No. 265/18A/3
Contract No. DDWD-71
Drawing No. 696285 B
SH-101 of 04



Slope	Batter	Row Number	Depth Below Slope Crest (mm)	Bolt Inclination	Drill Hole Diameter (mm)	Spacing V x H (m)	Bolt Length (m)	Bar Diameter (mm)	Working Load (kN)	Associated Slope Protection
RHS (Ch 15695 to 15800)	1	1	1.2	-15°	150	2.5 X 2.5	5.0	28	29	K1
		2	3.7						29	
		3	6.2						39	
		4	8.7						115	
RHS	2,3,4,5 & 6	1	1.2	-15°	150	2.5 X 2.5	3.0	28	42	K1
		2	3.7						42	
		3	6.2						42	
		4	8.7						82	

Appendix 6

As-built Drawings



NOTES
1. For notes refer to Drawing No. 696284

ID	CHAINAGE FROM	CHAINAGE TO	TYPE (BOX / SIDE LONG)	CUT HEIGHT LHS	CUT HEIGHT RHS	EXPECTED GEOLOGICAL CONDITIONS	EXPECTED GROUNDWATER CONDITIONS	SLOPE PROTECTION – COVERAGE OF TOTAL CUT FACE AREA (%) – EROSION PROTECTION: TYPE B-PLUS – FIBRECRETE	TYPE D1 (1V:1H HW/MW SANDSTONE, BASALT)	TYPE D2 (1V:1H HW/MW INTERBEDDED, CLAYSTONE/ MUDSTONE AND XW SANDSTONE)	TYPE D3 (1V:1.5H HW/MW CLAYSTONE/MUDSTONE AND HW/MW INTERBEDDED CLAYSTONE/MUDSTONE /SILTSTONE	SLOPE REINFORCEMENT (REFER NOTE 4) TYPE K – PATTERN BOLTING (K1 WITH SHOTCRETE, K2 WITH HIGH TENSILE STEEL MESH) TYPE J – SPOT BOLTING WITH SHOTCRETE: TYPE	SPACING V x H (m)	SOIL NAIL/ROCK ANCHOR LENGTH (m)	COVERAGE OF TOTAL CUT FACE AREA %	SUB-SURFACE DRAINAGE – TYPE I OR TYPE II SUB-HORIZONTAL DRAINAGE: SPACING (m)	DRAIN HOLE LENGTH (m)	TOTAL DRAIN HOLES	ROCKFALL PROTECTION LENGTH (M) LHS	RHS	REMARKS
CUT 20	12500	12710	Side Long	12.8	2.5	Residual; Sandstone – XW to MW	EB145 – 30.43m bgl – RL393.85m – 24/02/2016 EB146 – 33.45m bgl – RL426.95m – 24/02/2016 EB141 – 31.37m bgl – RL421.68m – 24/02/2016														
[illegible]	12710	12950	Box	45.1	24.0	Minor colluvium; Residual; Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – XW to MW; Mudstone – XW to SW; Coal seams and Ferricrete; Basalt (massive) – XW to SW, Undifferentiated Tertiary Sediments (UTS)	BH115 – Moist at base 65.03m bgl – RL438.95m – 12/01/2016 BH115 – 65.58m bgl – RL438.40m – 01/02/2016 BH116 – 70.04m bgl – RL412.49m – 14/01/2015 BH116 – 69.97m bgl – RL412.56m – 01/02/2015 EB045 – 33.92m bgl – RL454.92m – 26/11/2015 E3045 – 33.92m bgl – RL454.92m – 13/01/2016 E3045 – 33.42m bgl – RL455.42m – 13/01/2016 to 01/02/2016 EB045 – 33.92m bgl – RL454.92m – 01/02/2016 EB045 – 33.95m bgl – RL454.89m – 24/2/2016 EB045 – 33.96m bgl – RL454.88m – 22/03/2016 EB048 – 29.25m bgl – RL461.70m – 25/11/2015 EB149 – 12.90m bgl – RL448.24m – 24/02/2016 EB149 – 15.14m bgl – RL446.00m – 22/03/2016	RHS, 5% RHS – 1 (applied locally between Cut 21/22 transition and Cut 21)	RHS – 20	LHS – 60 RHS – 40	LHS – 25					2	5	133			Ancillary support (concrete buttress with Type 2 drainage) between CH12975 – CH13125 RHS – Batter 4, between CH13070 – CH13090 LHS – Batter 4.
	12950	13240	Box	50.3	57.2																
	13240	13340	Box	6.0	23.2	Colluvium (slope instability area); Basalt – MW to SW (with some extremely weathered seams and infill joints); Interbedded Sandstone/Siltstone/Mudstone – HW, Undifferentiated Tertiary Sediments (UTS)															
CUT 24	14380	14770	Box	34.2	31.3	Residual; Interbedded Sandstone/Siltstone/Mudstone – XW to SW, Coal Seams; Basalt – HW	BH119 – 29.445m bgl – RL412.46m – 12/01/16 BH119 – 30.44m bgl – RL411.46m – 01/02/16 EB060 – 29.25m bgl – RL413.677m – 27/11/2015 EB061 – 26.24m bgl – RL414.894m – 26/11/2015 EB061 – 31.93m bgl – RL409.20m – 14/1/2016 EB061 – 31.93m bgl – RL409.20m – 1/2/2016 EB061 – 31.95m bgl – RL409.18m – 24/02/2016 EB061 – 31.97m bgl – RL409.16m – 23/03/2016			LHS – 60 RHS – 55	LHS – 10 RHS – 5	K1	2.5 x 2.5	3	5						Ancillary support (concrete buttress with Type 2 drainage) between CH14610 – CH14625 RHS – Batter 3.
CUT 25	15100	15200	Box	8.3	26.5	Colluvium (slope instability area); Residual; Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – HW to MW	BH043 – 30.765 m bgl – RL433.035m – 04/01/16 BH043 – 30.72 m bgl – RL433.08m – 12/01/16 & 02/02/16 EB064 – 17.54 m bgl – RL449.987m – 14/01/16 EB064 – 18.44 m bgl – RL449.087m – 02/02/16 EB065 – Dry @ 19.50 m bgl – RL451.059m – 04/01/16 EB065 – Dry @ 19.65 m bgl – RL450.909m – 14/01/16 EB065 – Dry @ 19.69 m bgl – RL450.869m – 02/02/16		RHS – 75												
	15200	15340	Box	12.1	26.1																
[illegible]	15480	15600	Box	11.1	33.3	Colluvium; Sandstone – XW to SW; Interbedded Sandstone/Siltstone/Mudstone – XW to SW	EB066 – 31.10m bgl – RL468.77m – 02/02/2016 EB067a – 38.43m bgl – RL475.01m – 02/02/2016	RHS – 10	RHS – 25			[illegible]	[illegible]	[illegible]	RHS – 5 RHS – 40 RHS – 1						
	15600	15680	Box	11.1	53.6																
	15680	15850	Side Long	0.0	59.3																
EMBANKMENT 24	15710	16230	Side Long	0.0	10.2	Colluvium. Amygdaloidal Basalt – XW to SW		RHS – 100 B+													
CUT 27	16230	16380	Box	12.9	42.0	Colluvium; Basalt (Amygdaloidal) – XW to MW; some tuff and paleosoil bands	BH049 (off alignment 50m) – Dry at 39.5m bgl – RL524.24m BH050 (off alignment 50m) – Dry at 33.5m bgl – RL518.64m		RHS – 50			K1 K1 J	2.3 x 2.3 Staggered for Batter 1 & 2 2.8 x 2.8 Staggered for Batter 2 2.5m centres	4 4 4	RHS – 50 RHS – 1						
EMBANKMENT 25	16380	16592	Side Long	11.7	20.3	Residual (near surface); Basalt (Amygdaloidal) – XW to SW	EB073 – 10.12 m bgl – 516.01 RL – 2/2/2016	Type B RHS – 15	RHS – 50			K1	2.3 x 2.3 Staggered for Batter 1	4	RHS – 35						

The works shown on this drawing are a factual representation of the works constructed.
Signature
Date 10/09/2019
Name Mike Millar
Title Project Director

	Revisions/Descriptions	Certification	Date	Microfiled
C	As Constructed	NR	10/09/19	
B1	DSRFI-01288 CRFI-002540 (Orig. Cert. Valid)	MD 20314	19/06/19	
B	Updated due to Emb. 24 redesign (Cert. Updated)	SG 12463	11/05/18	
A2	DSRFI-00455 (Orig. Cert. Valid)	MS 18732	22/06/17	
A1	DSRFI-00413 (Orig. Cert. Valid)	BA 10244	13/04/17	
A	Issued For Construction			

Associated Job Nos
Auxiliary Drg Nos
Survey Data: Datum GDA94; Horiz Grid MGA94 Z56; Height Origin AHD Derived; Survey Books MR93920
Scales
Dimensions ... except where ...

LOCKYER VALLEY RC AND TOOWOOMBA RC
WARREGO HIGHWAY – GORE HIGHWAY
CTL CHGE 0.000 – 43100.000 (MC0A00)
Reference Points: Preceding | Dist. to start | From start to | From end to | Following

BATTER PROTECTION
CUTTING BATTER TREATMENT SCHEDULE
EAST – SHEET 2

Drawn J Brennan

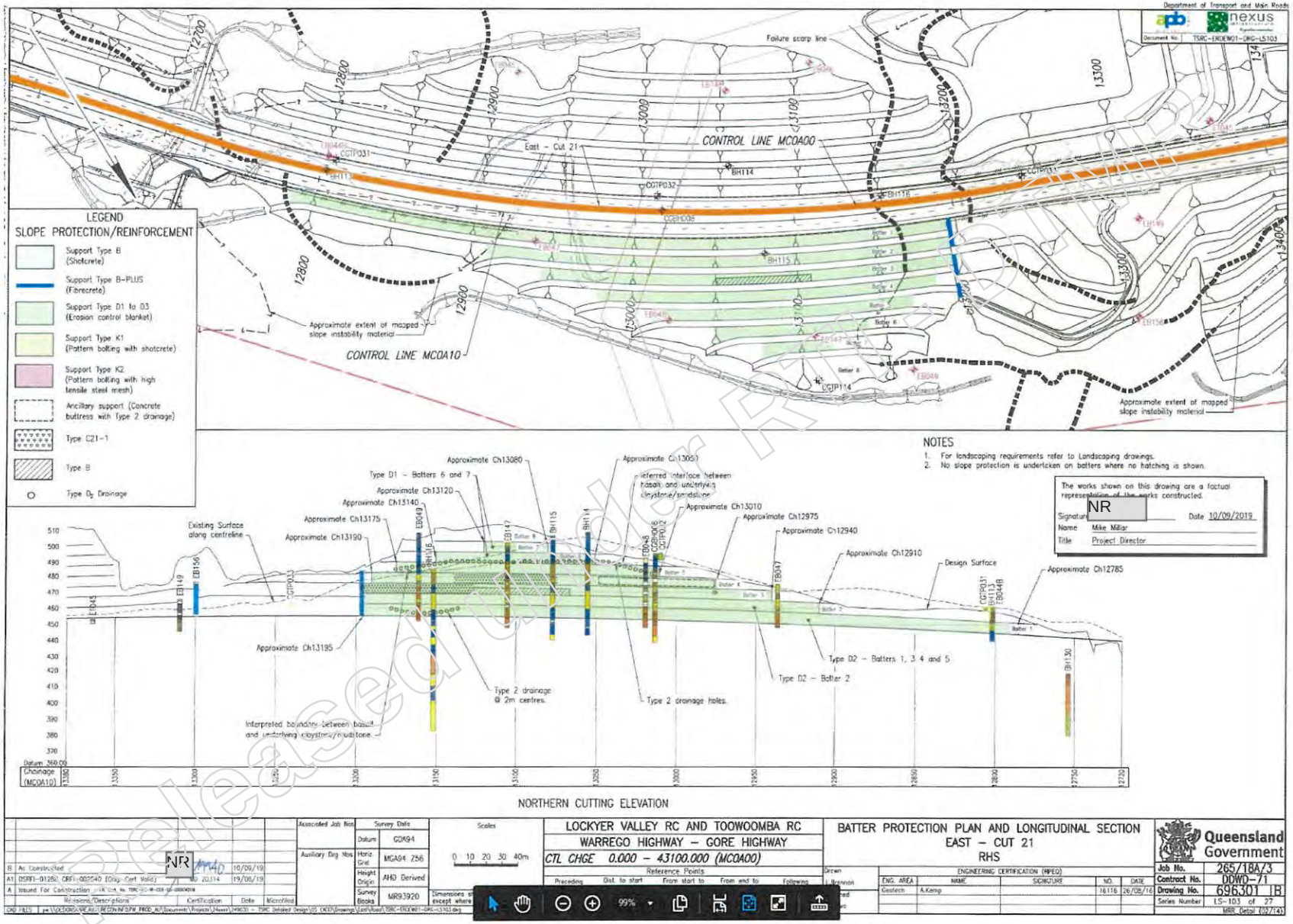
ENGINEERING CERTIFICATION (RPEQ)

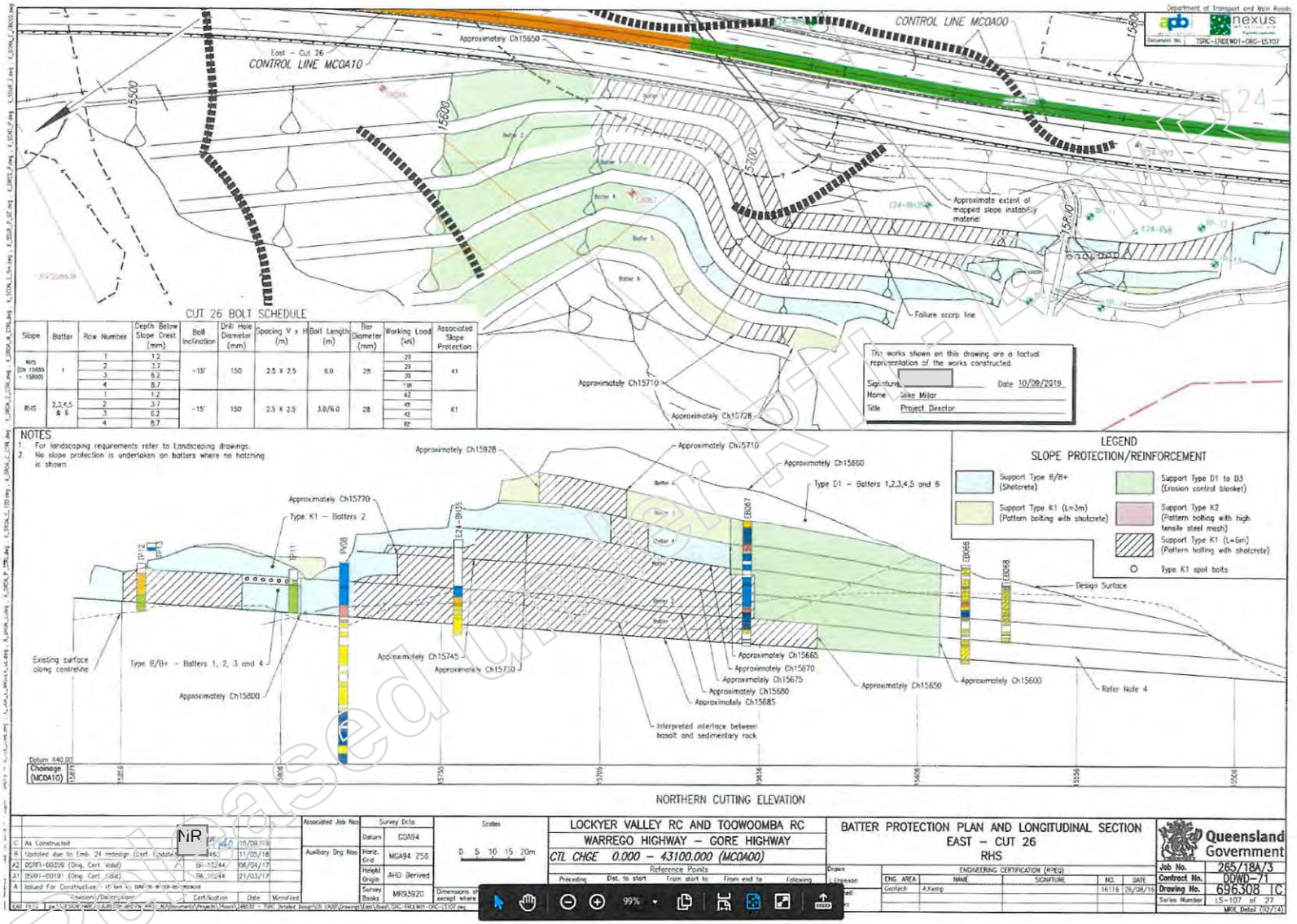
ENG. AREA	NAME	SIGNATURE	NO.	DATE
Geotech	A.Kemp		16116	26/08/16

Queensland Government
Job No. 265/18A/3
Contract No. DDWD-71
Drawing No. 696285 1C
Series Number SH-101 of 04
MRR Detail (02/14)

Document No. TSRC-ERDEW01-DRG-SH101

CAD FILES pw:\\designshare.au.aurecon.info:PW_PROD_AU\Documents\Projects\2xxxxx\249339 – TSRC Detailed Design\05 CADD\Drawings\East\Road\TSRC-ERDEW01-DRG-SH101.dwg





Slope	Batter	Row Number	Depth Below Slope Crest (mm)	Bolt Inclination	Drill Hole Diameter (mm)	Spacing V x H	Bolt Length (m)	Bar Diameter (mm)	Working Load (kN)	Associated Slope Protection
RHS (Ch 13685 – 15800)	1	1	1.2	-15°	150	2.5 X 2.5	6.0	28	23	K1
		2	3.7						23	
		3	6.2						35	
		4	8.7						118	
RHS	2,3,4,5 & 6	1	1.2	-15°	150	2.5 X 2.5	3.0/6.0	28	42	K1
		2	3.7						42	
		3	6.2						42	
		4	8.7						82	

Appendix 7

Diagram of Likely Geotechnical Failure Mechanism at Cut 26