Tonkin+Taylor

13 June 2024
Job No: 1090767

Otago Regional Council
Private Bag 1954
Dunedin 9054.

Attention: Shay McDonald

Dear Shay

Mount Cooee Landfill

Landfill and Geotechnical Consent Technical review RM21.668

1 Introduction

Tonkin & Taylor Ltd(T+T) have reviewed selected reports and response compiled to support the consent application for the partial closure and extension of the Mt Cooee landfill in Balclutha for the Otago Regional Council (ORC). The review has been conducted as per the Purchase Order number PO 030980, issued 20 April 2023 and the included short form agreement.

This letter report relates to review of the following additional documents provided by ORC, following a meeting with WSP on 1 February 2024, and related dates received by T+T:

- Response to additional Section 92 questions regarding the Groundwater Assessment, 27 February 2024
- Response to s92 letter, 9 April 2024.
- Design Drawing Set reissue, 9 April 2024.
- Memorandum -Geotechnical assessment report and appendices, 21 June 2024.

The reports were reviewed to assess the design information, landfill design and geotechnical engineering, for the landfill development only, and did not include a review of the proposed resource recovery centre.

2 Response to ORC question form

For all technical matters
Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions? Yes, or no. If not, what are the flaws?
No, refer responses below in section 3.

Are there any other matters that appear relevant to you that have not been included? Or is additional information needed? Please specify what additional info you require and why [please explain]
Yes, refer responses below in sections 3.
If granted, are there any specific conditions that you recommend should be included in the consent?
Yes, see some suggested conditions in the geotechnical section below, however until the below matters are resolved we do not believe it is appropriate to provide recommendation on all aspects.
Landfill Design
Reports to audit: AEE, App B Design Report, App C Design Drawing Set, App G Sheet Pile, App S Proposed Conditions of Consent, App V Landfill Management Plan, and any other reports/sections of reports that you consider relevant to your understanding
Q: Is the Landfill design and management fit for purpose with regards to the Technical Guidelines for Disposal to Land (WasteMINZ, 2022)? Please explain.
No, require further clarification, refer responses below in sections 3, and drawing markups attached (Appendix A).
Q: Is the leachate and stormwater management appropriate for the site, including the current landfill area and the proposed expansion area? Please explain.
No, require further clarification, refer response below in section 3 and drawings markups attached (Appendix A).
Q: Is the landfill gas management appropriate for the site, including the changes proposed by the Applicant as part of this application? Please explain.
No, require further clarification, refer responses below in sections 3 and drawing markups attached (Appendix A).
Q: Does the risk of landfill fire need to be assessed? Please explain.
Yes, landfill fire is a real risk both from internal and external generation, and can impact the new extension landfill liner. The risk of a landfill fire should be assessed by the applicant as outlined in Technical Guidelines for Disposal to Land (WasteMINZ, 2023). This should also take into consideration fires generated from the disposal of inappropriate items such as discarded lithium-ion batteries.
Q: In your opinion, are the proposed conditions of consent appropriate to mitigate adverse effects on persons and the environment?

Until the below matters are resolved we do not believe it is appropriate to comment on this item.

Geotechnical
Reports to audit: AEE, App E Geotech Factual, App F Geotech Interpretive, App S Proposed Conditions of Consent, App V Landfill Management Plan, and any other reports/sections of reports that you consider relevant to your understanding.
Q: Is the geological and geotechnical information provided sufficient to understand the site and the land stability effects from the continued operation, closure, and aftercare of the landfill? Please explain.
We have reviewed the updated geotechnical assessment and believe it is appropriately representative of the landfill design, follows appropriate assessment standards and achieves acceptable performance outcomes for long term and temporary cases under static and seismic loading cases. (i.e. acceptable FOS and deformation are demonstrated through analysis of landfill sections). However, there appears to be differences, or lack consistency, between the geotechnical sections analysed and what is presented in the drawings set. This primarily relates to the piggyback section of the landfill design, as shown on the markup versions the drawing set attached in Appendix A. The geotechnical assessment also highlights the critical requirement for an underdrainage or subsoil drainage system for the site to prevent uplift pressures on the liner system. Details of the subsoil drainage system is lacking from the provided updated drawing set. Minor comments on the geotechnical assessment are attached in Appendix B.
Q: Does the application adequately address potential effects on landfill stability for continued filling in current area and proposed expansion area? Please explain.
Yes, refer to above response.
Q: Do you agree with the conclusions reached in Section 10 and recommendations in Section 11 of the Geotechnical Interpretive Report?
Refer to attached comments on revised Memorandum -Geotechnical assessment report and appendices, 21 June 2024 and above response.
Q: In your opinion, are the proposed conditions of consent appropriate to mitigate adverse effects on persons and the environment?
We recommend appropriate aspects for the geotechnical assessment are adopted as part of the consent conditions if granted. This likely relate the following main areas: i Guidance on appropriate analysis requirements (specific consideration of liner interface) and critical section selection.

ii	Static and seismic loading considerations, including groundwater and leachate considerations.
iii	Performance criteria, Factor of Safety and deformation limits.
iv	Inclusion of a 2m high toe bund.
v	Summary of any independent review requirements, if a Peer Review Panel is not adopted as part of the consent conditions.
Q: Do you agree with the Applicant's conclusion as the level of adverse effects (from a geotechnical perspective) on persons and the environment?	
Yes, provided clarification is provided on the consistency between the sections analysis in the geotechnical assessment and those presented in the final drawing set.	

3 Review of selected s92 responses.

Landfill Design, drawing set-We have reviewed the revised set of drawings, some of the items previously raised have been addressed however, there remain items previously queried that have not been addressed. A markup up set of drawings is attached to this letter report in Appendix A, along with additional comments in the MS Excel spreadsheet in Appendix C (also issued in digital format with this letter). In providing comments on the drawing set and tracking spreadsheet we have focused on aspects we believe are fundamental to the landfill performance and providing a suitable level of concept information that is representative of the proposed landfill activity. Not resolving the above items could result in reduced landfill performance and could influence the Applicants proposed leakage rates. We recommend the above aspects are highlighted to those reviewing the downstream effects of the landfill.

4 Applicability

This report has been prepared for the exclusive use of our client Otago Regional Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Otago Regional Council in undertaking its regulatory functions in connection with the consent review for the Mount Cooee Landfill, Balclutha, reference RM21.668.

Tonkin & Taylor Ltd

Report prepared by:

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Pete Abernethy
Senior Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:

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Jonathan Shamrock
Project Director

13-Jun-24
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Appendix A Drawing set

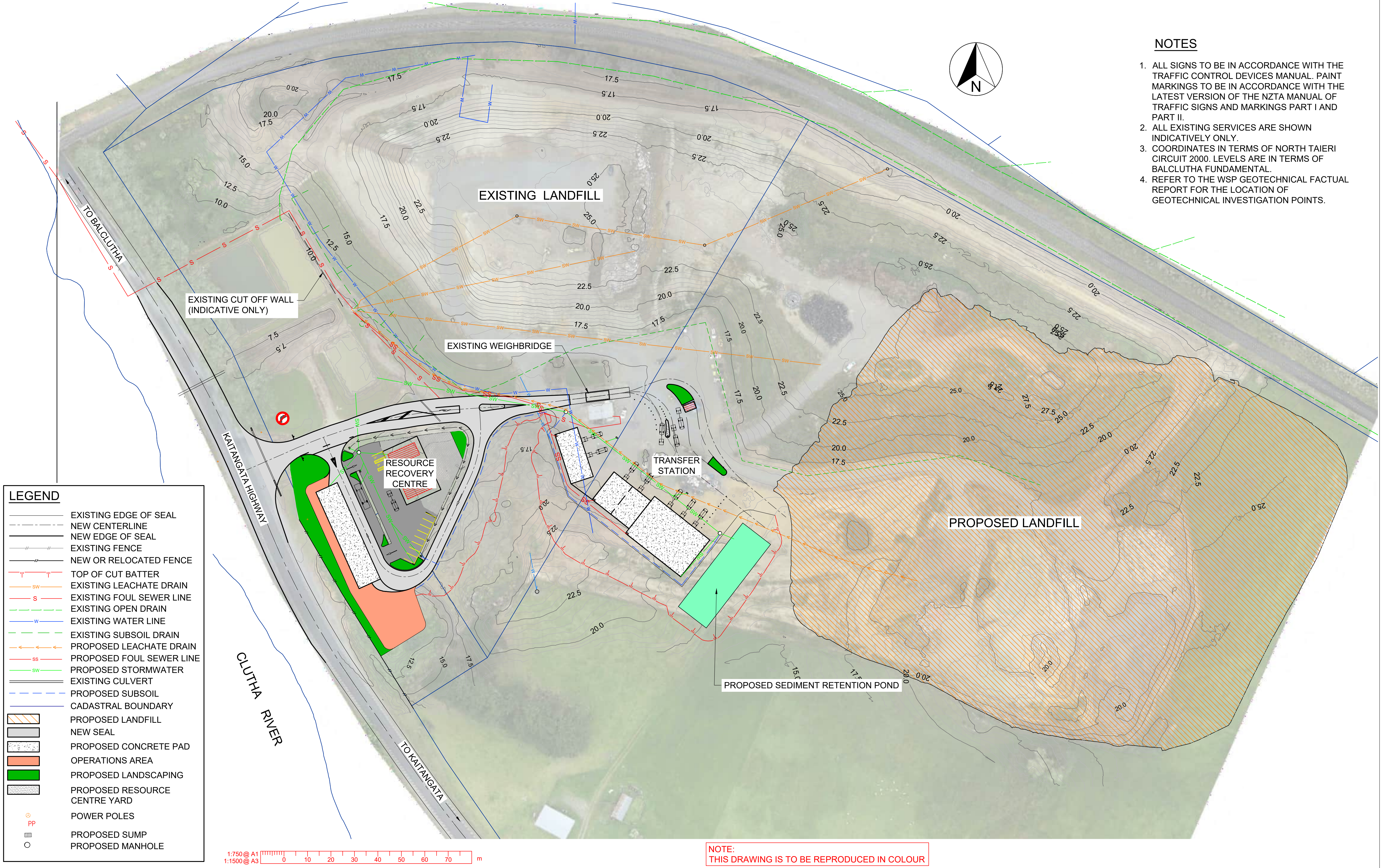
T+T comments 10/6/2024

INDEX

CLUTHA DISTRCT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

CIVIL
CONSENT

Project No: CO082.00
Date: 2024_04_08



NOTES

1. ALL SIGNS TO BE IN ACCORDANCE WITH THE TRAFFIC CONTROL DEVICES MANUAL. PAINT MARKINGS TO BE IN ACCORDANCE WITH THE LATEST VERSION OF THE NZTA MANUAL OF TRAFFIC SIGNS AND MARKINGS PART I AND PART II.
2. ALL EXISTING SERVICES ARE SHOWN INDICATIVELY ONLY.
3. COORDINATES IN TERMS OF NORTH TAIERI CIRCUIT 2000. LEVELS ARE IN TERMS OF BALCLUTHA FUNDAMENTAL.
4. REFER TO THE WSP GEOTECHNICAL FACTUAL REPORT FOR THE LOCATION OF GEOTECHNICAL INVESTIGATION POINTS.

LEGEND

- EXISTING EDGE OF SEAL
- NEW CENTERLINE
- NEW EDGE OF SEAL
- EXISTING FENCE
- NEW OR RELOCATED FENCE
- TOP OF CUT BATTER
- EXISTING LEACHATE DRAIN
- EXISTING FOUL SEWER LINE
- EXISTING OPEN DRAIN
- EXISTING WATER LINE
- EXISTING SUBSOIL DRAIN
- PROPOSED LEACHATE DRAIN
- PROPOSED FOUL SEWER LINE
- PROPOSED STORMWATER
- EXISTING CULVERT
- PROPOSED SUBSOIL
- CADASTRAL BOUNDARY
- PROPOSED LANDFILL
- NEW SEAL
- PROPOSED CONCRETE PAD
- OPERATIONS AREA
- PROPOSED LANDSCAPING
- PROPOSED RESOURCE CENTRE YARD
- PP POWER POLES
- PROPOSED SUMP
- PROPOSED MANHOLE

1:750@ A1 1:1500@ A3 0 10 20 30 40 50 60 70 m

NOTE:
THIS DRAWING IS TO BE REPRODUCED IN COLOUR

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR REVIEW	C. FOX	2023-04-06

wsp
Invercargill Office
+64 3 211 3580
PO Box 647
Invercargill 9840
New Zealand

CIVIL

SCALES		ORIGINAL SIZE
1:750@ A1, 1:1500@A3		A1
DRAWN	DESIGNED	APPROVED
J.L. BOYDE	J.L. BOYDE	CHRIS FOX
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
CALLUM FEELY	ROWAN LATHAM	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL, TRANSFER STATION & RESOURCE RECOVERY CENTRE
OVERALL SITE PLAN

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
6-CO082.00	C101	A

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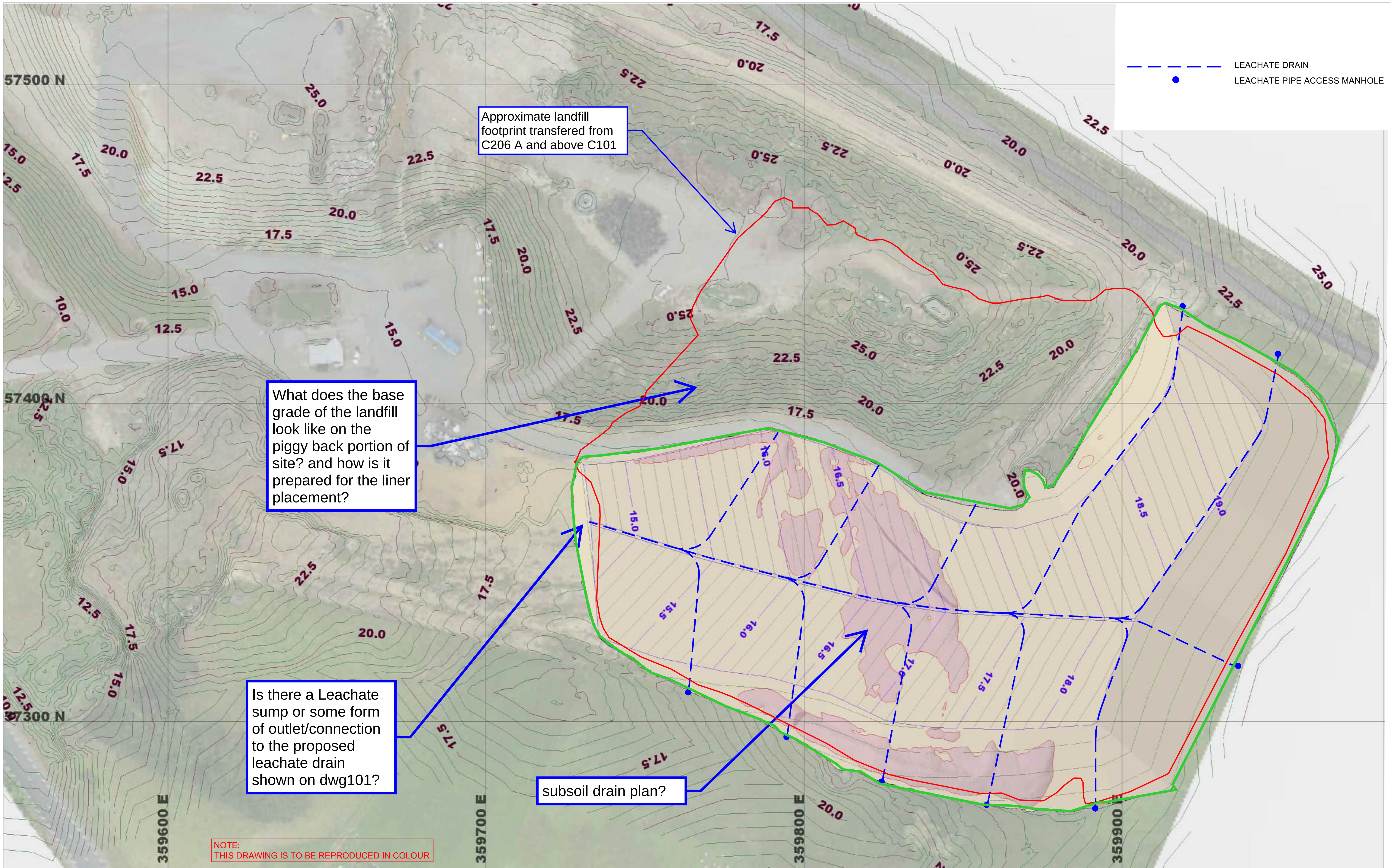

REVISION	AMENDMENT	APPROVED	DATE
A	NEW SHEET ADDED	C. FOX	2023-03-25

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SCALES: N.T.S
ORIGINAL SIZE: A1

DRAWN	DESIGNED	APPROVED
R.GOLDSMITH	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	**DESIGN VERIFIED**	**APPROVED DATE**
CALLUM FEELY	PETER ASKEY	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
FLOOR CONTOUR PLAN

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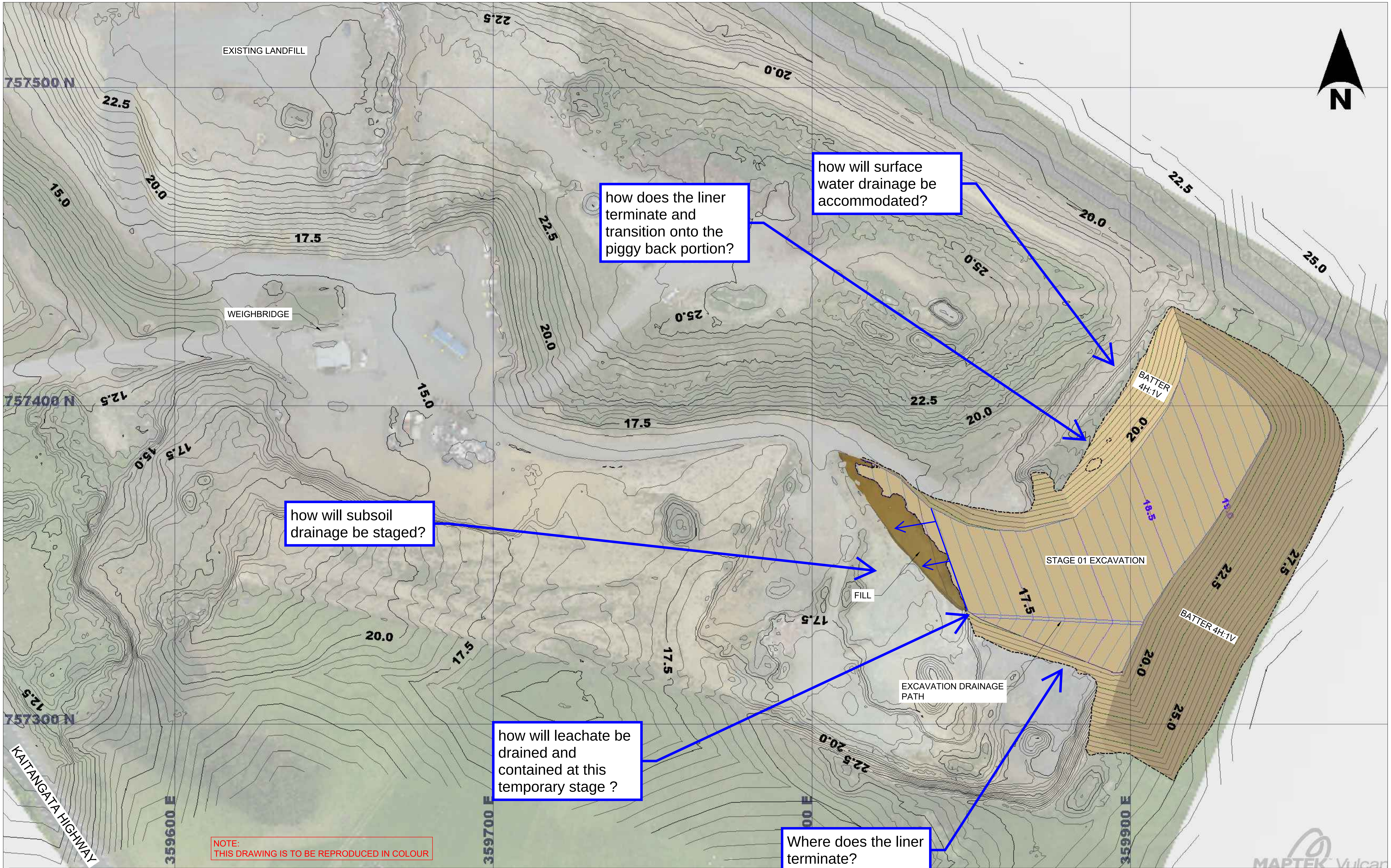

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR REVIEW	C. FOX	2023-04-06

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CIVIL

SCALES		ORIGINAL SIZE
N.T.S		A1
DRAWN	DESIGNED	APPROVED
R.GOLDSMITH	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
CALLUM FEELY	PETER ASKEY	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
STAGE 01 FLOOR DESIGN

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
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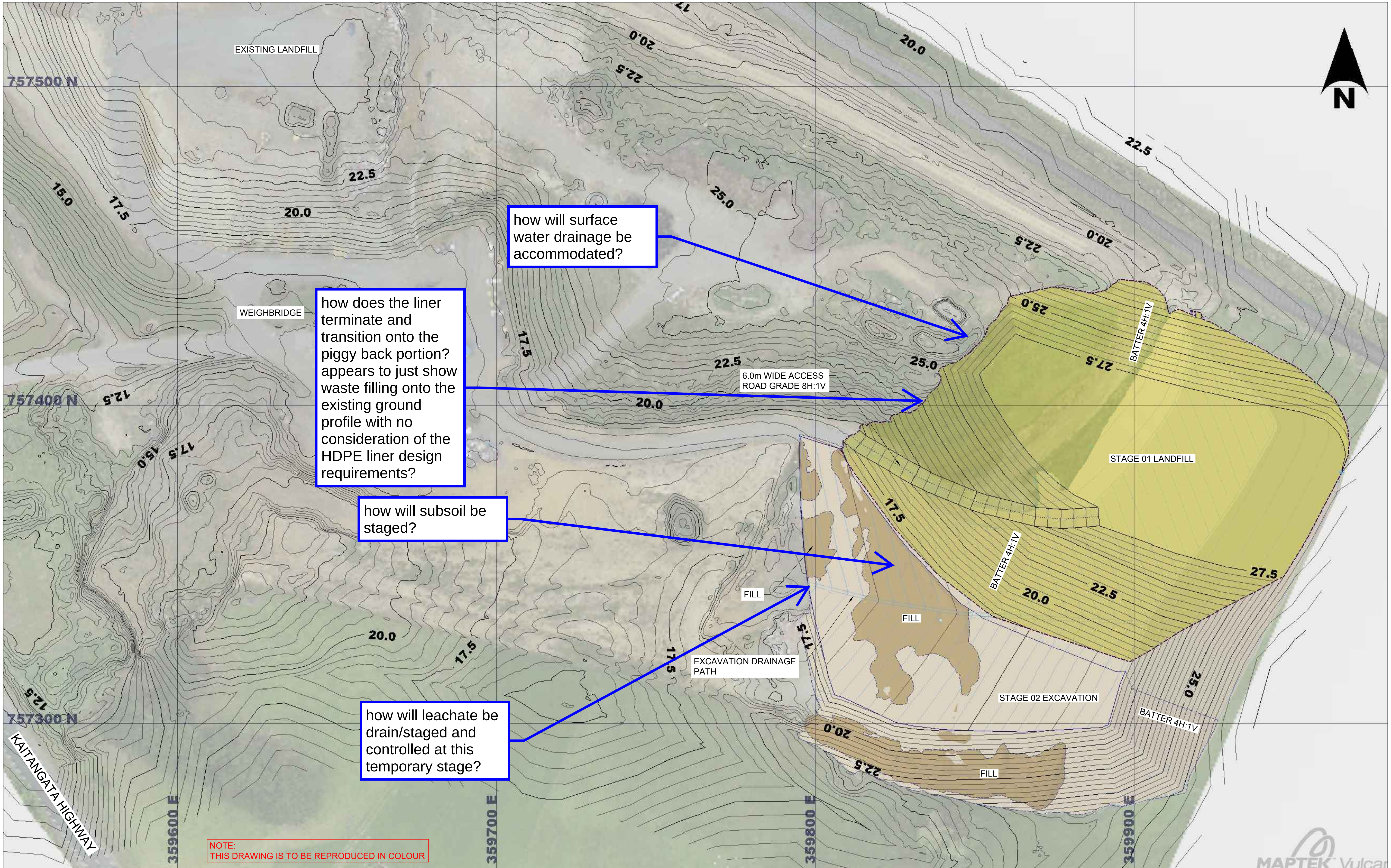

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR REVIEW	C. FOX	2023-04-06

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CIVIL

SCALES: N.T.S
ORIGINAL SIZE: A1

DRAWN	DESIGNED	APPROVED
R.GOLDSMITH	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	**DESIGN VERIFIED**	**APPROVED DATE**
CALLUM FEELY	PETER ASKEY	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LANDFILL STAGE 01 AND EXCAVATION STAGE 02

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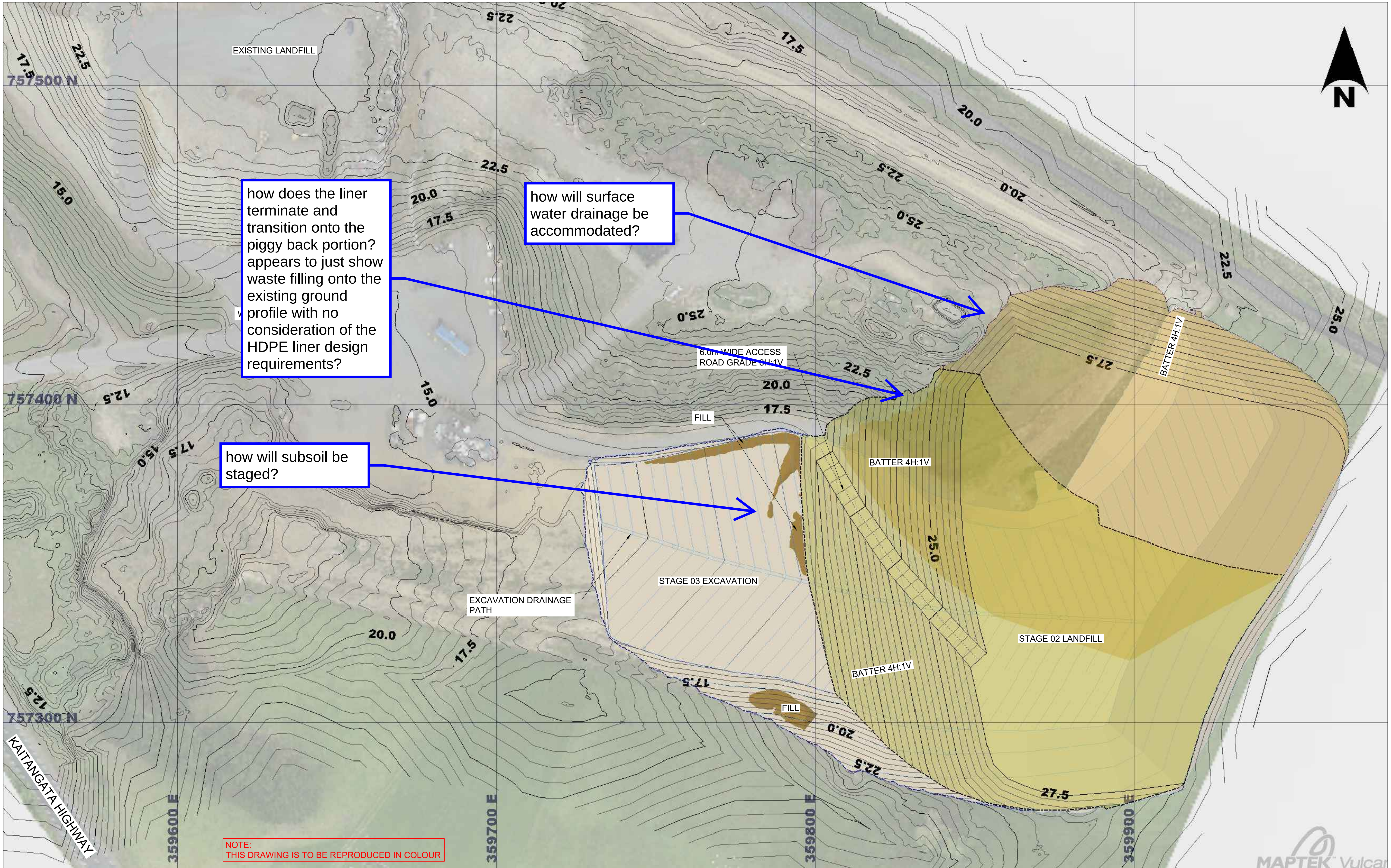

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SCALES: N.T.S
ORIGINAL SIZE: A1
DRAWN: R.GOLDSMITH
DESIGNED: R.GOLDSMITH
APPROVED: CHRIS FOX
DRAWING VERIFIED: CALLUM FEELY
DESIGN VERIFIED: PETER ASKEY
APPROVED DATE: 2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LANDFILL STAGE 02 AND EXCAVATION STAGE 03

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SHEET NO.: C202
REVISION: A

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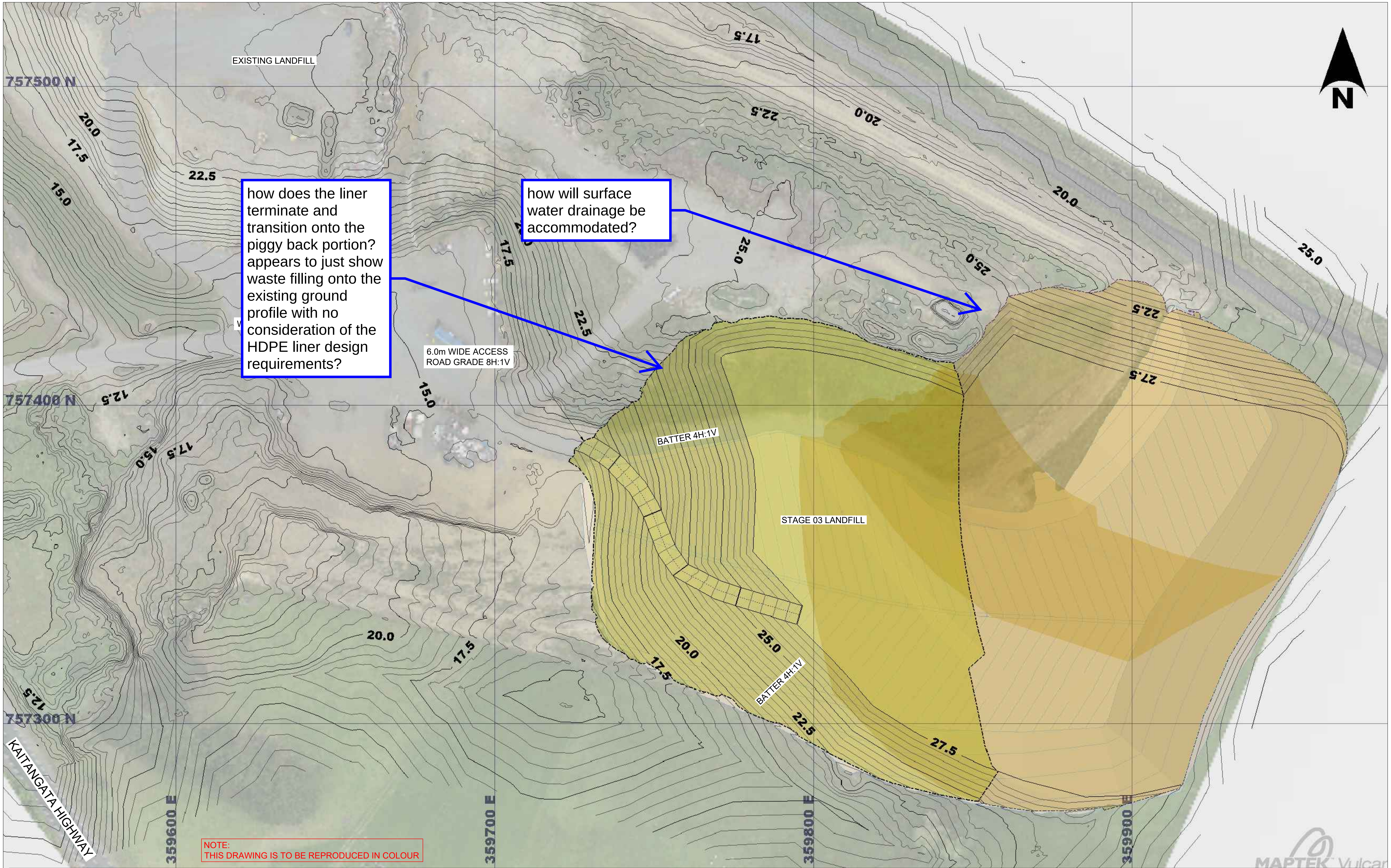

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SCALES N.T.S		ORIGINAL SIZE A1
DRAWN R.GOLDSMITH	DESIGNED R.GOLDSMITH	APPROVED CHRIS FOX
DRAWING VERIFIED CALLUM FEELY	DESIGN VERIFIED PETER ASKEY	APPROVED DATE 2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LANDFILL STAGE 03

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
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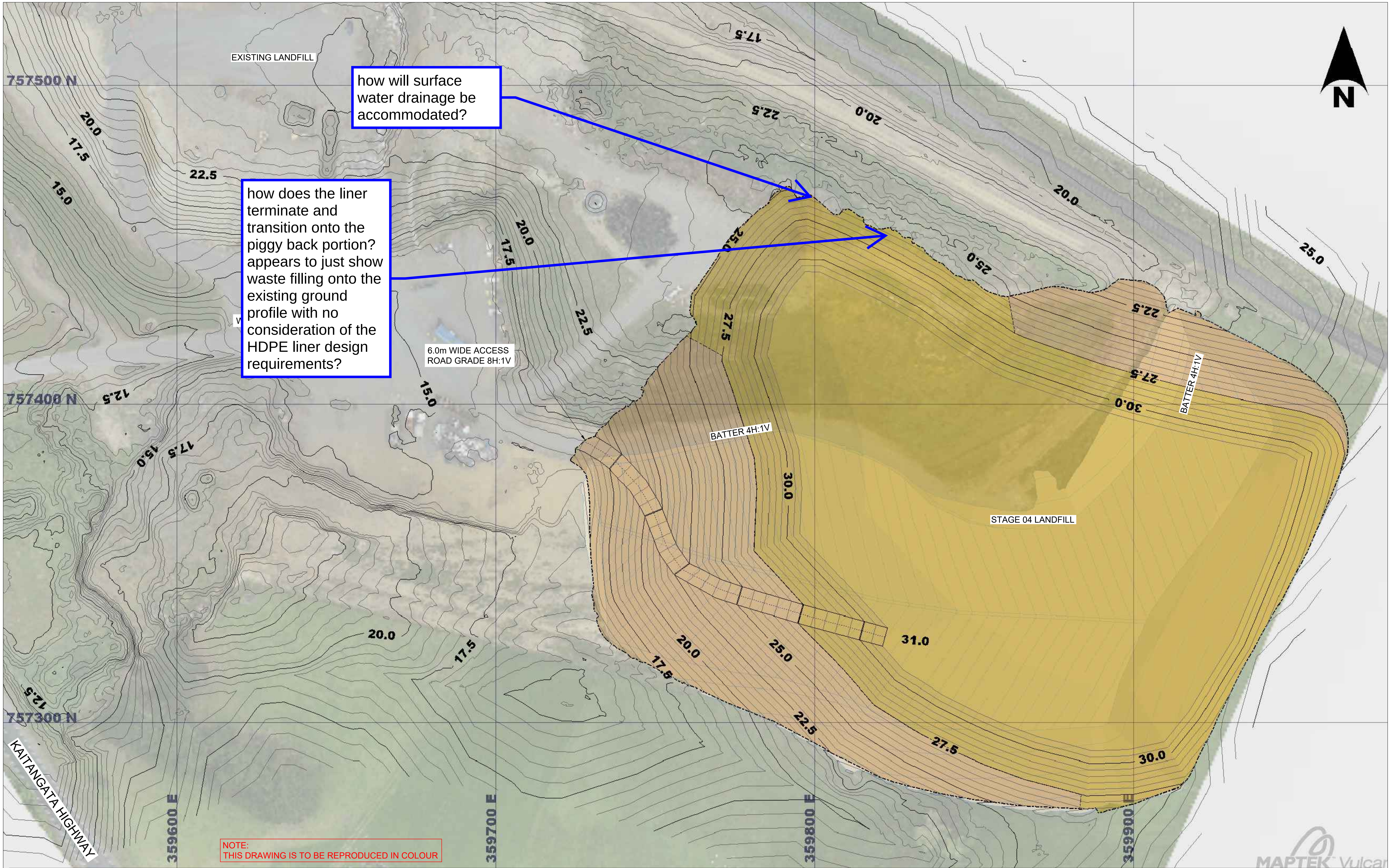

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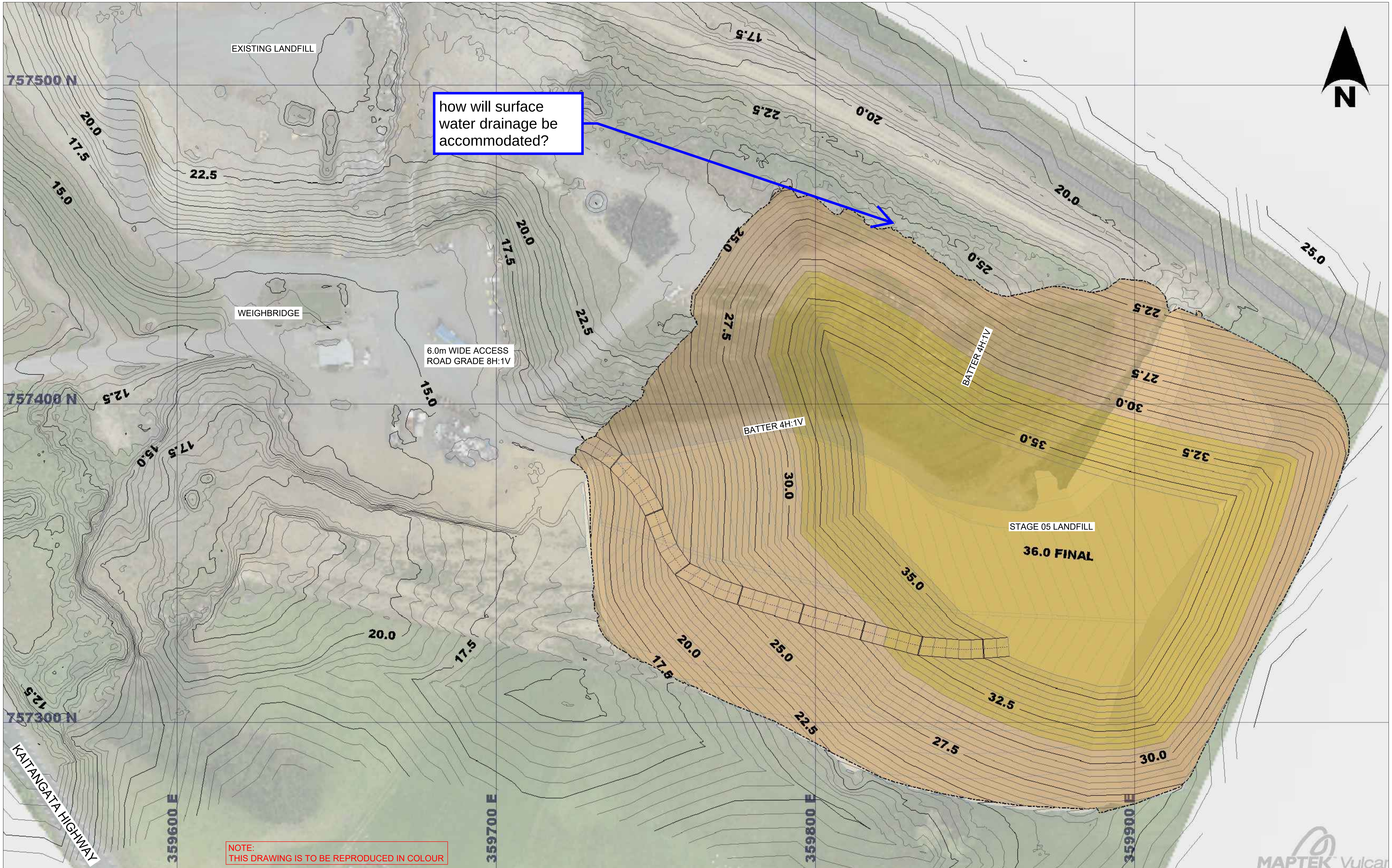
SCALES		ORIGINAL SIZE
N.T.S		A1
DRAWN	DESIGNED	APPROVED
R.GOLDSMITH	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
CALLUM FEELY	PETER ASKEY	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LANDFILL STAGE 04

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
6-CO082.00	C204	A



REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR REVIEW	C. FOX	2023-04-06

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SCALES: N.T.S
ORIGINAL SIZE: A1

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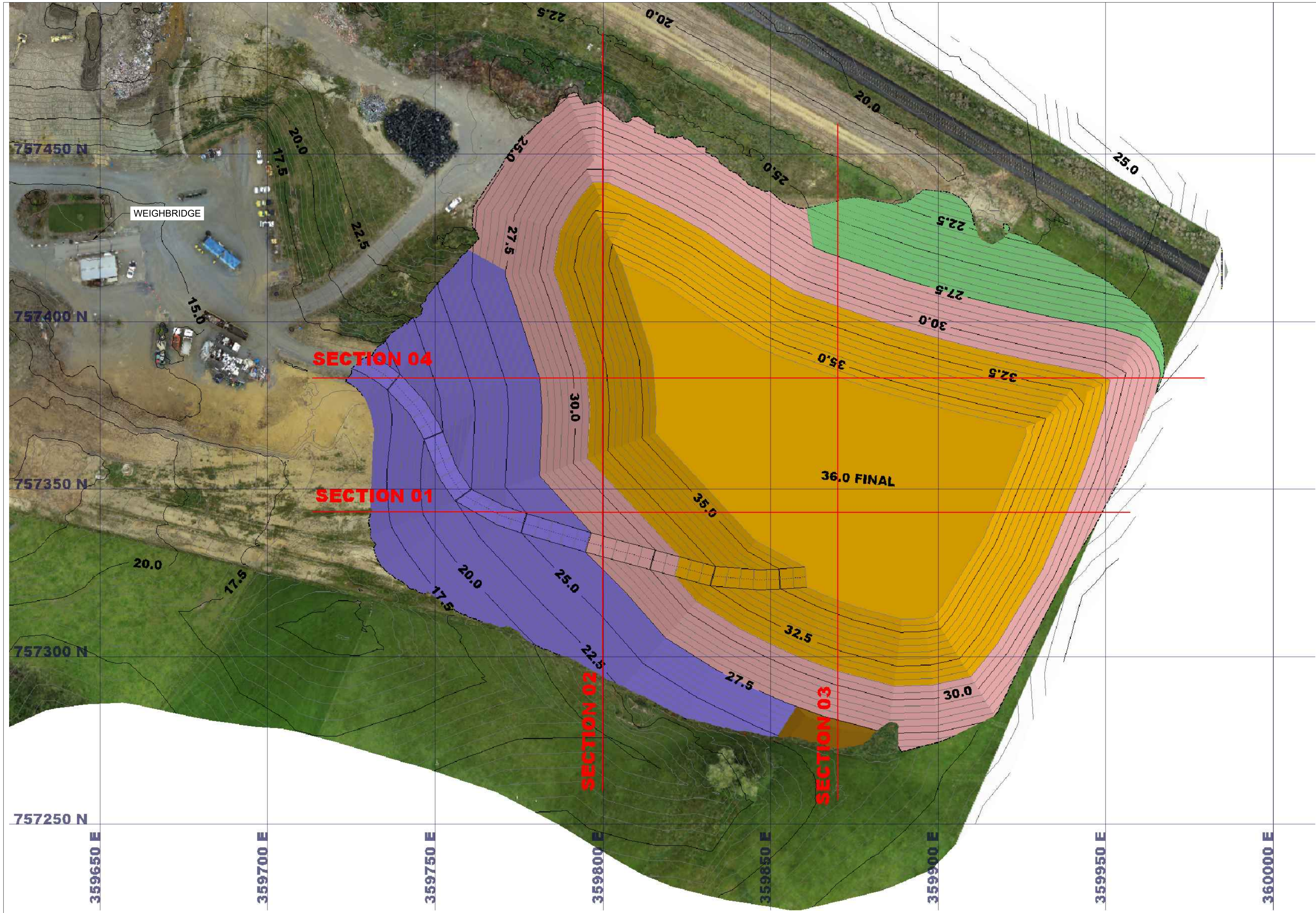
CALLUM FEELY	PETER ASKEY	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LANDFILL STAGE 05

WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.: C205
REVISION: A



LEGEND:

- LANDFILL STAGE 01
- LANDFILL STAGE 02
- LANDFILL STAGE 03
- LANDFILL STAGE 04
- LANDFILL STAGE 05

NOTE:
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REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR REVIEW	C. FOX	2023-04-06

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SCALES: N.T.S
ORIGINAL SIZE: A1
DRAWN: R.GOLDSMITH
DESIGNED: R.GOLDSMITH
APPROVED: CHRIS FOX
DRAWING VERIFIED: CALLUM FEELY
DESIGN VERIFIED: PETER ASKEY
APPROVED DATE: 2023-04-06

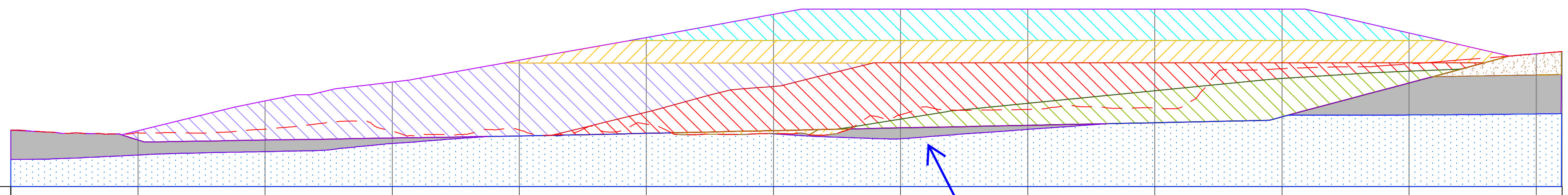
PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
SECTION LAYOUT PLAN

WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.: C206
REVISION: A

NOTE:
GROUND CONDITIONS ARE INDICATIVE ONLY AND TO BE CONFIRMED ON SITE.



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EXISTING LEVEL	16.46	17.03	16.72	16.94	17.83	16.36	19.30	20.14	20.34	26.56			
CUT/FILL	0.31	4.46	7.73	10.97	13.66	18.79	16.67	15.83	15.63	9.41			
STATION	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	244.07

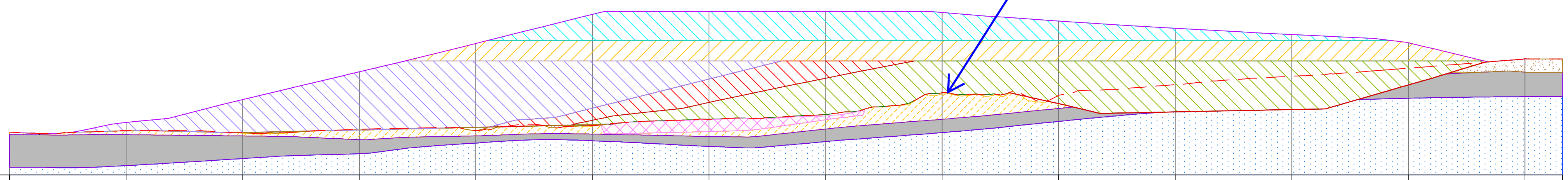
SECTION 01

where is the HDPE liner in all of these? landfill basegrade, seems at odds with other drawings?

LEGEND:

- TOPSOIL (UNIT 1)
- LANDFILL STAGE 01
- LANDFILL STAGE 02
- LANDFILL STAGE 03
- LANDFILL STAGE 04
- LANDFILL STAGE 05
- HISTORIC LANDFILL
- ALLUVIAL (UNIT 2)
- HIGHLY TO MODERATELY WEATHERED GREYWACKE, VERY WEAK TO WEAK SANDSTONE/SILTSTONE (UNIT 3b)
- SLIGHTLY WEATHERED TO FRESH, MODERATELY STRONG TO STRONG SANDSTONE/SILTSTONE (UNIT 3c)
- PROPOSED TOP OF PIT
- EXISTING GROUND

Top of pit?



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CUT/FILL	1.39	5.66	9.84	14.93	19.01	18.48	17.68	13.77	12.72	9.62	7.11			
STATION	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	266.42

SECTION 04

1:500 @ A1 / 1:1000 @ A3 — 0 5 10 15 20 25 30 35 40 45 50 m

NOTE:
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REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR COMMENT	C. FOX	2023-04-06

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CIVIL

SCALES: A1 1:500 , A3 1:1000
ORIGINAL SIZE: A1
DRAWN: R.GOLDSMITH | DESIGNED: R.GOLDSMITH | APPROVED: CHRIS FOX
DRAWING VERIFIED: CALLUM FEELY | DESIGN VERIFIED: PETER ASKEY | APPROVED DATE: 2023-04-06

PRELIMINARY

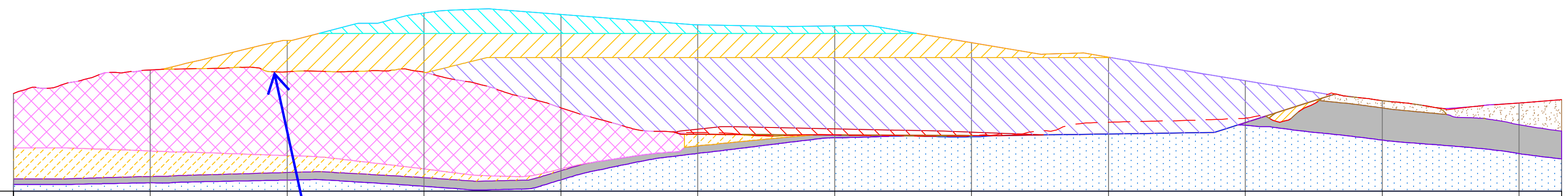
PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
EAST - WEST SECTIONS 01 AND 04

WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.: C207
REVISION: A

Original sheet size A1 (841x594) Plot Date 2023-04-06 at 4:04:58 pm U:\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\07_Phase 2 Design report\Task 3_Civil technical Drawings\(C) Civil\6-CO082.00_C207-208(A).dwg C207(A)

NOTE:
GROUND CONDITIONS ARE INDICATIVE ONLY AND TO BE CONFIRMED ON SITE.



Datum R.L. 8.00

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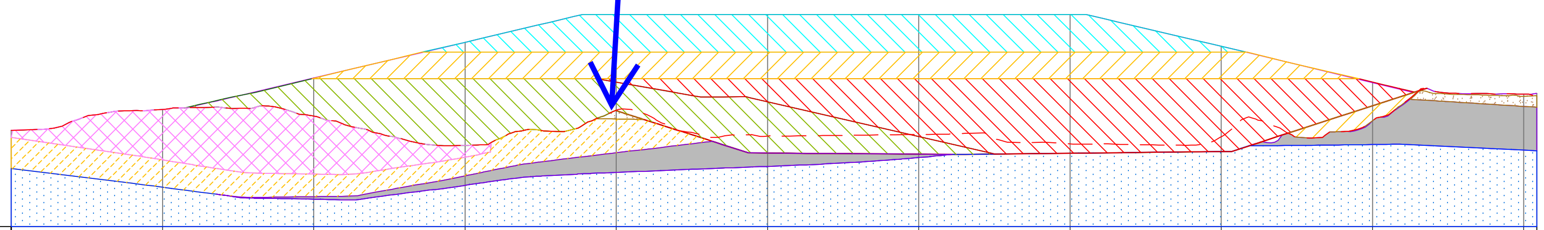
EXISTING LEVEL	25.67	25.40	25.34	20.15	16.57	16.23	16.09	18.05	18.66	21.19		
CUT/FILL	-0.02	4.57	8.65	13.61	15.68	15.86	13.57	9.49	5.44	0.00		
STATION	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	226.20

SECTION 02

Where is the HDPE liner? leachate containment/ drainage?

LEGEND:

- TOPSOIL (UNIT 1)
- LANDFILL STAGE 01
- LANDFILL STAGE 02
- LANDFILL STAGE 03
- LANDFILL STAGE 04
- LANDFILL STAGE 05
- HISTORIC LANDFILL
- ALLUVIAL (UNIT 2)
- HIGHLY TO MODERATELY WEATHERED GREYWACKE, VERY WEAK TO WEAK SANDSTONE/SILTSTONE (UNIT 3b)
- SLIGHTLY WEATHERED TO FRESH, MODERATELY STRONG TO STRONG SANDSTONE/SILTSTONE (UNIT 3c)
- PROPOSED TOP OF PIT
- EXISTING GROUND



Datum R.L. 8.00

PROPOSED LEVEL	23.46	27.61	32.32	35.97	35.97	35.97	35.97	31.80	26.99	25.48
EXISTING LEVEL	23.46	22.58	18.71	23.35	19.92	20.15	18.90	19.86	21.97	25.48
CUT/FILL	0.00	5.03	13.61	12.62	16.05	15.82	17.07	11.93	5.02	0.00
STATION	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00 201.72

SECTION 03

0 10 mm 50 100 200 300 mm

NOTE:
THIS DRAWING IS TO BE REPRODUCED IN COLOUR

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR COMMENT	C. FOX	2023-04-06

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New Zealand

CIVIL

SCALES: A1 1:500 , A3 1:1000
ORIGINAL SIZE: A1

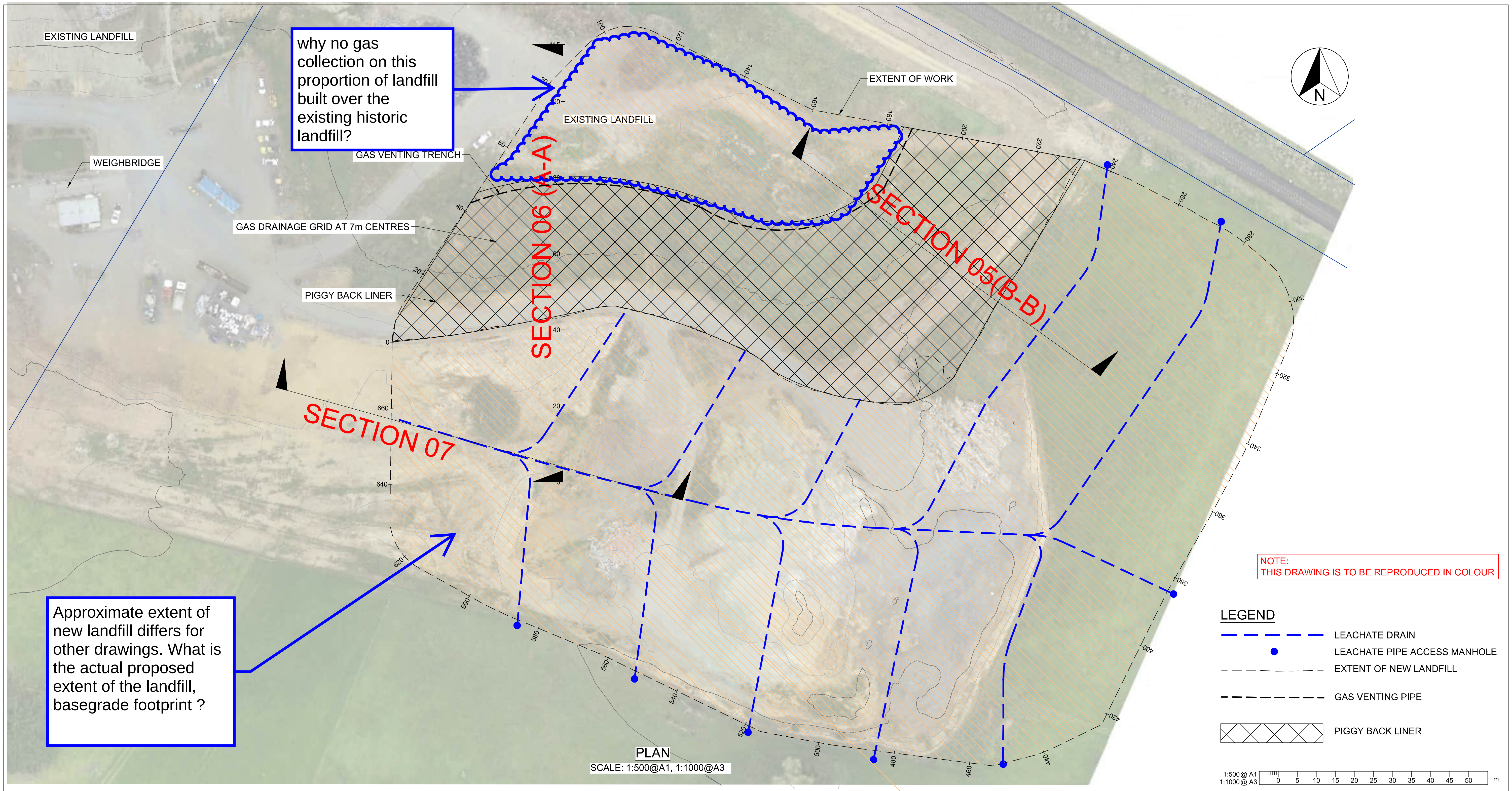
DRAWN	DESIGNED	APPROVED
R.GOLDSMITH	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
CALLUM FEELY	PETER ASKEY	2023-04-06

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
NORTH - SOUTH SECTIONS 02 AND 03

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
6-CO082.00	C208	A



PLAN

SCALE: 1:500@A1, 1:1000@A3

EXISTING GROUND LEVEL AT TOE OF LANDFILL

Datum R.L. 14.00

EXISTING LEVEL	17.00	19.53	21.67	23.68	25.07	24.73	24.81	24.80	24.96	25.01	25.69	26.33	26.12	26.14	26.07	26.14	25.20
STATION	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00

EXISTING LEVEL	24.29	23.52	22.79	22.23	21.90	21.67	21.89	22.42	23.04	23.77	24.67	25.68	26.62	27.31	27.74	28.15	28.20
STATION	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	260.00	270.00	280.00	290.00	300.00	310.00	320.00	330.00	340.00

EXISTING LEVEL	28.48	28.69	29.08	29.22	29.08	28.88	28.48	27.91	27.36	26.84	26.32	26.59	25.84	25.51	24.97	24.33	23.68
STATION	350.00	360.00	370.00	380.00	390.00	400.00	410.00	420.00	430.00	440.00	450.00	460.00	470.00	480.00	490.00	500.00	510.00

EXISTING LEVEL	23.27	23.00	22.71	21.94	20.88	19.86	18.93	17.91	17.15	16.17	15.36	15.77	16.14	16.25	16.02	16.10
STATION	520.00	530.00	540.00	550.00	560.00	570.00	580.00	590.00	600.00	610.00	620.00	630.00	640.00	650.00	660.00	670.00

Toe of Fill Batter

PROFILE ALONG TOE OF FILL BATTER

SCALE: 1:1000@A1, 1:2000@A3

1:1000@ A1
1:2000@ A3
0 10 20 30 40 50 60 70 80 90 100 m

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR COMMENT	C. FOX	2023-10-17
B	GAS VENTING AND PIGGYBACK LINER ADDED	C.FOX	2024-03-25

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New Zealand

CIVIL

SCALES
A1 1:500 , A3 1:1000

ORIGINAL SIZE
A1

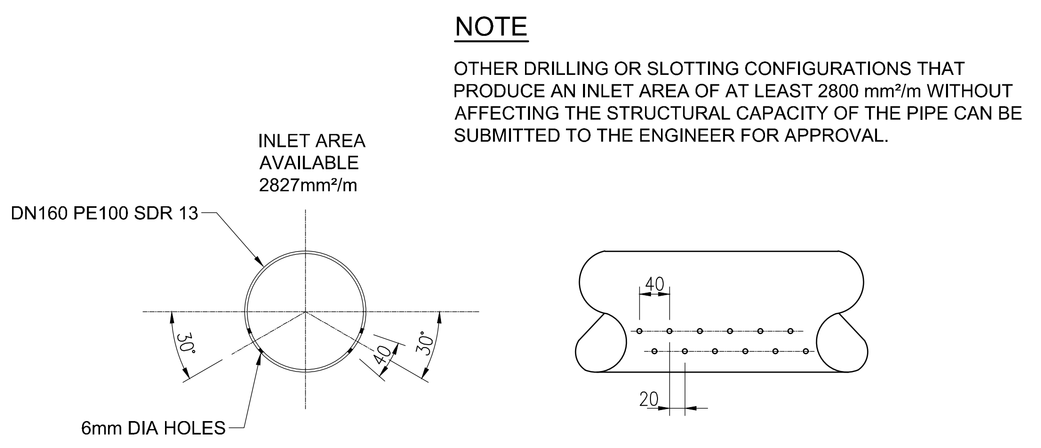
DRAWN	DESIGNED	APPROVED
J.L. BOYDE	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	DESIGN VERIFIED	APPROVED DATE
CALLUM FEELY	PETER ASKEY	2023-10-17

PRELIMINARY

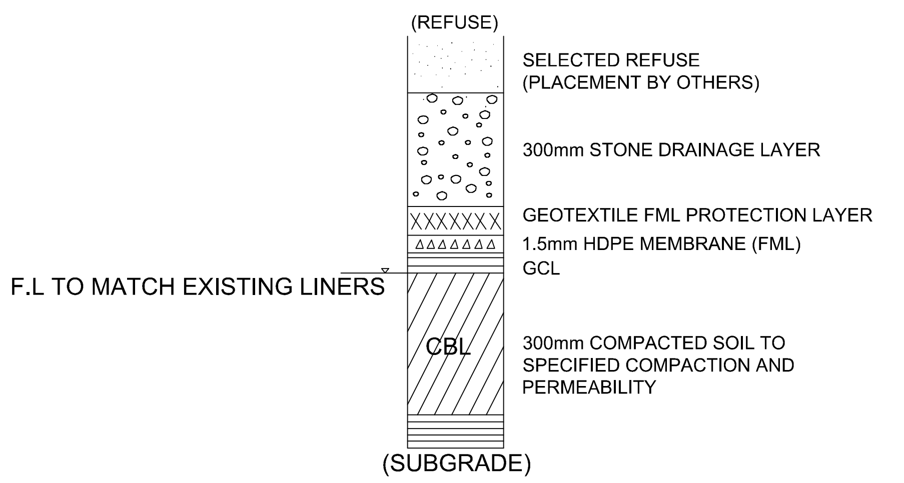
PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LEACHATE DRAINAGE LAYOUT PLAN AND TOE OF FILL PROFILE

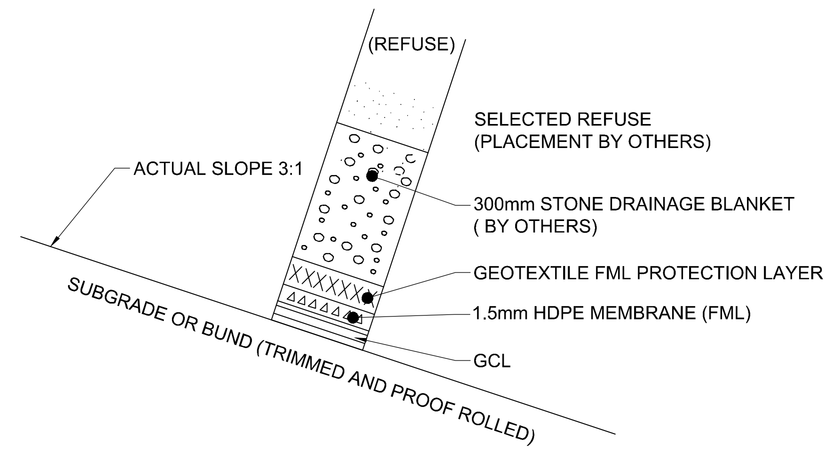
WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.: C209
REVISION: B



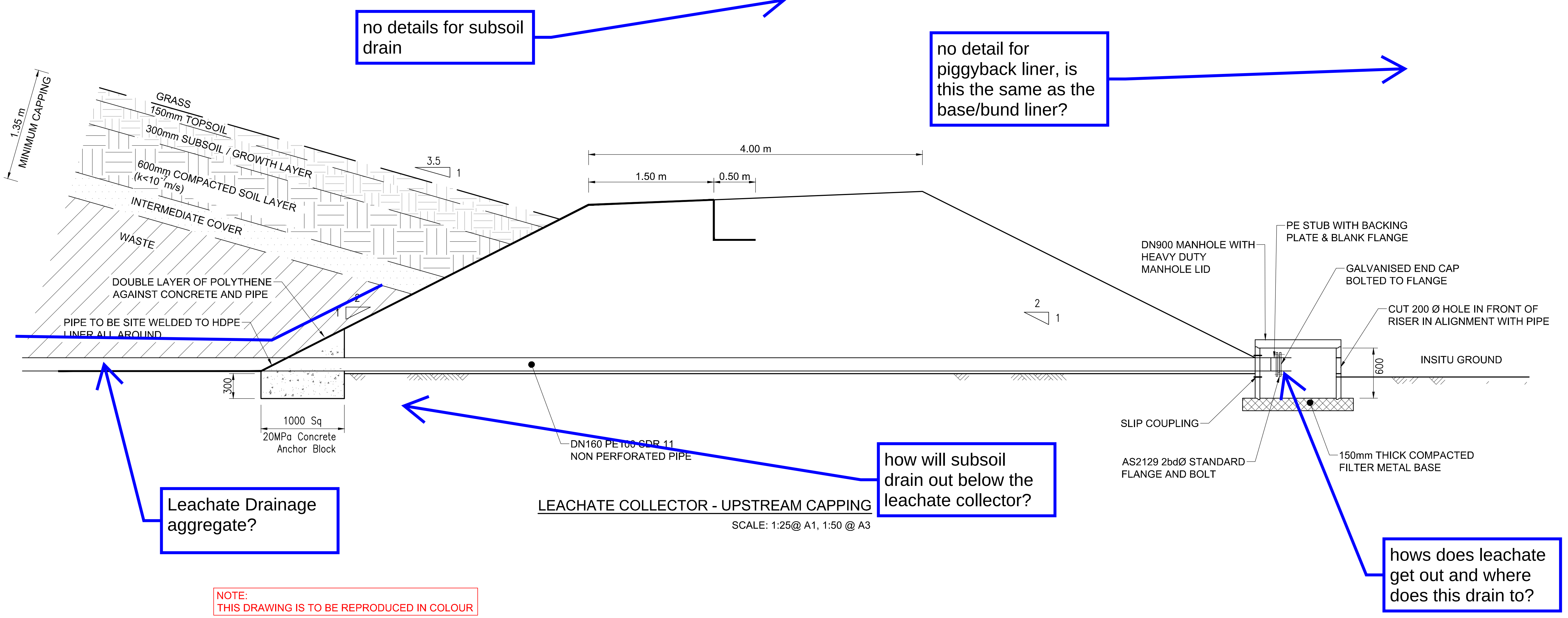
TYPICAL LEACHATE PIPE DETAIL
Scale 1:5 (A1) 1:10 (A3)



TYPICAL FLOOR DETAIL
(N.T.S)



TYPICAL DETAIL FOR LINER PLACED AGAINST BUND
(N.T.S)



LEACHATE COLLECTOR - UPSTREAM CAPPING
SCALE: 1:25@ A1, 1:50 @ A3

NOTE:
THIS DRAWING IS TO BE REPRODUCED IN COLOUR

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR COMMENT	C. FOX	2023-10-17

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PO Box 647 Invercargill 9840 New Zealand

CIVIL

SCALES: AS SHOWN — ORIGINAL SIZE: A1

DRAWN	DESIGNED	APPROVED
J.L. BOYDE	R.GOLDSMITH	CHRIS FOX
DRAWING VERIFIED	**DESIGN VERIFIED**	**APPROVED DATE**
CALLUM FEELY	PETER ASKEY	2023-10-17

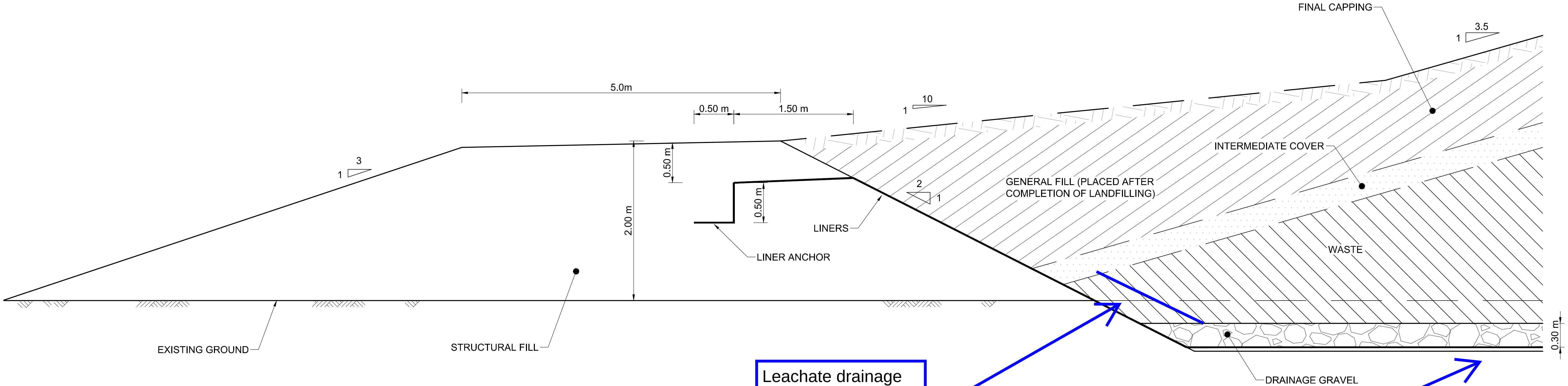
PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
LEACHATE DETAILS

WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
6-CO082.00	C210	A

Original sheet size A1 (841x594) Plot Date 2023-10-19 at 11:37:07 am U:\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\07_Phase 2 Design report\Task 3_Civil technical Drawings\(C) Civil\6-CO082.00_C209-C212(A).dwg C210(A)



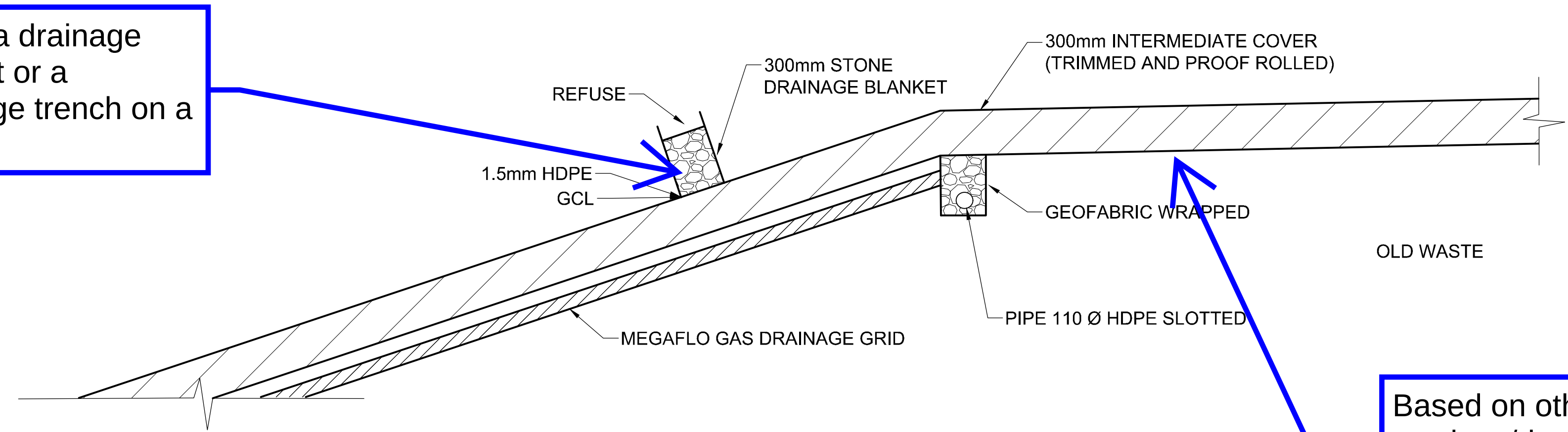
Leachate drainage aggreate?

Subsoil drainage?

TOE BUND DETAIL

SCALE: 1:25@ A1, 1:50 @ A3

is this a drainage blanket or a drainage trench on a slope?



Based on other cross sections/drawings the existing topography doesn't appear to be a uniformly grade surface ready for the over lying piggy back liner like shown

PIGGYBACK LINER AND GAS VENTING DETAIL

SCALE: 1:25@ A1, 1:50 @ A3

NOTE:
THIS DRAWING IS TO BE REPRODUCED IN COLOUR

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR COMMENT	C. FOX	2023-10-17
B	PIGGYBANK LINER AND GAS VENTING DETAIL ADDED	C.FOX	2024-03-25

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SCALES: AS SHOWN		ORIGINAL SIZE: A1
DRAWN: J.L. BOYDE	DESIGNED: R.GOLDSMITH	APPROVED: CHRIS FOX
DRAWING VERIFIED: CALLUM FEELY	DESIGN VERIFIED: PETER ASKEY	APPROVED DATE: 2023-10-17

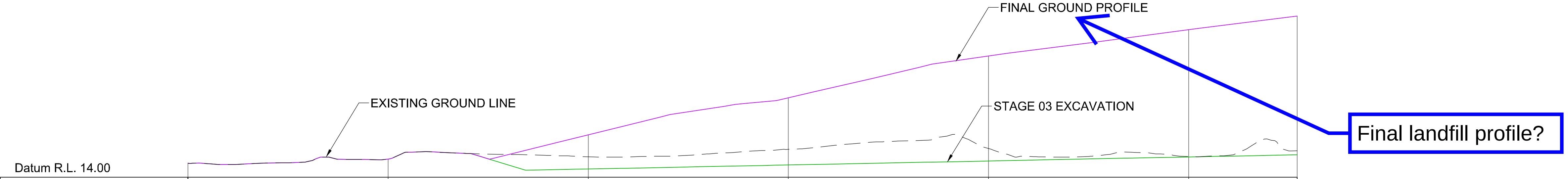
PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
DETAILS

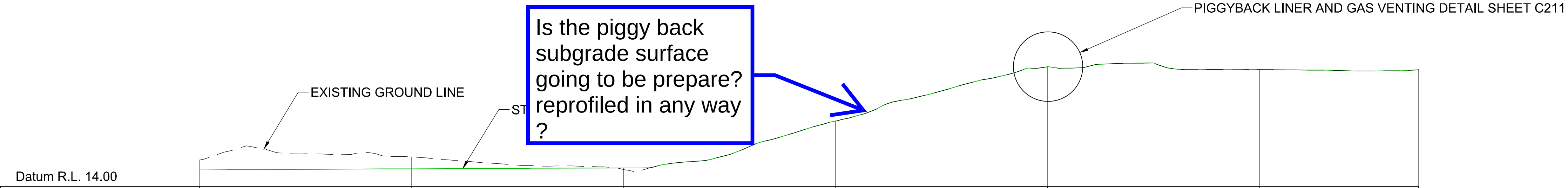
WSP PROJECT NO. (SUB-PROJECT)	SHEET NO.	REVISION
6-CO082.00	C211	B

Original sheet size A1 (841x594)   Plot Date 2024-04-08 at 2:22:22 pm   U:\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\07_Phase 2 Design report\Task 3_Civil technical Drawings\(C) Civil\6-CO082.00_C209-C212(B).dwg C211(B)



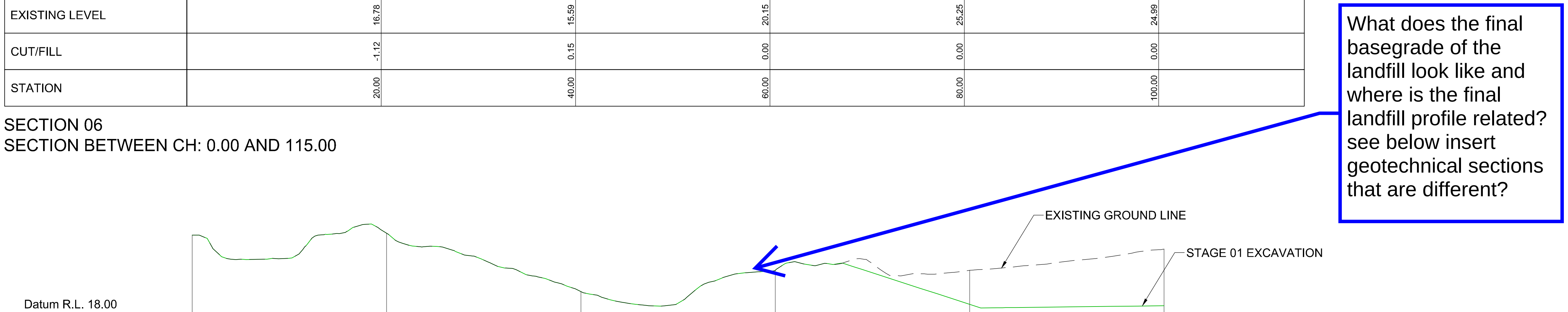
PROPOSED LEVEL	15.81	14.82	15.22	15.63	16.03
EXISTING LEVEL	15.81	16.05	16.79	16.87	16.07
CUT/FILL	0.00	-1.22	-1.56	-1.25	-0.05
STATION	20.00	40.00	60.00	80.00	100.00

SECTION 07
SECTION BETWEEN CH: 0.00 AND 110.83



PROPOSED LEVEL	15.66	15.74	20.15	25.25	24.99
EXISTING LEVEL	16.78	15.59	20.15	25.25	24.99
CUT/FILL	-1.12	0.15	0.00	0.00	0.00
STATION	20.00	40.00	60.00	80.00	100.00

SECTION 06
SECTION BETWEEN CH: 0.00 AND 115.00



PROPOSED LEVEL	26.23	20.23	22.42	18.92
EXISTING LEVEL	26.23	20.23	22.42	22.41
CUT/FILL	0.00	0.00	0.00	-3.49
STATION	20.00	40.00	60.00	80.00

SECTION 05 (B-B)
SECTION BETWEEN CH: 0.00 AND 100.00

NOTE:
GROUND CONDITIONS ARE INDICATIVE ONLY AND TO BE CONFIRMED ON SITE.

NOTE:
THIS DRAWING IS TO BE REPRODUCED IN COLOUR

REVISION	AMENDMENT	APPROVED	DATE
A	PLANS ISSUED TO CLIENT FOR COMMENT	C. FOX	2023-10-17
B	DETAIL LOCATION SHOWN	C.FOX	2024-03-25

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New Zealand

CIVIL

SCALES: A1 1:250 , A3 1:500
ORIGINAL SIZE: A1
DRAWN: J.L. BOYDE
DESIGNED: R.GOLDSMITH
APPROVED: CHRIS FOX
DRAWING VERIFIED: CALLUM FEELY
DESIGN VERIFIED: PETER ASKEY
APPROVED DATE: 2023-10-17

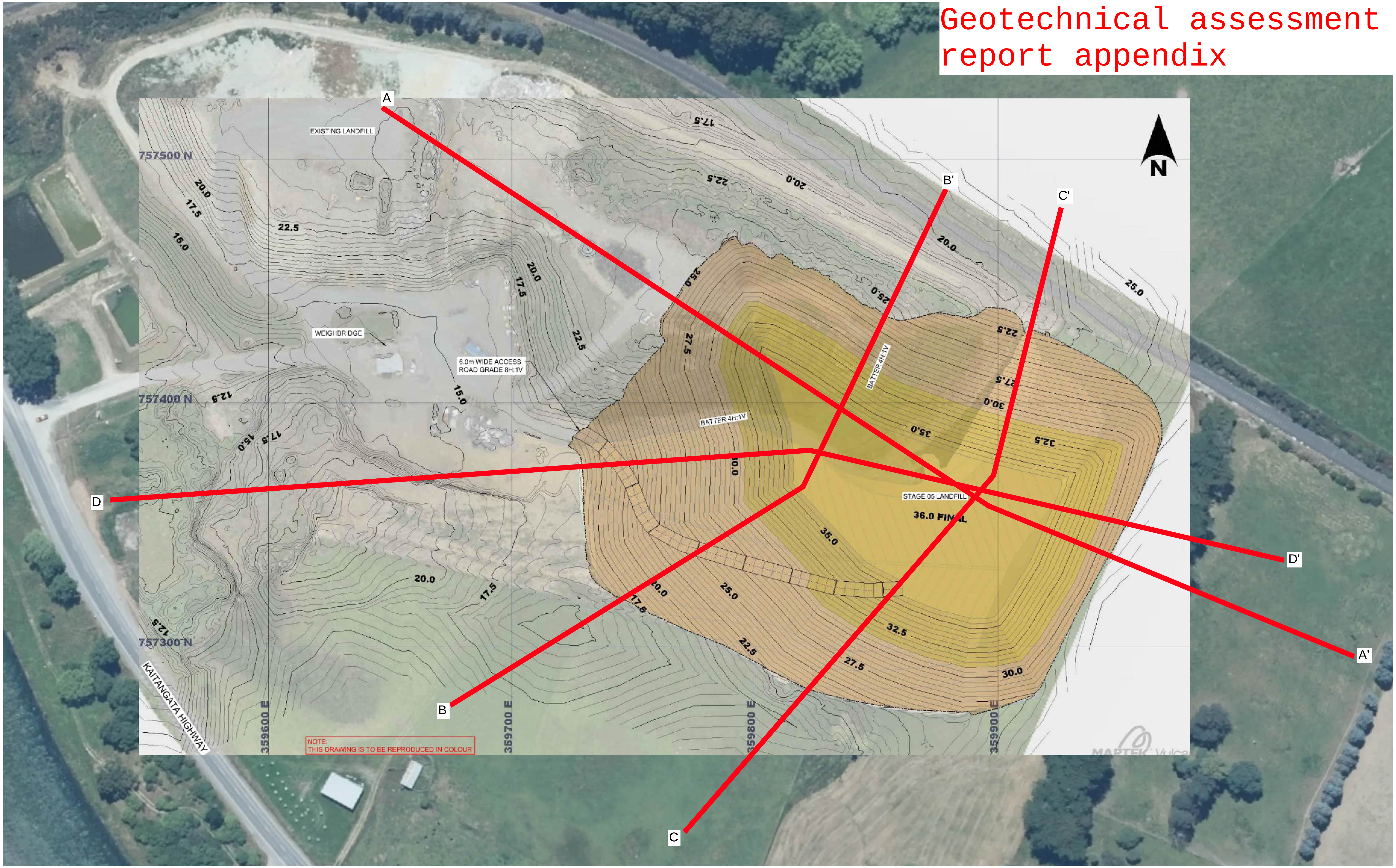
PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION
SECTIONS 05 (B-B), 06(A-A) AND 07

WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.: C212
REVISION: B

T+T-Inserted from the Geotechnical assessment report appendix



REVISION	AMENDMENT	APPROVED	DATE

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Invercargill 9840
New Zealand

CIVIL

SCALES
ORIGINAL SIZE A1
DRAWN | DESIGNED | APPROVED
DRAWING VERIFIED | DESIGN VERIFIED | APPROVED DATE

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION

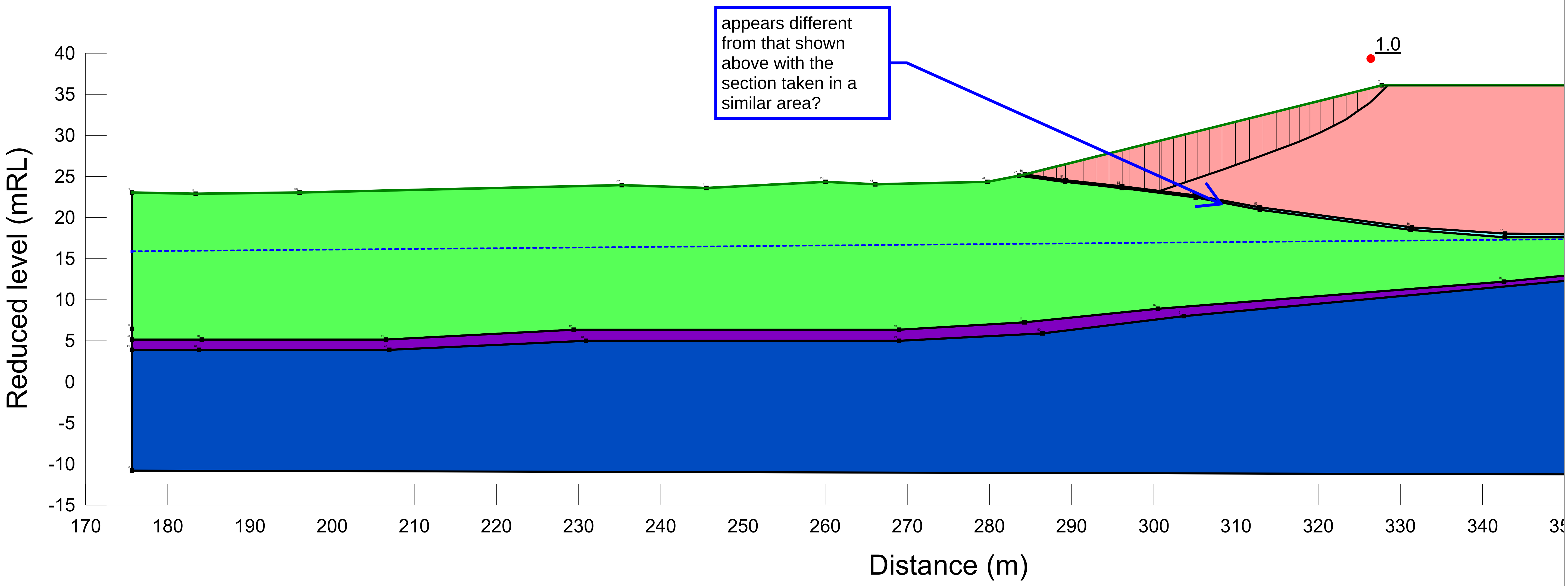
WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.:
REVISION: A

Horz Seismic Coef.: 0.24

Method: Morgenstern-Price

Section A-A(west)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



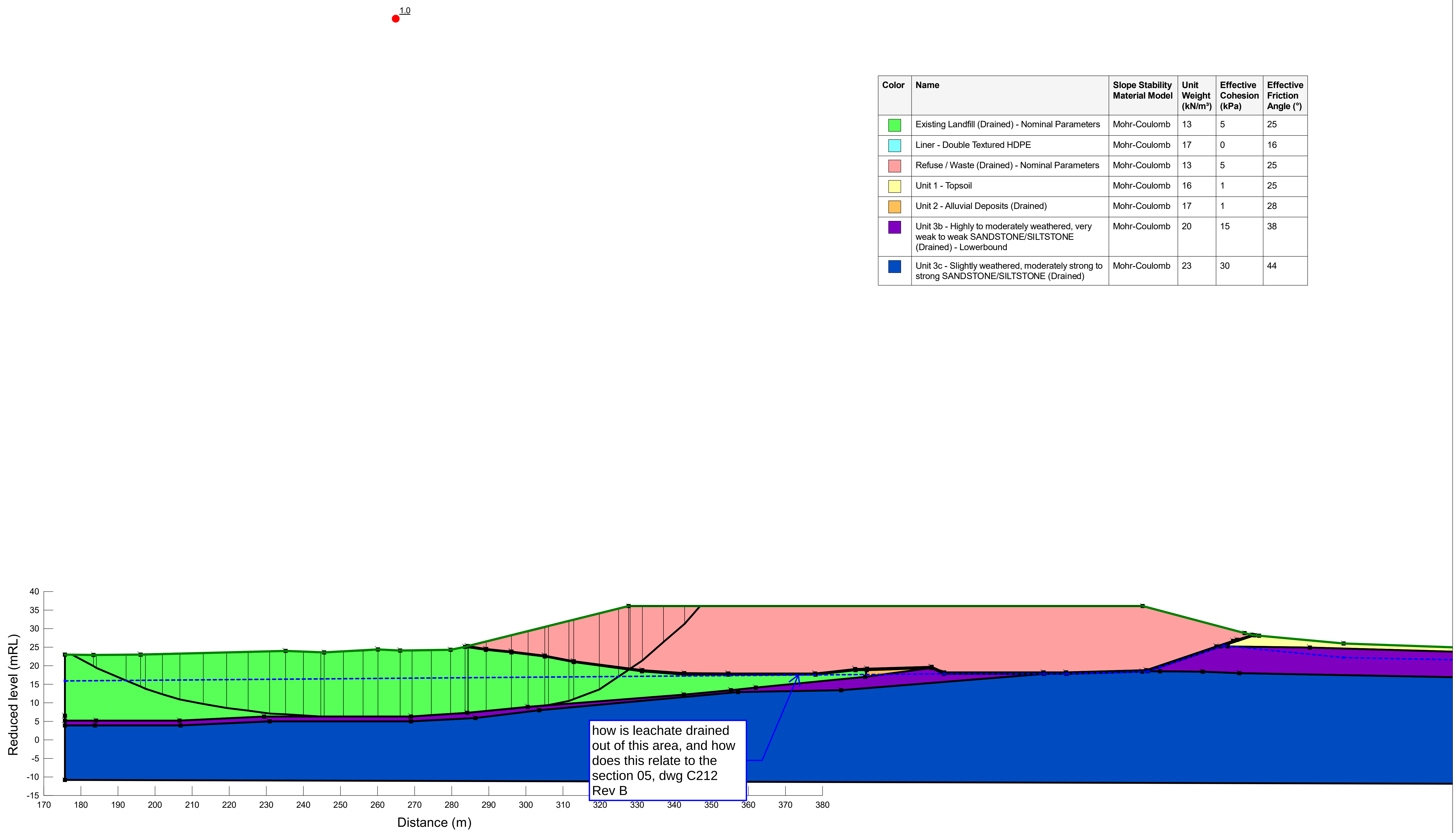
WSP	Mt Cooee Landfill Development Plan	4.0 Section A-A' 4.0.5 Seismic - Yield Acceleration (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Section A-A(west and east)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	4.0 Section A-A' 4.0.4 Seismic - ULS (1/1000yr) MBIE	6-CO082.00 / Date: 10/05/2024 Scale: 1:1,000 / By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

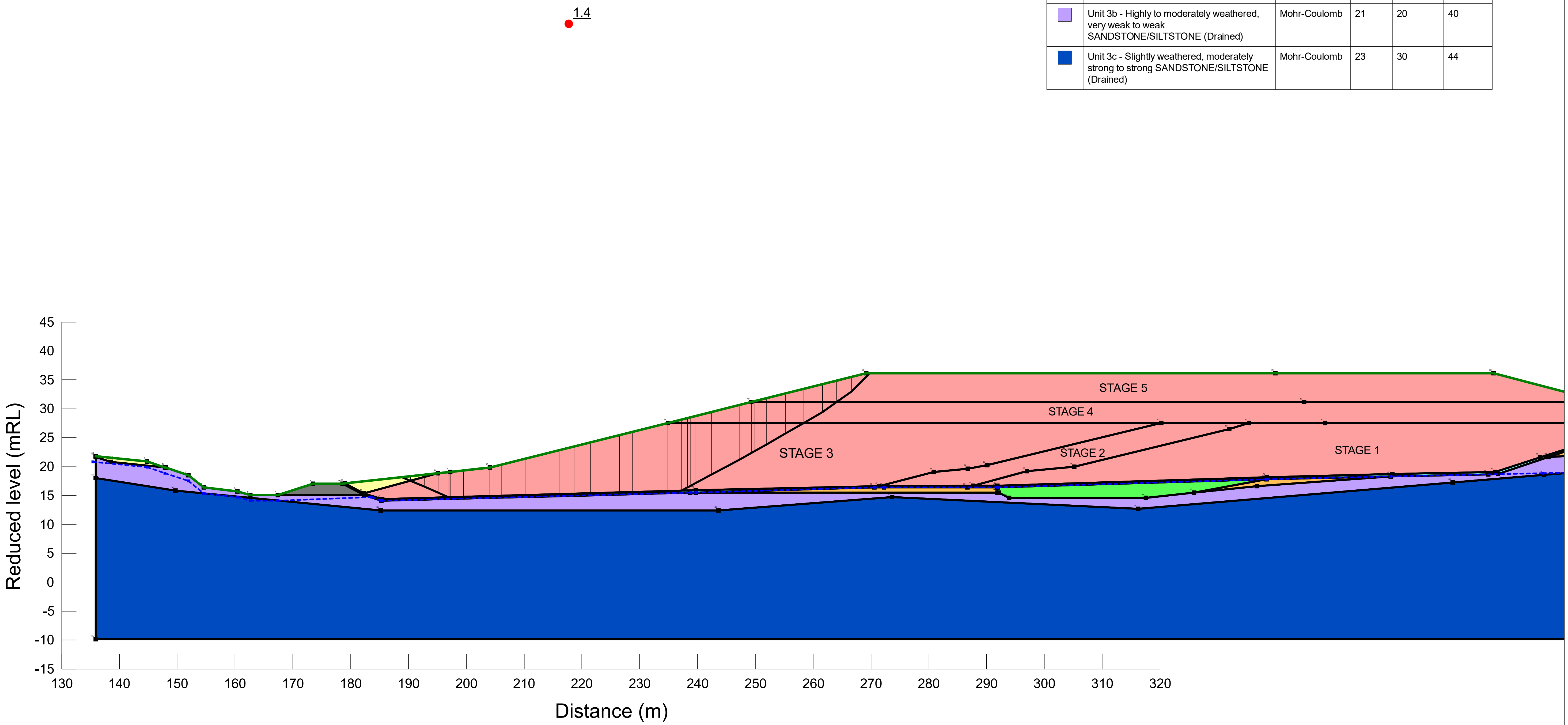
DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Section D-D(west)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(green)	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
(cyan)	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
(pink)	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
(grey)	Structural Fill	Mohr-Coulomb	19	0	36
(yellow)	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
(orange)	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
(purple)	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
(blue)	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



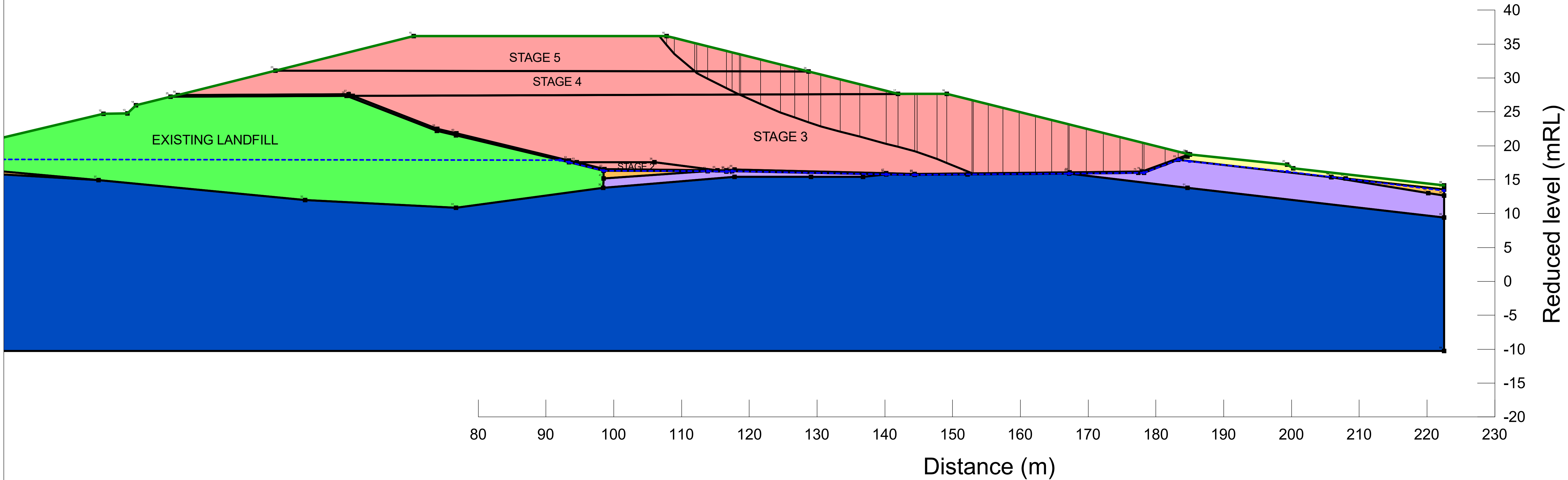
WSP	Mt Cooee Landfill Development Plan	3.0 Section D-D' 3.0.3 Seismic - SLS (1/50yr)	6-CO082.00	Date: 10/05/2024
			Scale: 1:700	By: B. HARRISON

Horz Seismic Coef.:

Method: Morgenstern-Price

Section B-B(south)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.1 Section B-B' 1.1.1 Static - Long term	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

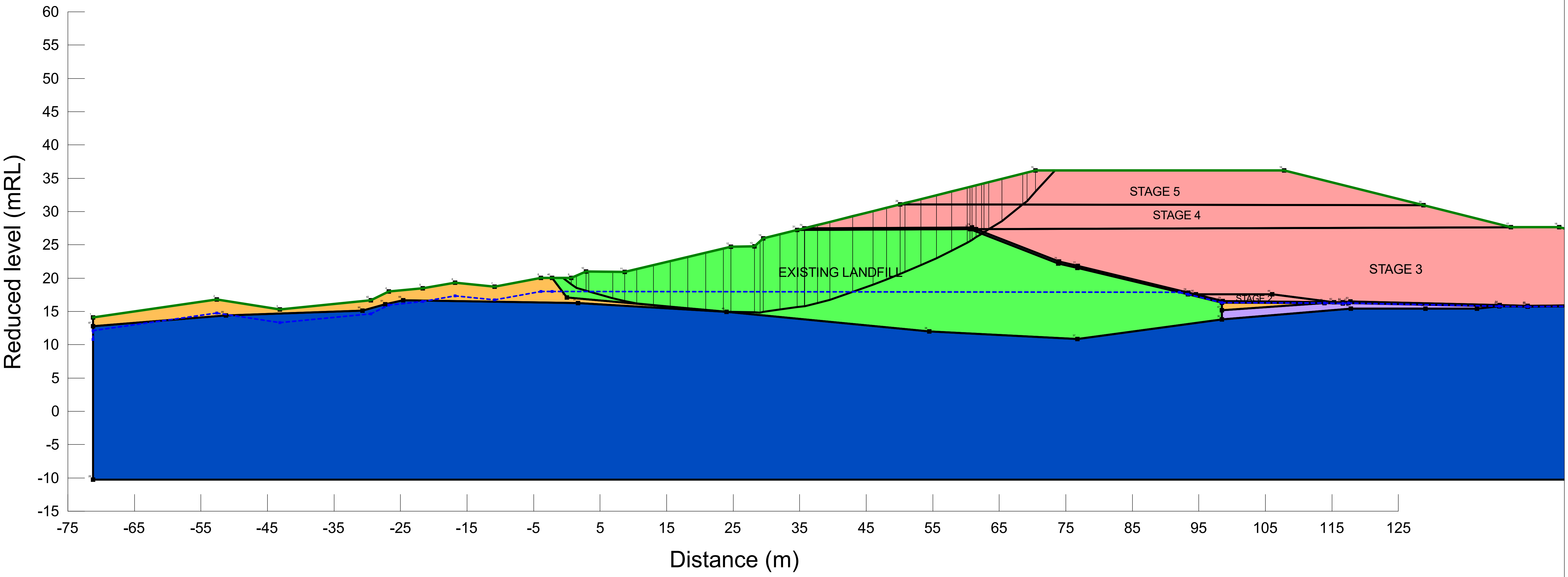
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Section B-B(north)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' 1.0.1 Static - Long term	6-CO082.00 Scale: 1:600	Date: 10/05/2024 By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:28:23 pm

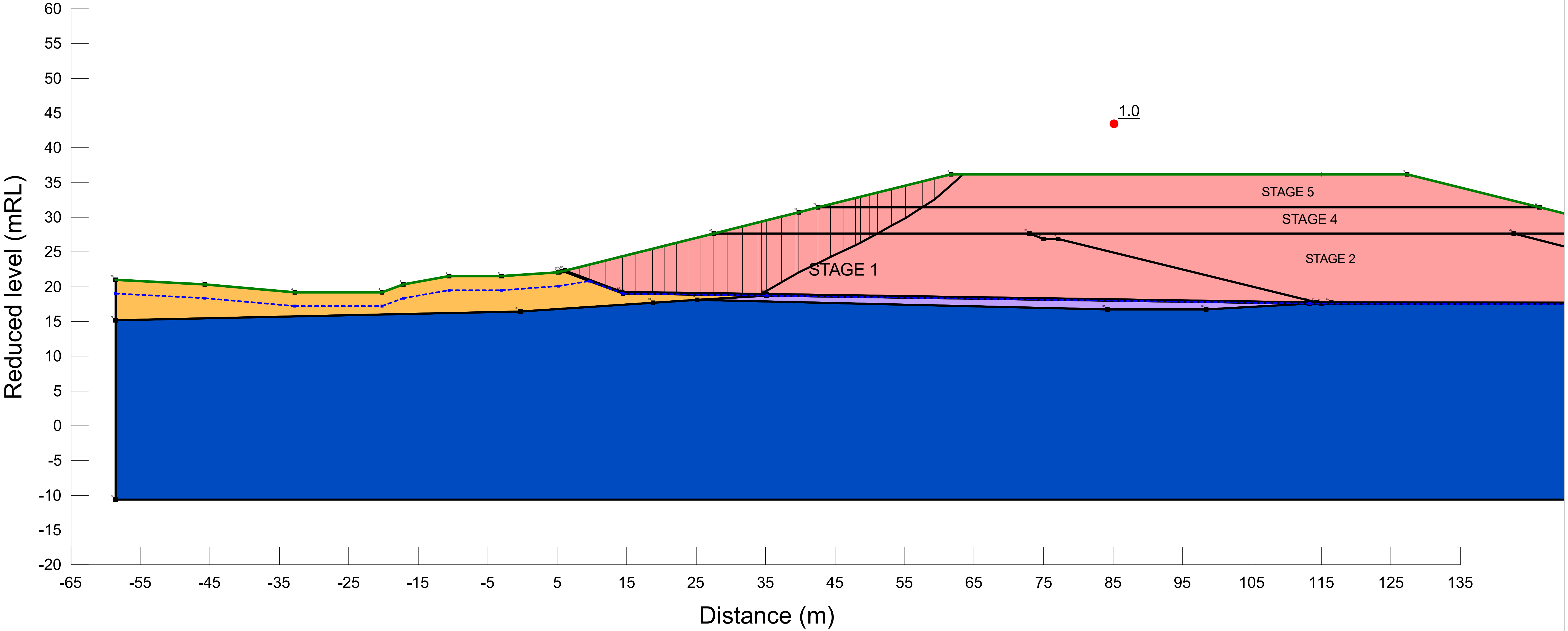
DO NOT SCALE

Horz Seismic Coef.: 0.2

Method: Morgenstern-Price

Section C-C(north)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



	Mt Cooee Landfill Development Plan	2.0 Section C-C' 2.0.5 Seismic - Yield Acceleration	6-CO082.00 / Date: 10/05/2024 Scale: 1:600 / By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\.20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:45:49 pm

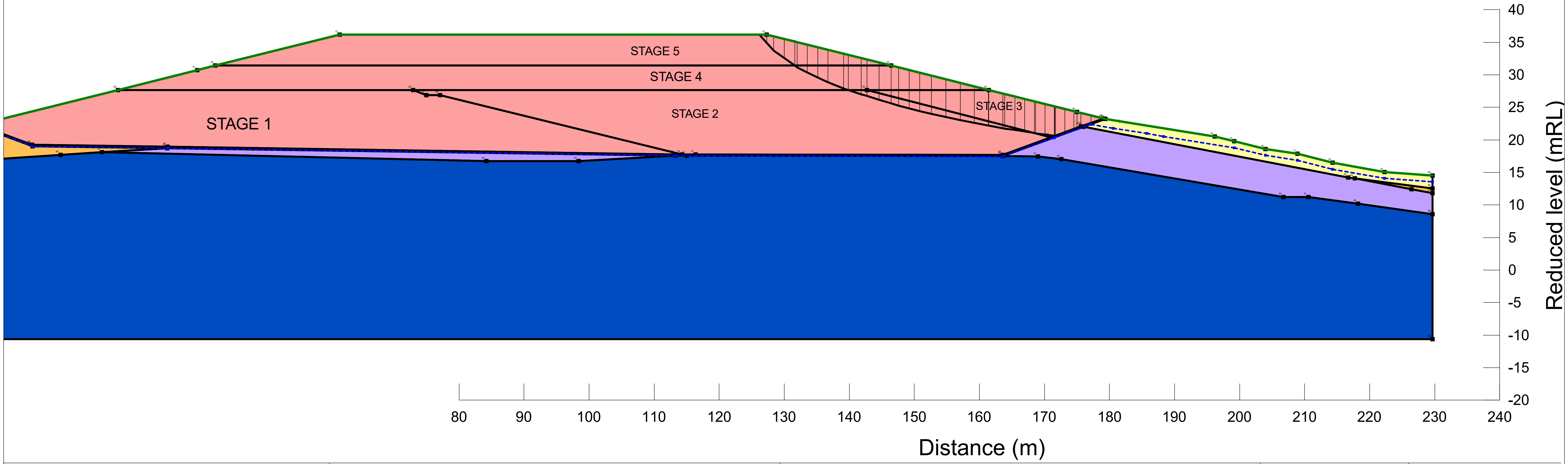
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Section C-C(south)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



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			Scale: 1:600	By: B. HARRISON

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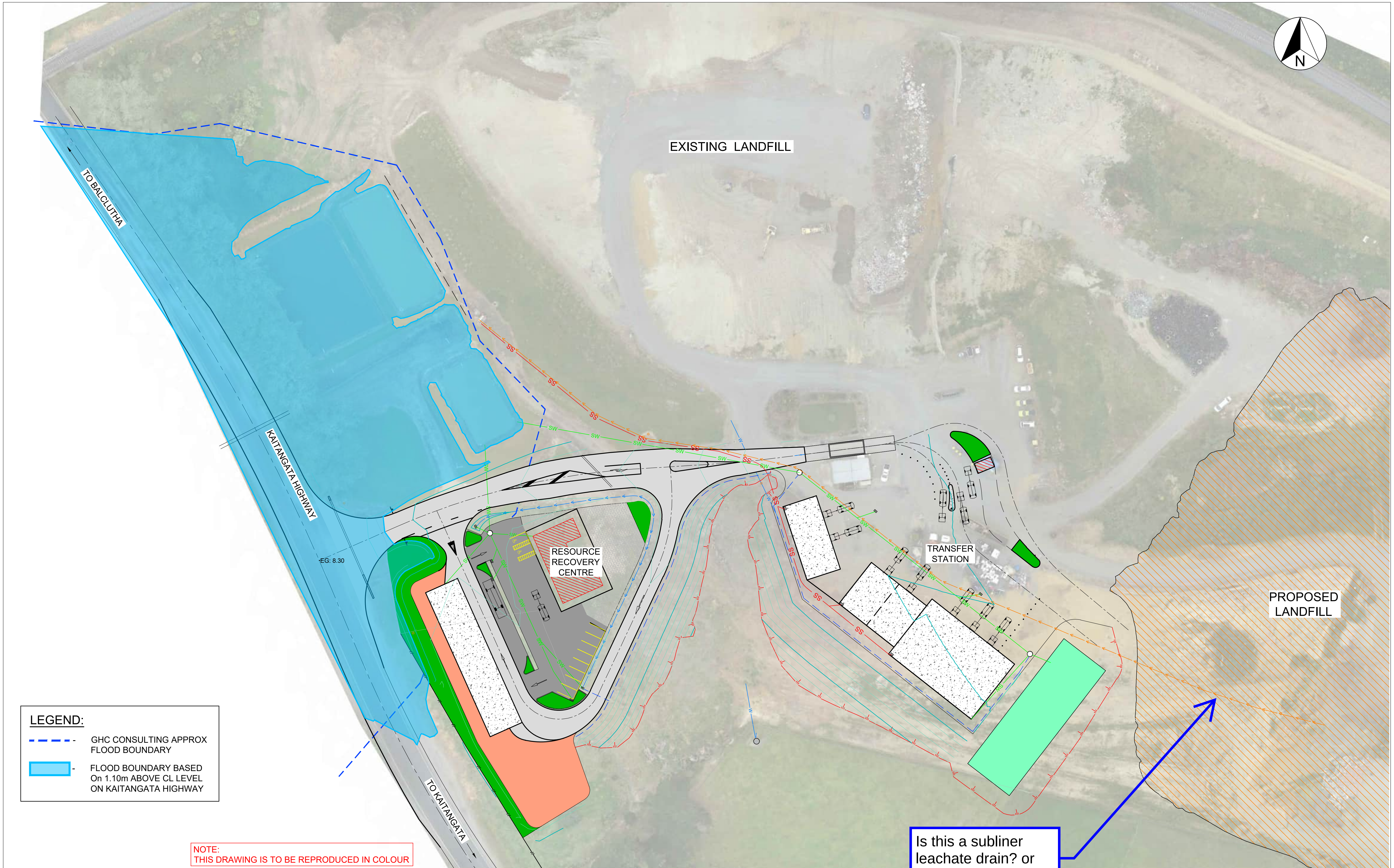

NOTE:
THIS DRAWING IS TO BE REPRODUCED IN COLOUR

REVISION	AMENDMENT	APPROVED	DATE
A	DRAFT FOR COMMENT		
B	BOUNDARY REVISED		

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Invercargill 9840
New Zealand

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SCALES
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DRAWN: S. HILTON
DESIGNED
APPROVED
DRAWING VERIFIED: J.L. BOYDE
DESIGN VERIFIED
APPROVED DATE

FOR INFORMATION

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL, RESOURCE RECOVERY CENTRE & TRANSFER STATION
FLOOD RISK BOUNDARY

WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.: C501
REVISION: B

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Appendix B Geotechnical assessment

T+T comments, dated 10/6/2024

Memorandum

To	Aileen Craw
Copy	Greg Saul, Chris Fox, Carrie Hartley
From	Bryce Harrison
Office	Dunedin
Date	20 May 2024
File/Ref	6-CO082.00/0230C
Subject	Peer Review Global Stability Analyses

1 Introduction

This memorandum has been prepared to summarise key changes made to the global stability assessments analysed in response to the peer review comments provided by Tonkin & Taylor on 1 February 2024. Geotechnical design parameters and the Geological model have been maintained from the Geotechnical Interpretive Report by WSP dated 27 April 2023.

2 Seismicity

2.1 Seismic Design Criteria

New Zealand has no specific standard developed to assess design earthquakes for landfills, and landfills are not specifically mentioned within NZS1170.0:2002. We have assessed the importance level of the landfill facility based on the assumption that it is categorised within *'Buildings and facilities not designated as post disaster containing hazardous materials'* as described in Table 3.2 of NZS 1170.0: 2002.

Based on Tables 3.1 and 3.2 in NZS1170.0:2002, we consider the landfill to be an Importance Level 3 structure.

The landfill will have an operative life of approximately 35 years, followed by anticipated 15 - 20 years of aftercare. Therefore, we have adopted a design working life of 50 years to derive the seismic loads for the landfill.

2.2 Seismic Loads

The New Zealand Seismic Hazard Model (NSHM) has been updated and in line with this, the New Zealand Geotechnical Society (NZGS) (2021) released an updated Module 1 – Earthquake Geotechnical Engineering Guideline. The NZGS guideline provides interim peak ground accelerations recommended for use in design which have been provided in Table 1.

To anticipate potential change in seismic design criteria due to the revised NSHM (2023), PGAs sourced from the NSHM have been summarised in Table 1. The PGAs have been assessed for the landfill location assuming a V_{s_30} of 150m/s for the landfill development area. The increase in PGA sourced from the current MBIE guidelines compared to the NSHM translates to approximately a 25% increase for both SLS and DCLS events in terms of PGA and corresponds to 100% increase in ULS displacements as discussed in section 4.1.2.

Table 1: Summary of seismic loads for the site

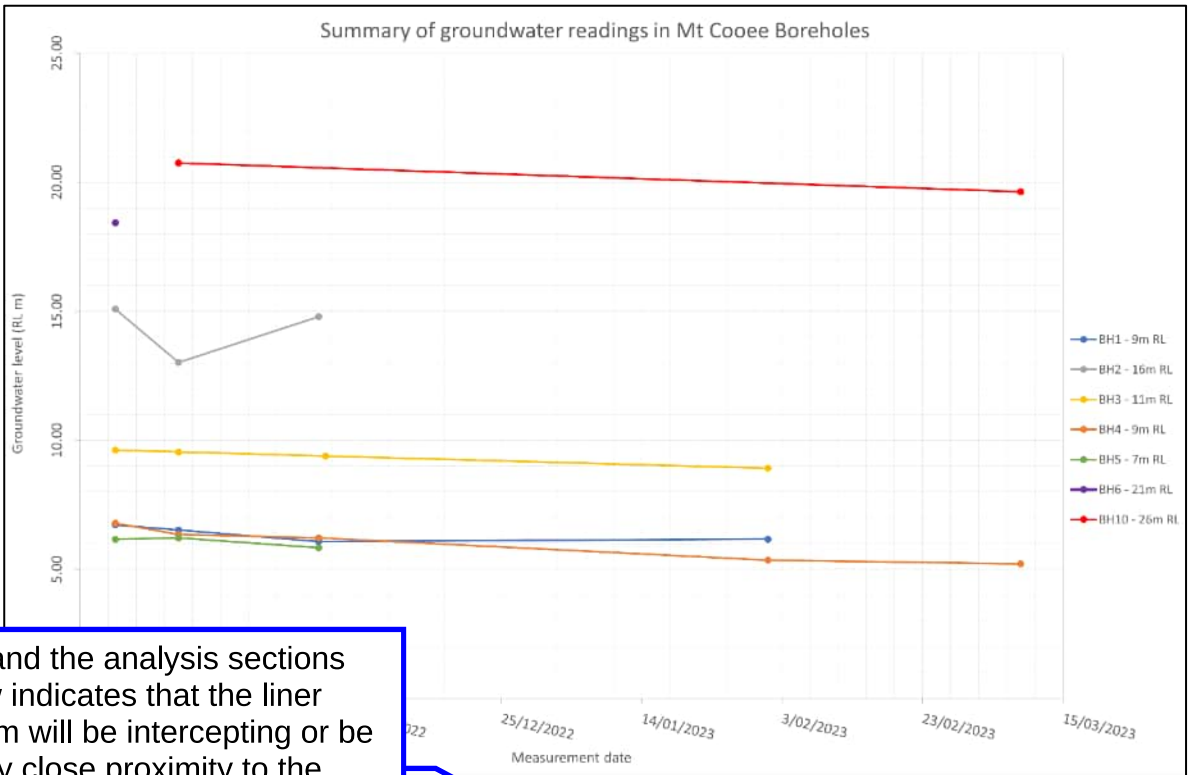
Seismic Case	Annual Probability of Exceedance	Probability of Exceedance (% in 50 years)	MBIE Module 1 (2021) PGA (g)	NSHM (2023) PGA (g)**	Effective Magnitude***
Serviceability Limit State (SLS)	1/50	63%	0.08	0.10	6.0
Ultimate Limit State (ULS)	1/1000	5%	0.29	0.36	6.0

* Annual Probability of Exceedance (APE) are based on Table 3.3 of NZS 1170.0, Table 3.5 of NZS 1170.5 and Table 5.3 of Bridge Manual
** Typical values assuming a V_{s_30} of 150 m/s for the landfill development area.
*** Effective magnitudes are taken from Table A1 from MBIE Module 1 (2021)

3 Groundwater

3.1 Groundwater observations within the proposed landfill expansion area

Groundwater was recorded at depths ranging between approximately 1.2 m and 5.6 m bgl within the machine boreholes during the investigation. Several rounds of monitoring were undertaken of the piezometers installed in BH1 – BH6 and BH10. A summary of the readings to date is presented in the Geotechnical Factual Report by WSP dated 31 March 2023. A plot of groundwater levels (in m RL based on the NZ Vertical Datum 2016) carried out to date is presented in
Figure 1 below. The existing ground levels (in m RL) at borehole locations are presented on the plot legend. Borehole locations are shown indicatively in Appendix A.



This and the analysis sections below indicates that the liner system will be intercepting or be in very close proximity to the ground water.

...evels recorded within standpipe piezometers since October 2022

...groundwater level is anticipated at depths ranging between 6 m to 20 m RL (in the order of 1 m to 4 m below existing ground levels) across the site, with flow towards the Clutha River / Mata-Au in the south. Across the western section of the site, long-term groundwater is anticipated at lie approximately 2 m bgl and within the alluvial deposits. The piezometer readings in the boreholes across the eastern section suggest groundwater typically lies within the fractured rock or close to the interface between rock and overlying soils. Except for a groundwater level of 2.3 m bgl (~ 18.7 m RL) measured in October 2022, the piezometer readings in BH6 at the proposed landfill site have indicated dry conditions. Elevated groundwater levels may be anticipated during heavy rainfalls and have been considered in the preliminary geotechnical analyses.

3.2 Seasonal Groundwater Fluctuation

Long-term monitoring of groundwater contamination has been undertaken in a selection of groundwater monitoring wells. As part of these monitoring activities, a record of the ground water levels has been maintained. The response zone is typically founded in greywacke of varying strength/weathering or inferred as greywacke based on the driller's logs..

The groundwater monitoring wells are concentrated more toward the existing landfill than the proposed landfill expansion area, however, this dataset still provides an indication for the anticipated seasonal fluctuation in groundwater level. A summary plot of the groundwater measurements from February 2020 to April 2024 has been provided in Figure 2 on the following page and a description of the observed behaviour has been described below:

- BH02 was installed to the north of the existing landfill site, on the northern bank of the railway line in October 2022. Monitoring data is limited at this location, but the data does indicate some seasonal fluctuation, peaking around May/June and at a minimum around November/December.
- GW2 is located east of the existing sedimentation pond. There has been no clear seasonal trend of the groundwater. However, there was an increase of approximately 1.0 m observed in July 2022 from the typical level.
- GW3 is positioned south of the existing access road in the western portion of the site. There appears to be clear indication of seasonal fluctuation in this monitoring well with a difference of approximately 2 m between the low in January/March compared with the high observed in June/August.
- GW4 is positioned north of the access track, towards the centre of the site. This well seems to be mostly insensitive to seasonal groundwater fluctuations.
- GW5 is positioned in proximity to the western face of the proposed landfill expansion. This monitoring well appears to be mildly sensitive to seasonal fluctuation with an approximate 0.5 m difference between the spring/winter high and the summer/autumn low.
- GW6 is positioned along the northern face of the existing landfill with the response zone beginning at approximately 0.7 m above the base of the landfill (7.8 m bgl). GW6 indicated a gradual increase in the level of approximately 5.5 m between February 2020 and July 2022. The cause for the rise in groundwater in GW6 over this period is inconclusive based on the available information. After the groundwater appears to peak in July 2022, the levels appear to follow a seasonal trend with fluctuations of approximately 1.0 – 1.5 m. The groundwater level is now typically about 5 m above the base of the landfill at this location.
- GW7 this monitoring well is located east of the existing sedimentation pond. There has been no clear trend that indicates seasonal fluctuation of the groundwater. However, there was an increase of approximately 1.5 m observed in July 2022 from the typical level.

In summary, the measurements taken over this observation period indicate that groundwater levels at the site could fluctuate as much as 1 – 2 m between seasons in select locations. However, the eastern portion of the site where the landfill expansion is proposed has been observed to be mostly insensitive to seasonal fluctuations.

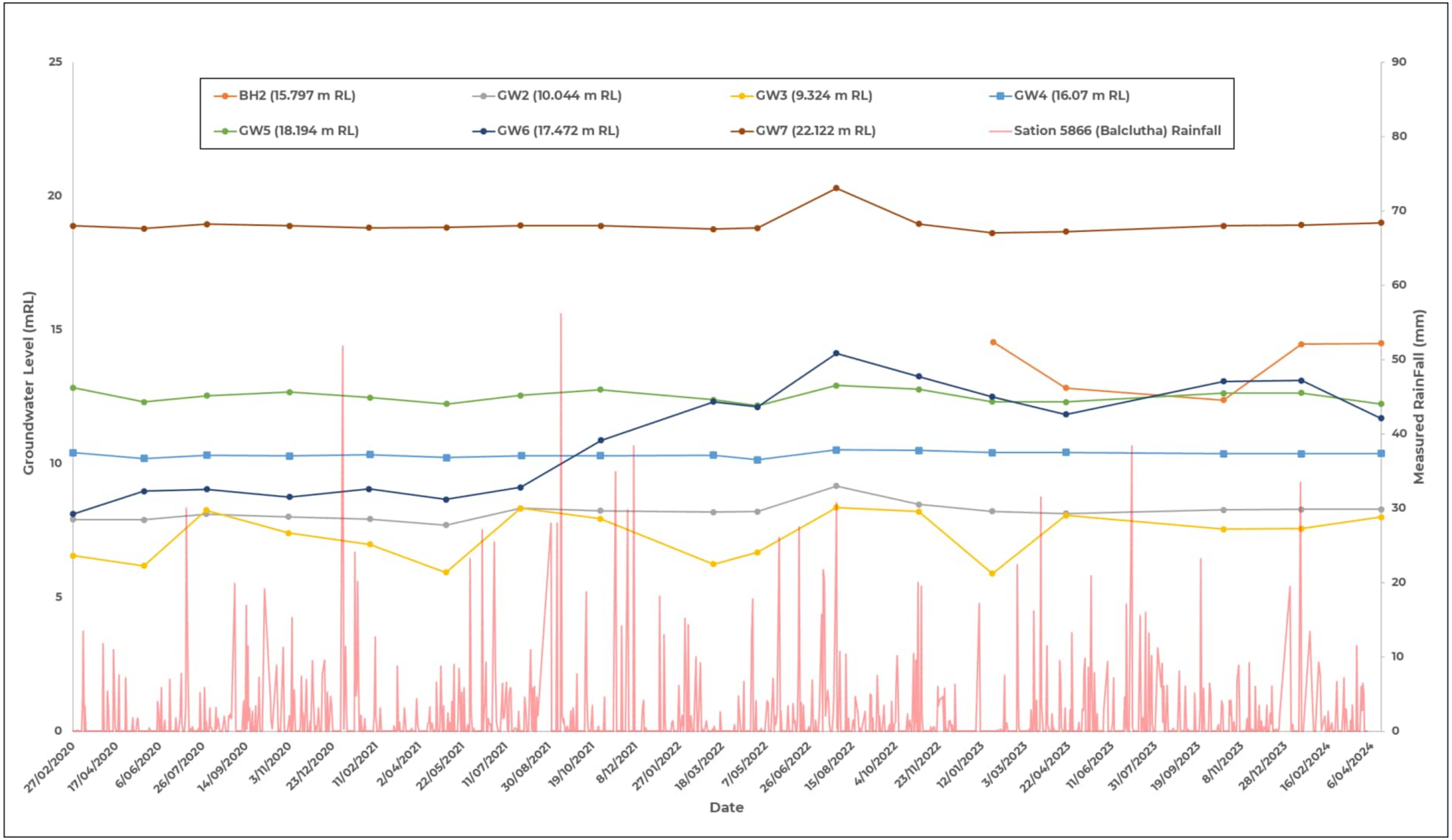


Figure 2: Seasonal fluctuation in groundwater

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4 Geotechnical Considerations

4.1 Global Stability

Preliminary global stability assessments have been carried out under static, seismic and high groundwater conditions using the GeoStudio software Slope/W (Version 2024.1.0). The assessment results are discussed below.

4.1.1 Landfill Expansion Stability

A preliminary global stability the proposed landfill expansion has been carried out under static, seismic and high groundwater conditions using the GeoStudio software Slope/W (Version 2024.1). The analyses have been based on four representative sections across the new landfill as described below. Indicative alignments of the sections are shown in Appendix B

- Section A-A' in the 'east/west' direction, over the piggy-back landfill.
- Section B-B' in the 'north/south' direction, over the piggy-back landfill
- Section C-C' in the 'north/south' direction, within the landfill expansion area
- Section D-D' in the 'east/west' direction, perpendicular to the drainage bund

The proposed landfill consists of 1(V): 4(H) side batters, with 1(V): 3(H) side slopes excavated into rock to form the landfill cell floor.

The minimum required Factors of Safety (FoS) in line with the industry practice are as follows:

- Minimum FoS of 1.5 and 1.25 under the 'static – long-term' and 'static – high groundwater level' conditions, respectively.
- Minimum FoS of 1.2 for the 'seismic' event, with allowance for seismically induced displacements if FoS < 1.2. These displacements have been estimated based on the methodologies by Jibson (2007), Ambraseys and Srbulov (1994) and Ambraseys & Menu (1988), as recommended by the Bridge Manual.

A summary of the global stability assessment results is presented in Table 2 below. Selected Slope/W outputs are presented in Appendix C of this report.

There is a very low risk of global instability of the proposed landfill extension toward the south (Clutha River / Mata-Au) due to the presence of bedrock at very shallow depth below the ground between the landfill and the highway. Therefore, the assessment is focused primarily on the stability of the landfill batters.

The assessments indicate the minimum factors of safety are achieved under the static case and the seismically induced slope movements are small and insignificant.

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Table 2: Global Stability Analysis Outputs

Case		Slope/W Factor of Safety	Minimum Target Factor of Safety	Yield Acceleration / Seismically Induced displacements (mm)
1.0 Section B'-B				
1.0.1	Static	2.3	1.5	
1.0.2	HGWL + Elevated Leachate	2.1	1.25	
1.0.3	SLS - Seismic	1.7	1.2	
1.0.4	ULS - Seismic	1.0	1.2*	0.27g/ <5 mm
1.0 Section B'-B (constrained)				
1.0.1	Static	1.9	1.5	
1.0.2	HGWL + Elevated Leachate	1.9	1.25	
1.0.3	SLS - Seismic	1.4	1.2	
1.0.4	ULS - Seismic	0.8	1.2*	0.18g/<15 mm
1.1 Section B-B'				
1.1.1	Static	2.1	1.5	
1.1.2	HGWL + Elevated Leachate	1.9	1.25	
1.1.3	SLS - Seismic	1.5	1.2	
1.1.4	ULS - Seismic	0.8	1.2*	0.21g/<10 mm
2.0 Section C'-C				
2.0.1	Static	1.9	1.5	
2.0.2	HGWL + Elevated Leachate	1.9	1.25	
2.0.3	SLS - Seismic	1.4	1.2	
2.0.4	ULS - Seismic	0.8	1.2*	0.20g/<10 mm
2.1 Section C-C'				
2.1.1	Static	2.3	1.5	
2.1.2	HGWL + Elevated Leachate	2.3	1.25	
2.1.3	SLS - Seismic	1.7	1.2	
2.1.4	ULS - Seismic	1.0	1.2*	0.29g/<5 mm
2.1 Section C-C' (Lower Slope)				
2.1.1 LS	Static	1.9	1.5	
2.1.2 LS	HGWL + Elevated Leachate	1.5	1.25	
2.1.3 LS	SLS - Seismic	1.3	1.2	
2.1.4 LS	ULS - Seismic	0.7	1.2*	0.16g/<25 mm

Case		Slope/W Factor of Safety	Minimum Target Factor of Safety	Yield Acceleration / Seismically Induced displacements (mm)
3.0 Section D-D'				
3.0.1	Static	1.9	1.5	
3.0.2	HGWL + Elevated Leachate	1.8	1.25	
3.0.3	SLS - Seismic	1.4	1.2	
3.0.4	ULS - Seismic	0.8	1.2*	0.17g/<20 mm
3.0.6	SLS - Seismic + HGWL + Elevated Leachate	1.3	1.2	
4.0 Section A'-A				
4.0.1	Static	2.1	1.5	
4.0.2	HGWL + Elevated Leachate	2.1	1.25	
4.0.3	SLS - Seismic	1.6	1.2	
4.0.4	ULS - Seismic	0.9	1.2*	0.24g/<5 mm
4.1 Section A-A'				
4.1.1	Static	2.3	1.5	
4.1.2	HGWL + Elevated Leachate	2.3	1.25	
4.1.3	SLS - Seismic	1.7	1.2	
4.1.4	ULS - Seismic	1.1	1.2*	0.29g<5 mm

* Factor of Safety of 1.2 or tolerable seismically induced displacements

4.1.2 Seismically Induced Ground Displacement

As reported above in Table 2, seismically induced displacements are expected to be less than 20 mm for the landfill batters based on the MBIE PGA values for the ULS design case. When considering the ULS PGA from the NSHM referenced in Table 2Table 1 the displacements are estimated to be up to 35 mm when adopting the critical yield acceleration for the landfill batters from analysis 3.0 (Section D-D'). We consider that an acceptable displacement limit of 40 mm (based on 10% yield strain[1] over a 400 mm development length, assessed from 20 m of waste overburden). We understand that HDPE liners can resist rupture from >500% strain which is equivalent to 2 m of strain. Sliding on the HDPE liner is only indicated in ULS seismic loading.

It is noted that at this strain the long term performance of the liner would be compromised and will lead to stress cracking (i.e. failure of the liner). As per research and reporting by Edward Kavazanjian (ASU) limiting deformation to be less than 300mm at the liner interface is an acceptable criteria, that the analysis achieves.

4.1.3 Temporary Stability

Temporary stability of the landfill has been assessed for section D-D', as this is understood to be the critical section for this analysis. Only the static conditions been analysed in this memorandum because they are temporary, and it is [illegible] be the same or flatter than the final slopes. Therefore [illegible] would also be similar and deemed acceptable.

A selection of Slope/W outputs for the temporary sta[illegible] Appendix D of this memo and a summary of the glo[illegible] below in Table 3.

[1] Liner strain limits based on the recommendations by Qian et al. (2002)

Table 3: Temporary stability case

Landfill construction stage	Slope/W Factor of Safety	Minimum Target Factor of Safety
Stage 1 - Excavation	1.5	1.2
Stage 1	2.1	1.2
Stage 2	1.9	1.2
Stage 3	2.3	1.2
Stage 4	2.0	1.2

5 Summary

The above analyses indicate that the proposed landfill will be able to meet the required design criteria with the revisions suggested by the peer reviewer. The geotechnical design parameters, groundwater level and leachate level adopted are at least moderately conservative to demonstrate the insensitivity to the landfill geometry from these variables.

6 References

Ambraseys, N., & Menu, J. (1988). Earthquake-Induced Ground Displacements. *Earthquake Engineering and Structural Dynamics, Vol. 16*, 985-1006.

Ambraseys, N., & Srbulov, M. (1995). Earthquake induced displacments of slopes. *Soil dynamics and Earthquake Engineering*, 59-71.

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Standards New Zealand. (2002). Sturctural Design Actions - Part 0: General Principles. *AS/NZS 1170.0:2002*.

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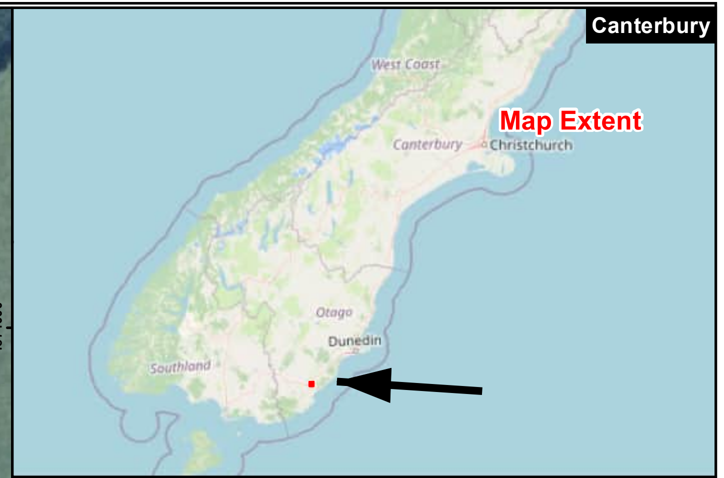
WSP. (2023, April 27). Mount Cooee Landfill Development Plan and Resource recovery Centre - Geotechnical Interpretive Report.

Appendix A

Site Plan



LEGEND

- Proposed New Shallow Groundwater Well
- Proposed Shared Hydro/Geotech Borehole
- Proposed Geotechnical Boreholes
- Existing Groundwater Monitoring Well
- Sediment Pond Monitoring Site
- Surface Water Monitoring Site
- Oxidation Ponds
- Pump Station
- Royds Boreholes (1993)
- Proposed Fill Area Expansion

ISSUED FOR COMMENT

DRAFT

NOTES

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2. Schematic only, not to be interpreted as an engineering design or construction drawing.

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0 50 100
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REFERENCE SCALE: 1:2,200 (at A3)

PROJECTION: NZGD 2000 New Zealand Transverse Mercator

CLIENT
CLUTHA DISTRICT COUNCIL

PROJECT
MT COOEE LANDFILL DEVELOPMENT PLAN

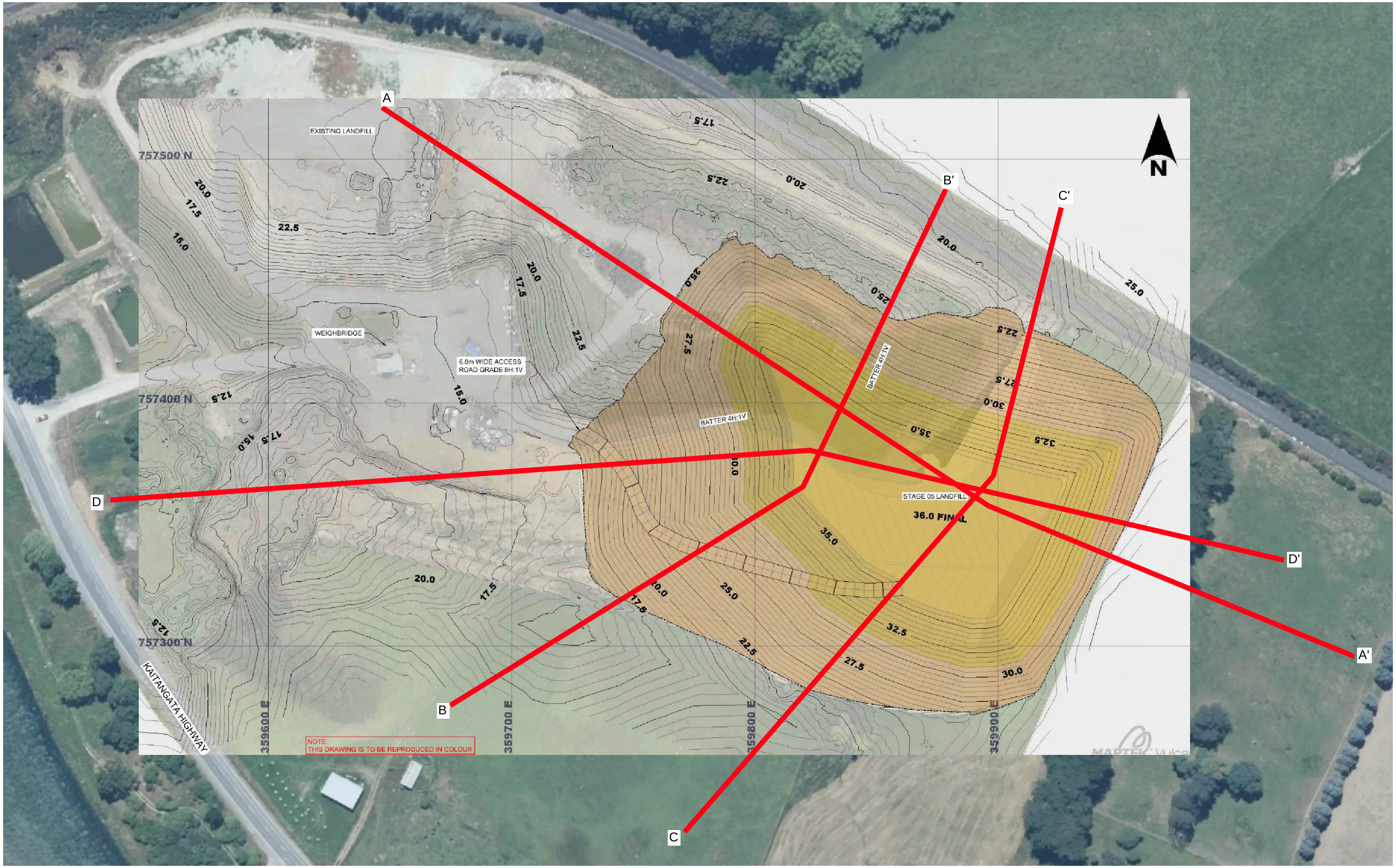
TITLE
MT COOEE PROPOSED DRILLING PLAN

CONSULTANT	YYYY-MM-DD	2022-07-06
WSP	PREPARED	KC

PROJECT NO.	REPORT	REV.	FIGURE
6-CO082.00	N/A	N/A	01

Appendix B

Section Plan



REVISION	AMENDMENT	APPROVED	DATE

wsp

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New Zealand

CIVIL

SCALES

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DRAWN | DESIGNED | APPROVED

DRAWING VERIFIED | DESIGN VERIFIED | APPROVED DATE

PRELIMINARY

PROJECT
CLUTHA DISTRICT COUNCIL
KAITANGATA HIGHWAY BALCLUTHA
MT COOEE LANDFILL DEVELOPMENT

TITLE
LANDFILL EXPANSION

WSP PROJECT NO. (SUB-PROJECT): 6-CO082.00
SHEET NO.
REVISION: A

Appendix C

Global Stability Outputs

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
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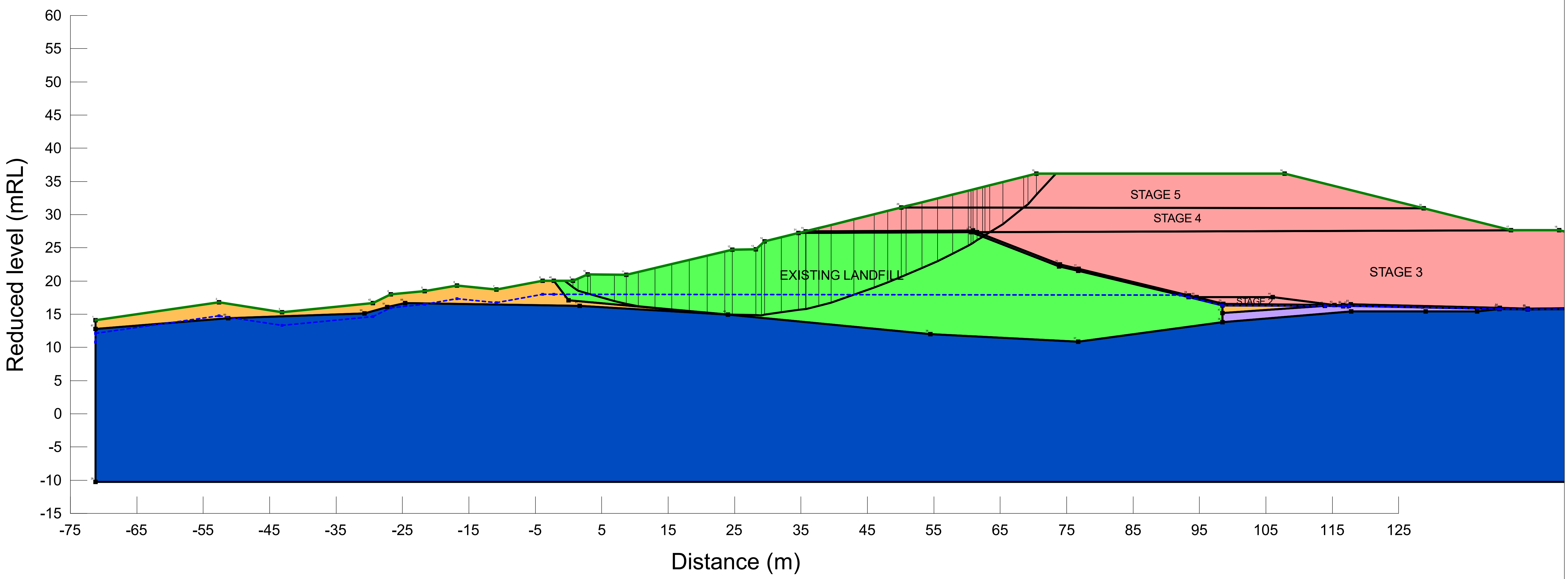
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' 1.0.1 Static - Long term	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
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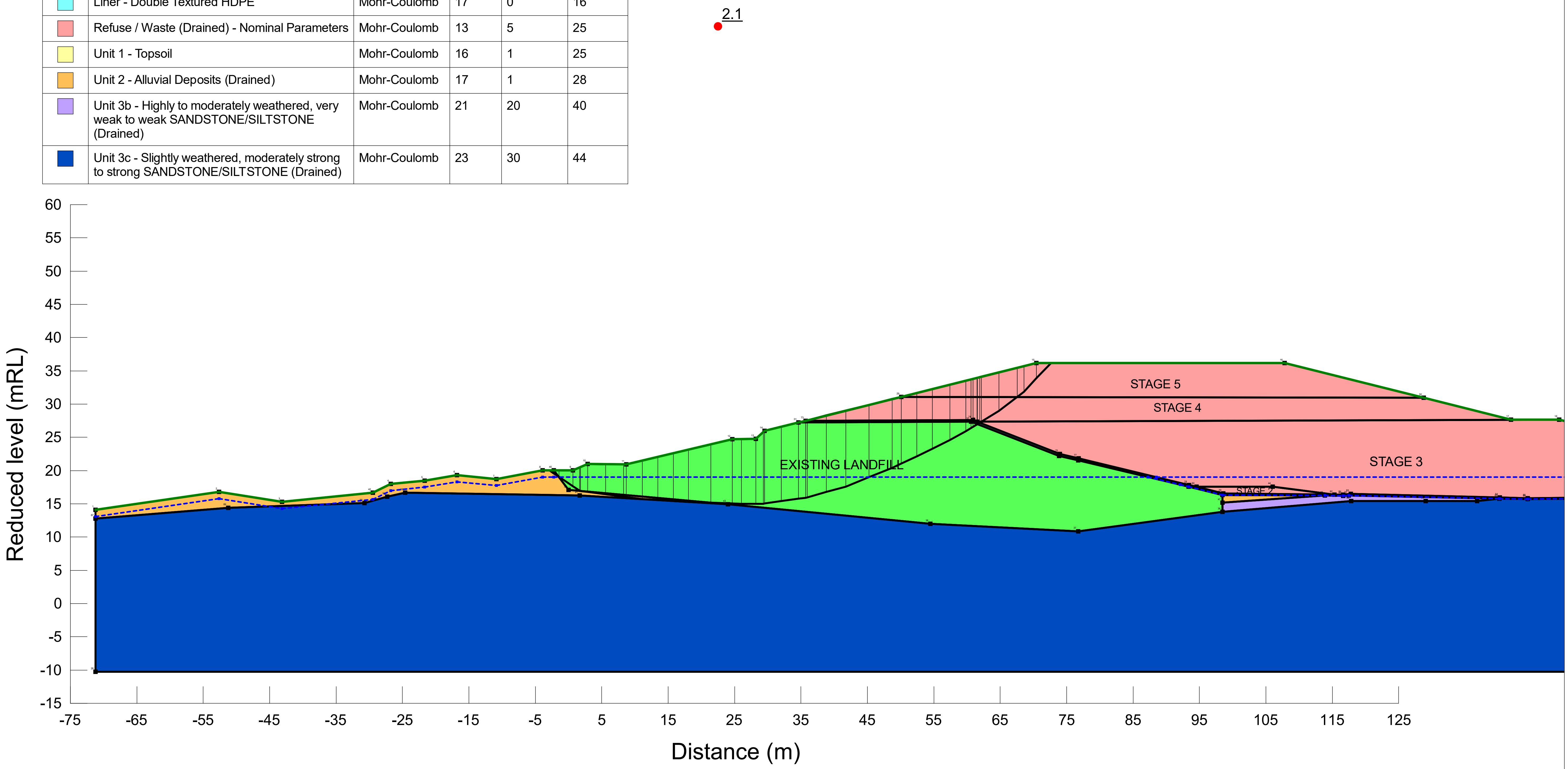

Mt Cooee Landfill Development Plan

1.0 Section B-B'
1.0.2 Static - HGWL+ Elevated Leachate

6-CO082.00

Date: 10/05/2024

Scale: 1:600

By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:28:23 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
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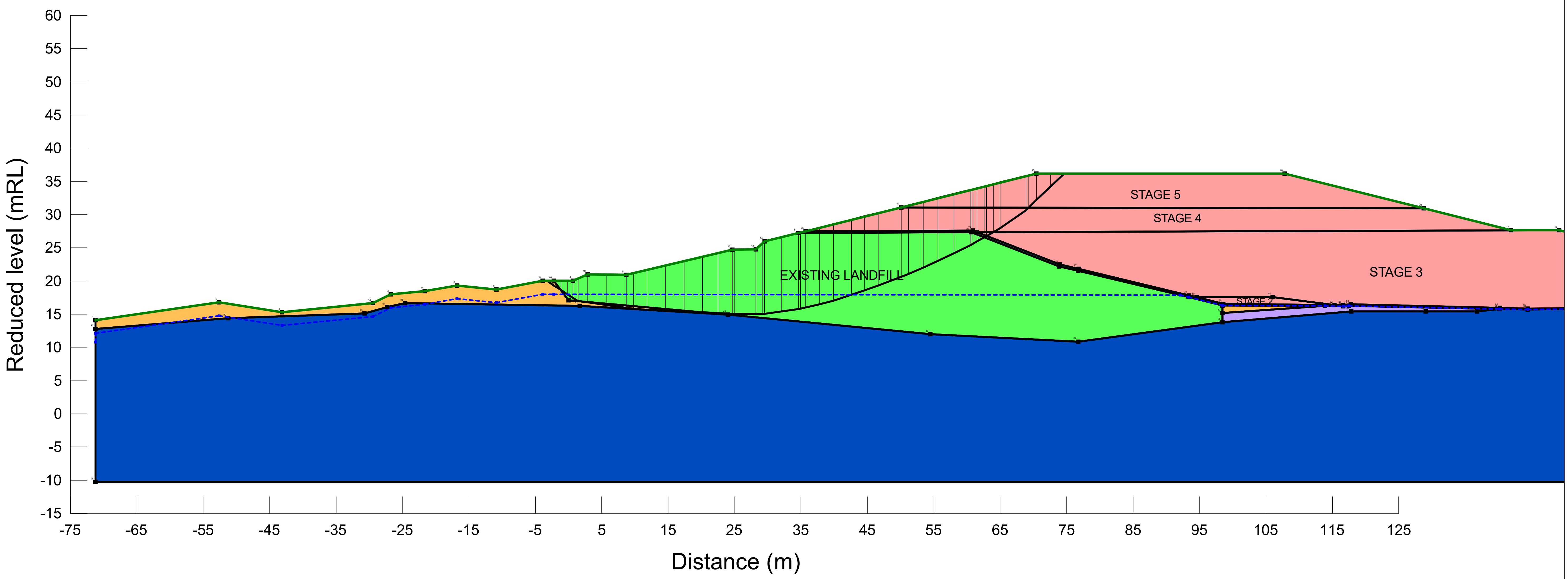
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

1.7



WSP	Mt Cooee Landfill Development Plan	1.0 Section B-B' 1.0.3 Seismic - SLS (1/50yr) MBIE	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

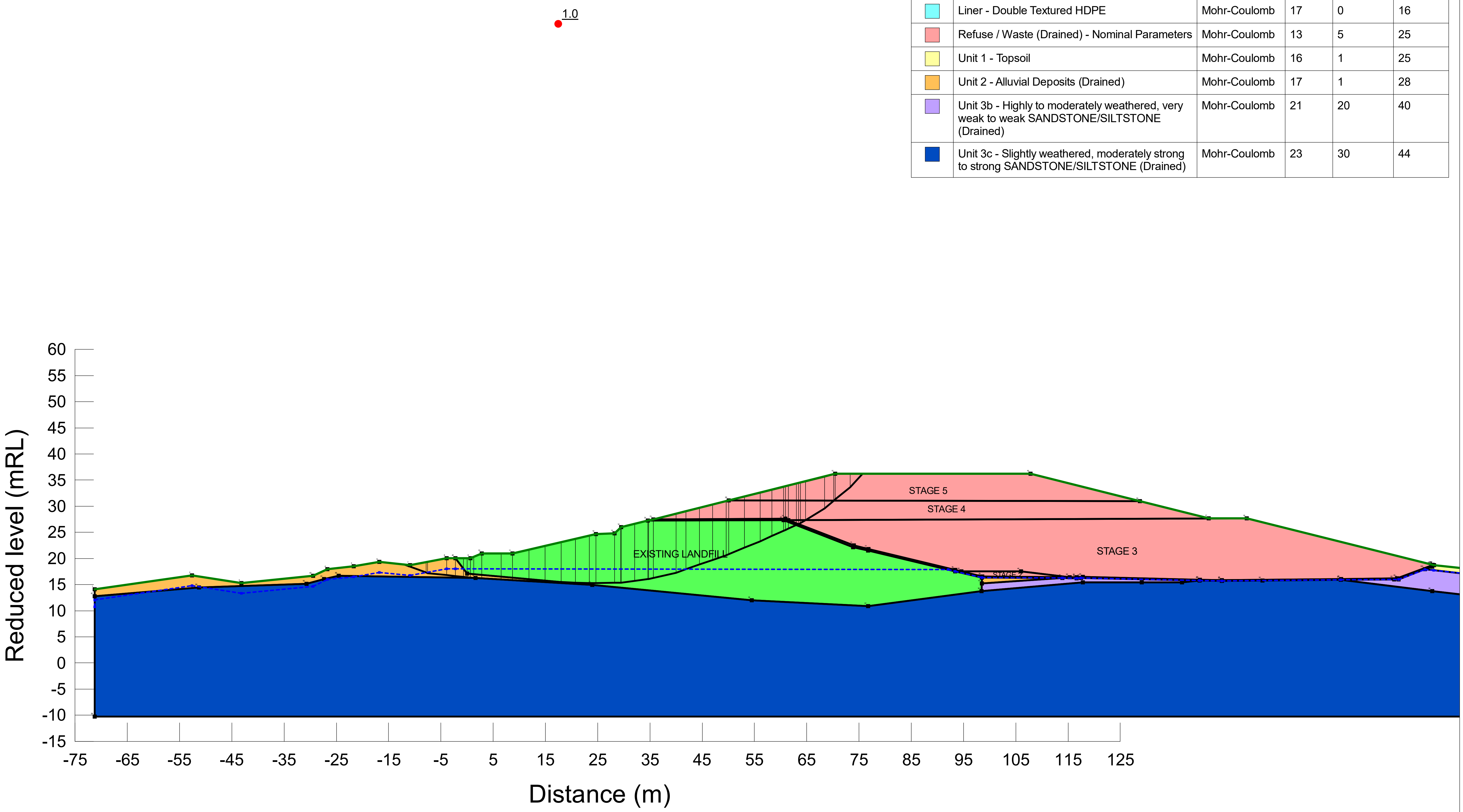
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:28:23 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

1.0 Section B-B'
1.0.4 Seismic - ULS (1/1000yr) MBIE

6-CO082.00

Date: 10/05/2024

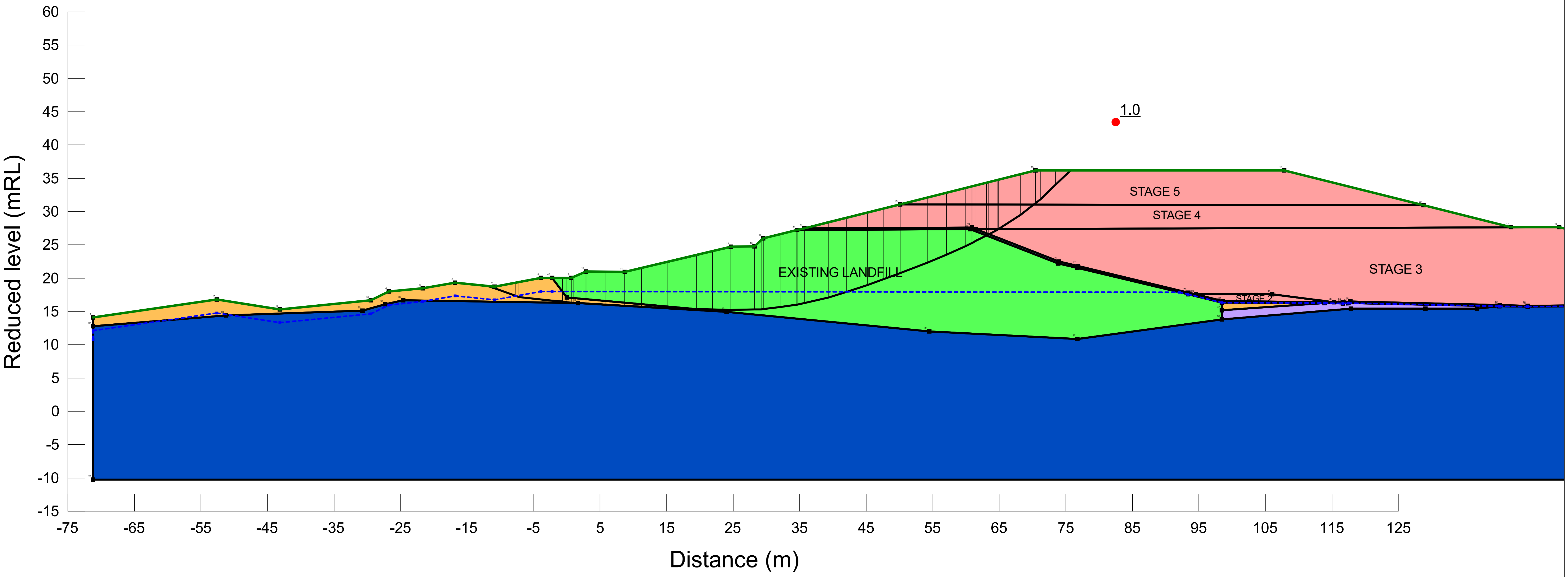
Scale: 1:700

By: B. HARRISON

Horz Seismic Coef.: 0.27

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' 1.0.5 Seismic - Yield Acceleration	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

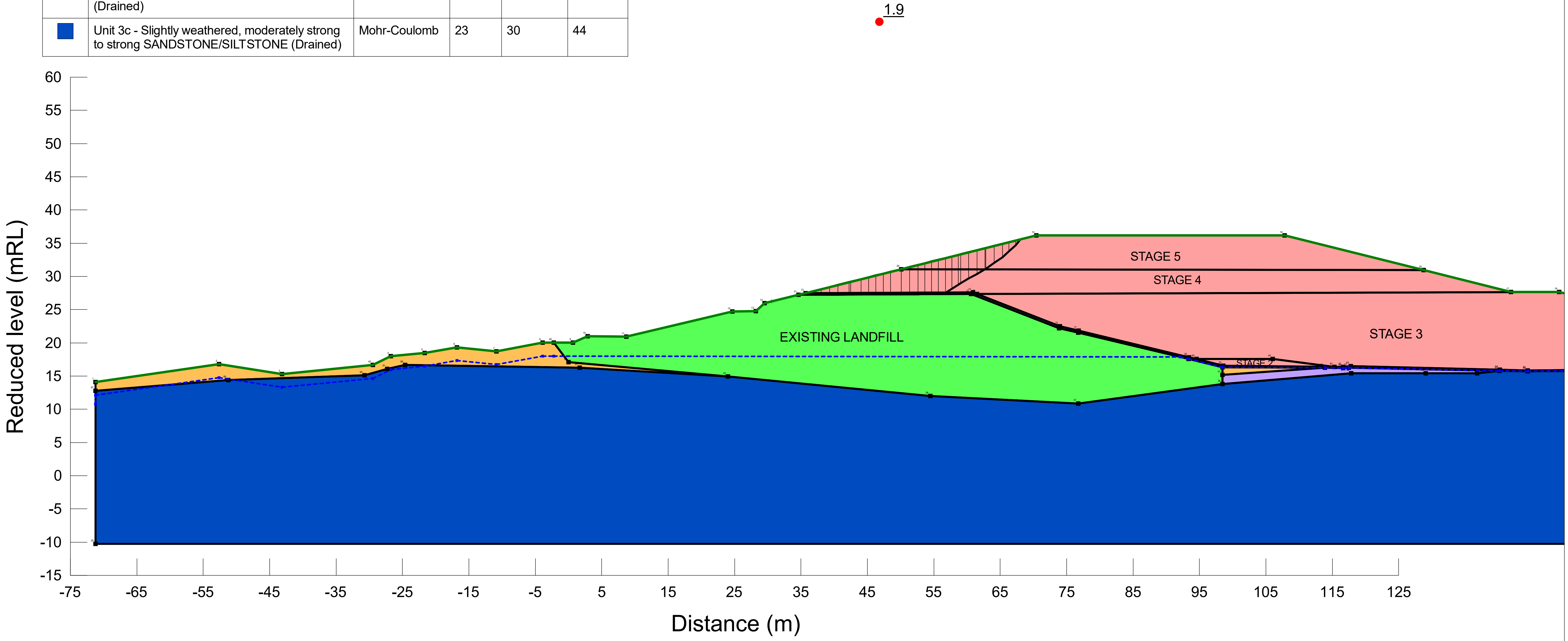
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:36:50 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

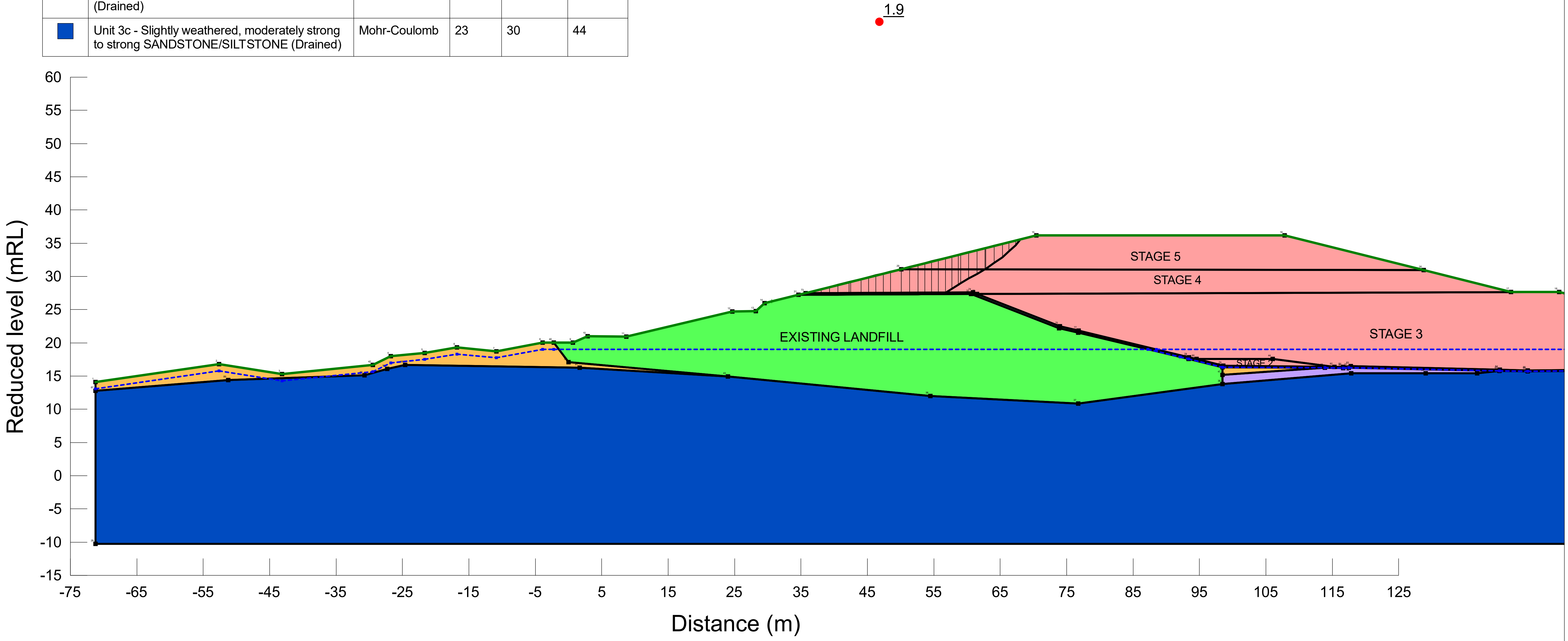


wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' (Constrained) 1.0.1 Static - Long term (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' (Constrained) 1.0.2 Static - HGWL+ Elevated Leachate (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

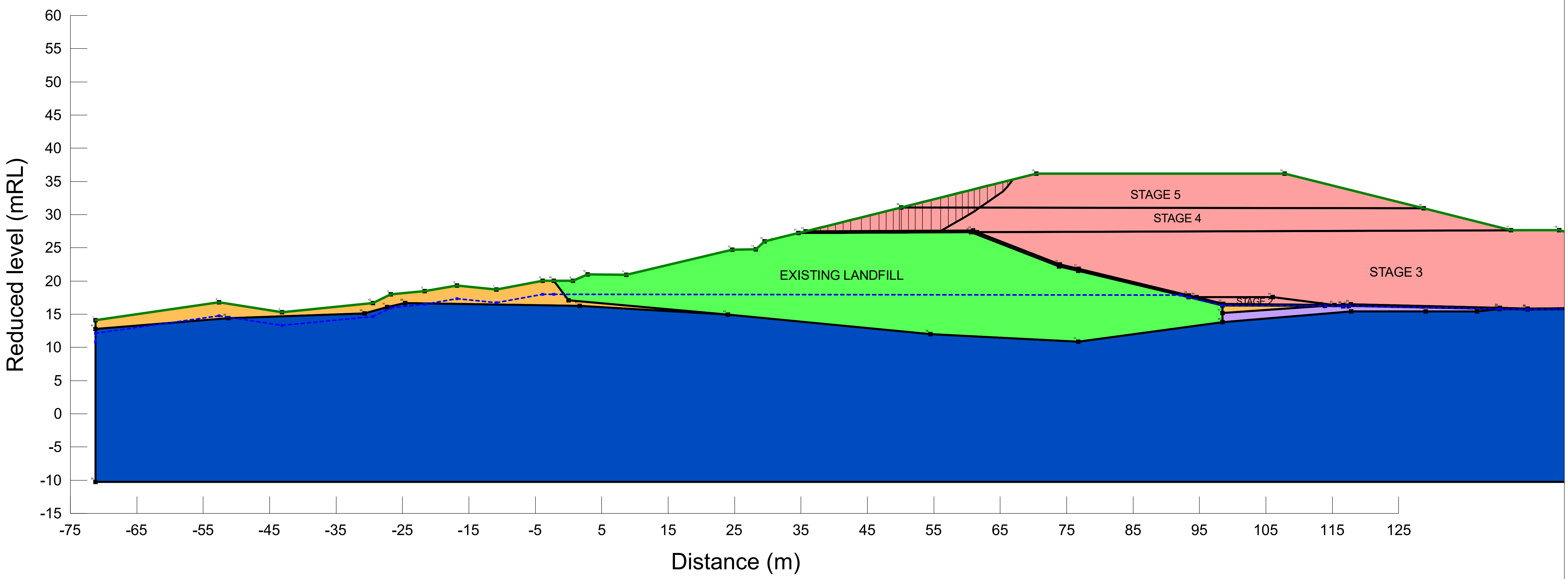
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:28:23 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

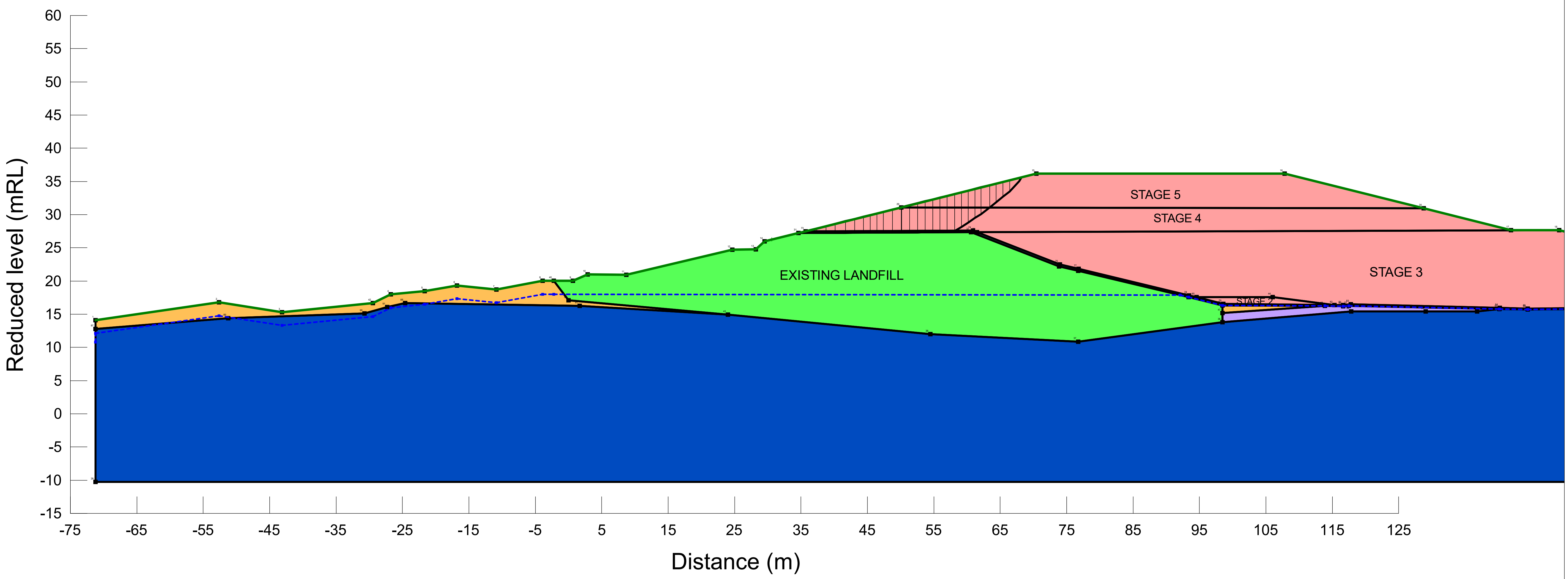


wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' (Constrained) 1.0.3 Seismic - SLS (1/50yr) MBIE (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(green)	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
(cyan)	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
(pink)	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
(yellow)	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
(orange)	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
(purple)	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
(blue)	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

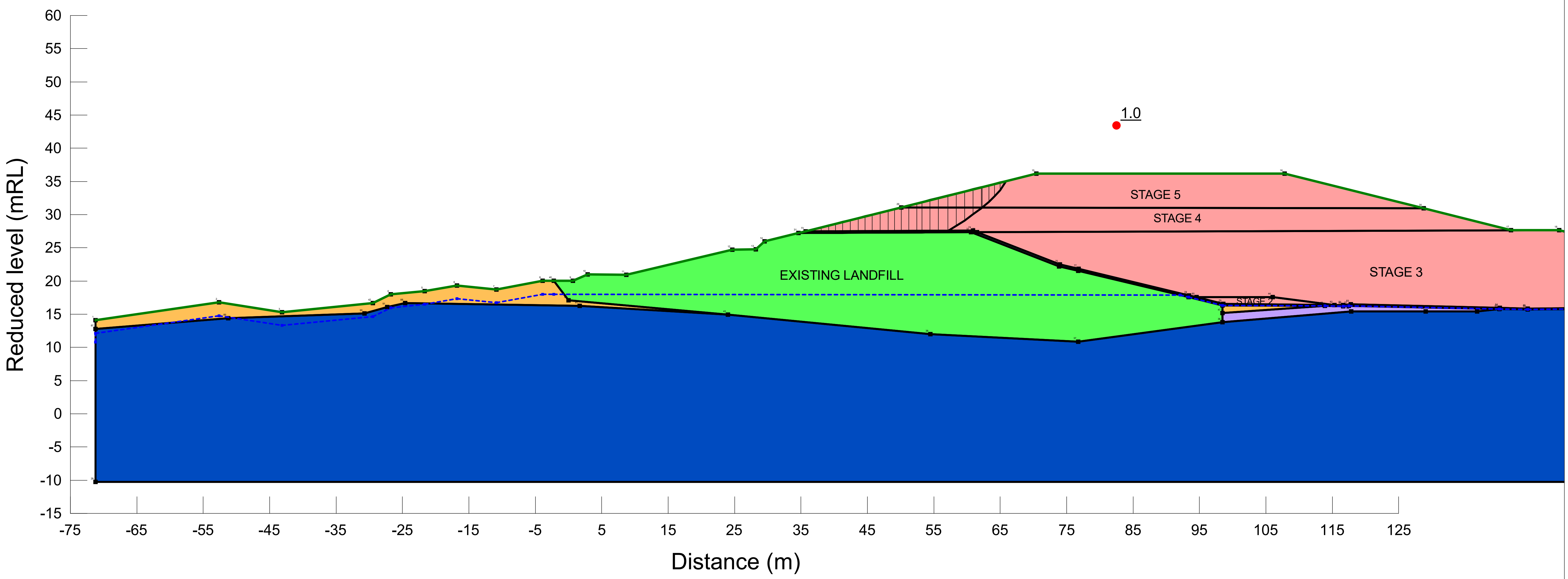


wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' (Constrained) 1.0.4 Seismic - ULS (1/1000yr) MBIE (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.: 0.18

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.0 Section B-B' (Constrained) 1.0.5 Seismic - Yield Acceleration (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:28:23 pm

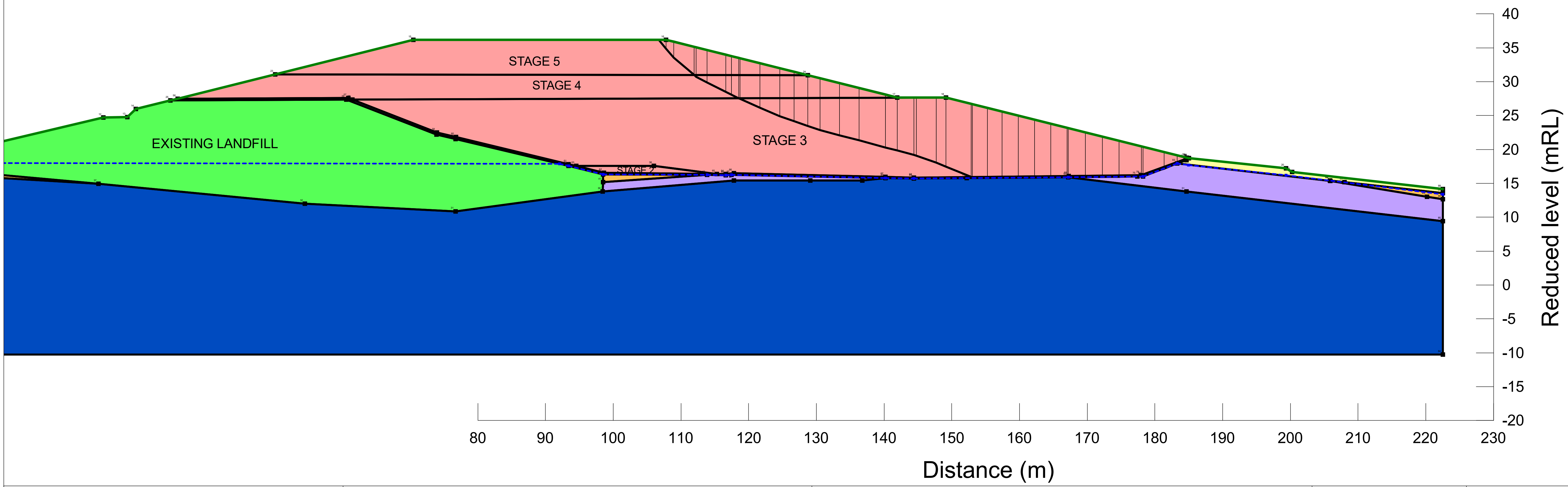
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

2.1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan	1.1 Section B-B' 1.1.1 Static - Long term	6-CO082.00	Date: 10/05/2024
		Scale: 1:600	By: B. HARRISON

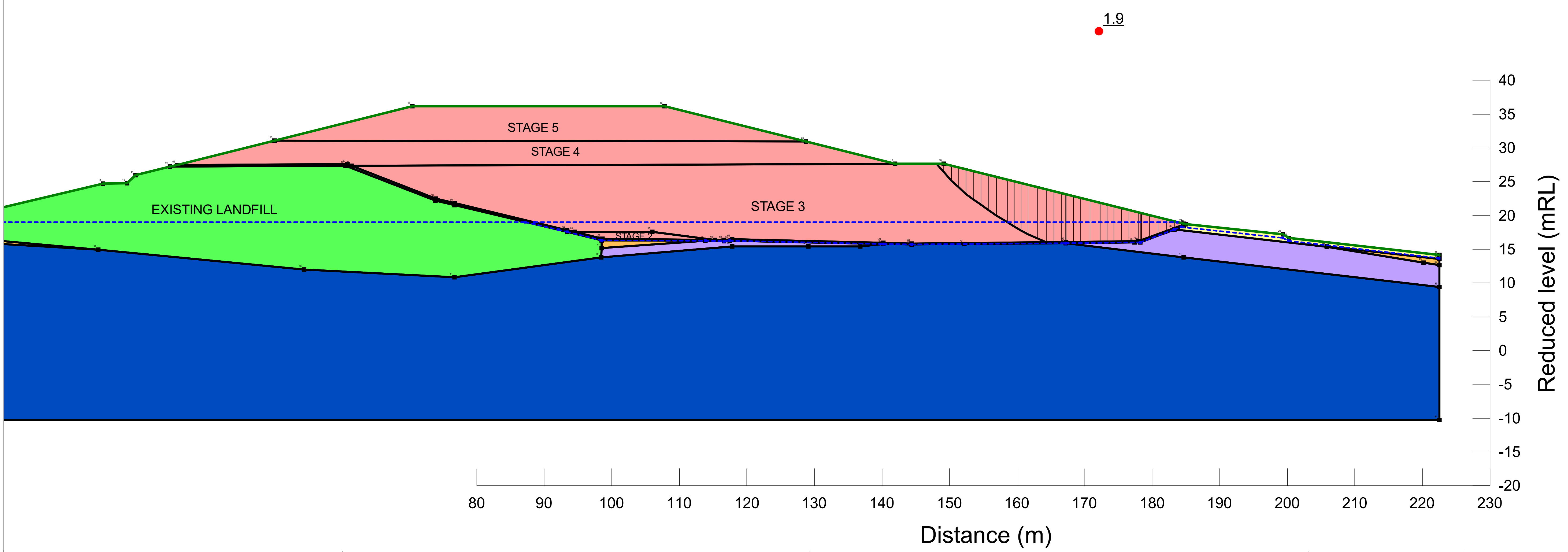
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

1.1 Section B-B'
1.1.2 Static - HGWL+ Elevated Leachate

6-CO082.00

Date: 10/05/2024

Scale: 1:600

By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

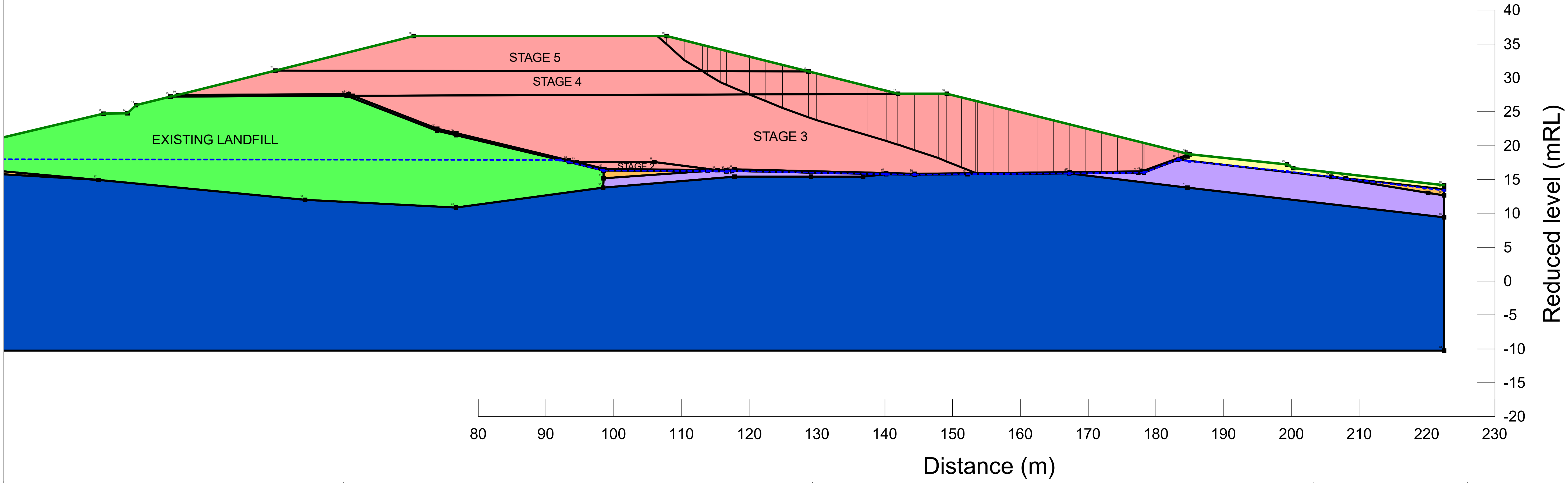
DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

1.5

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

1.1 Section B-B'
1.1.3 Seismic - SLS (1/50yr) MBIE

6-CO082.00

Date: 10/05/2024

Scale: 1:600

By: B. HARRISON

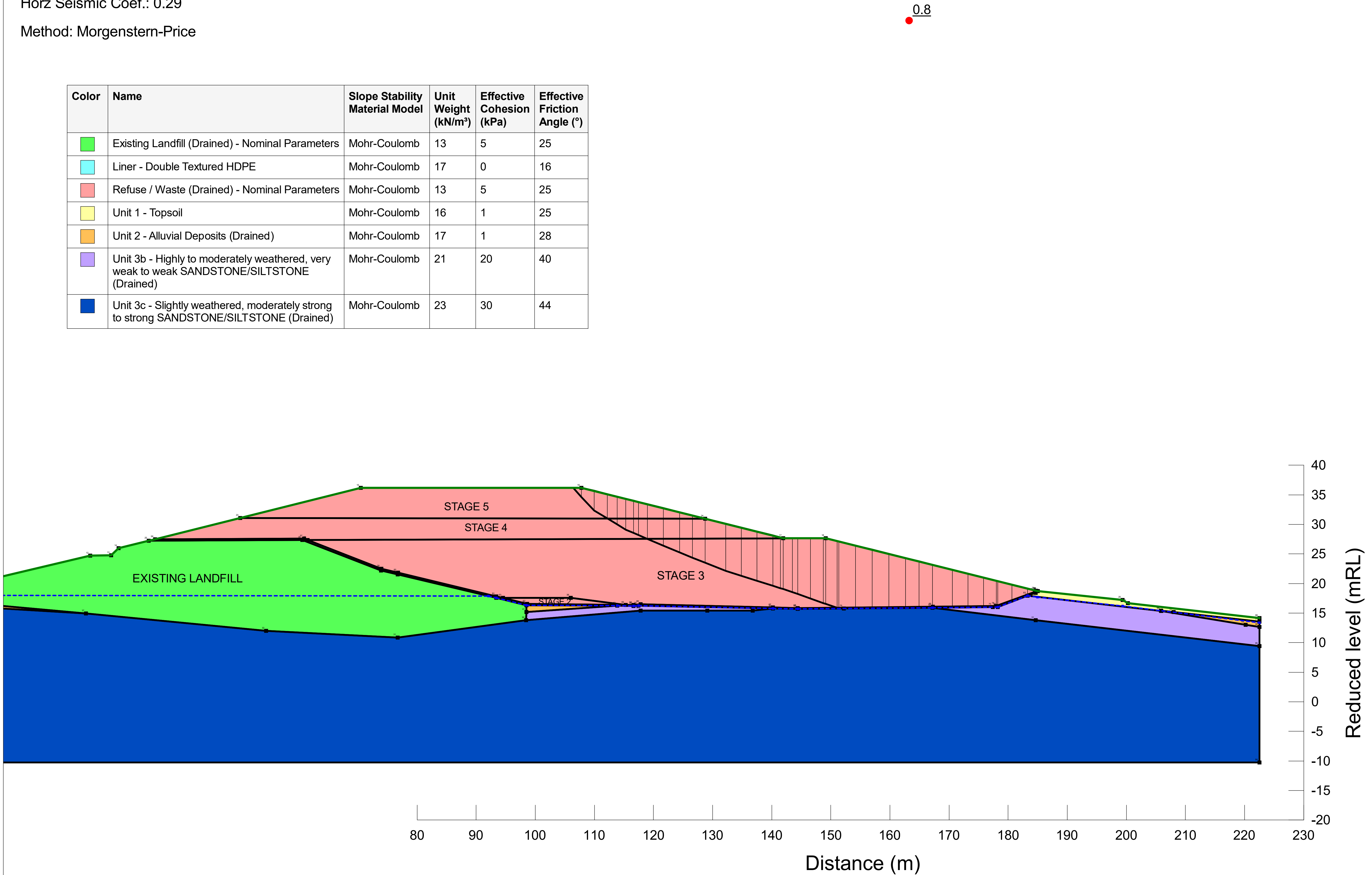
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.1 Section B-B' 1.1.4 Seismic - ULS (1/1000yr) MBIE	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

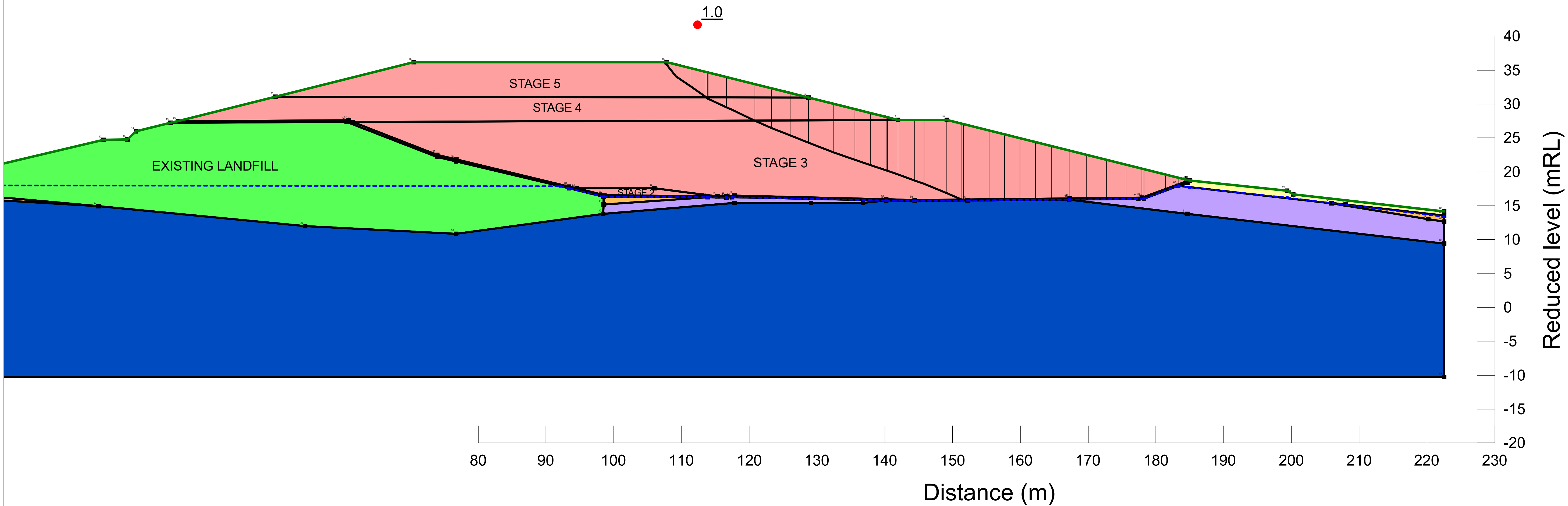
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.21

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	1.1 Section B-B' 1.1.5 Seismic - Yield Acceleration	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

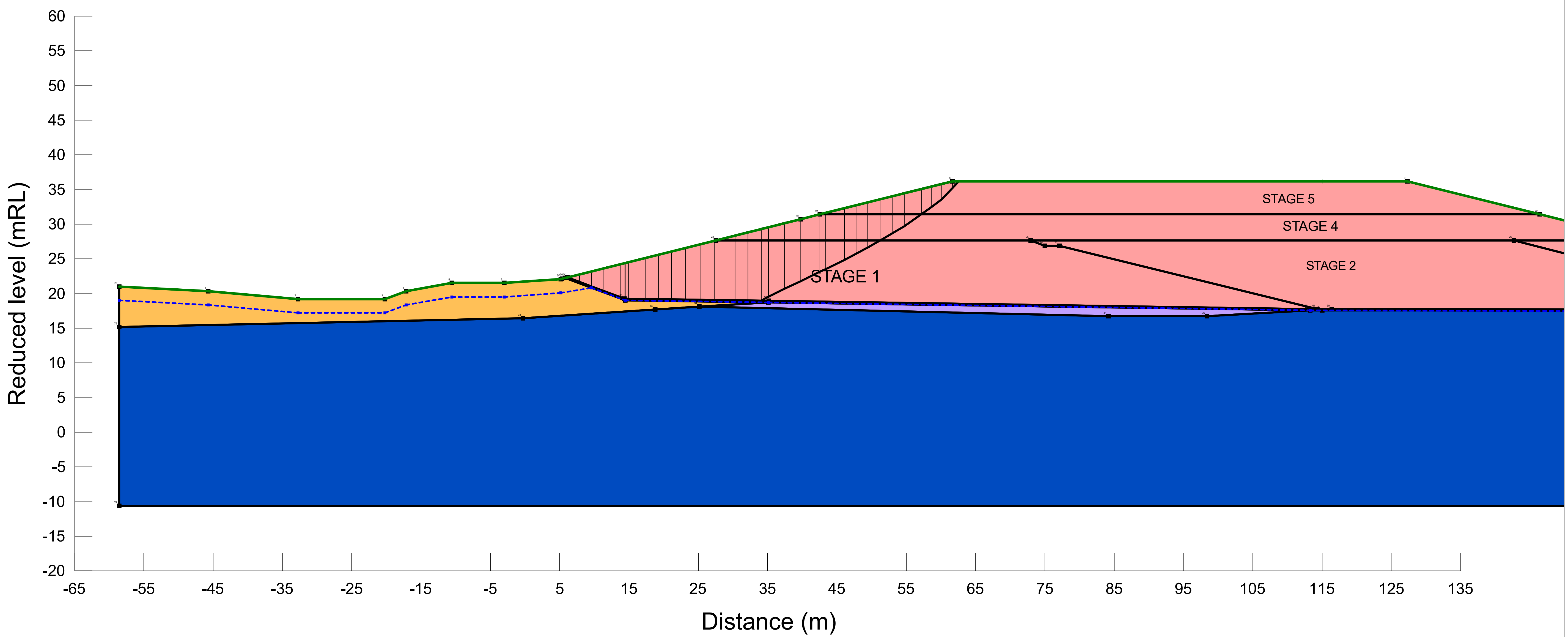
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan	2.0 Section C-C' 2.0.1 Static - Long term	6-CO082.00	Date: 10/05/2024
		Scale: 1:600	By: B. HARRISON

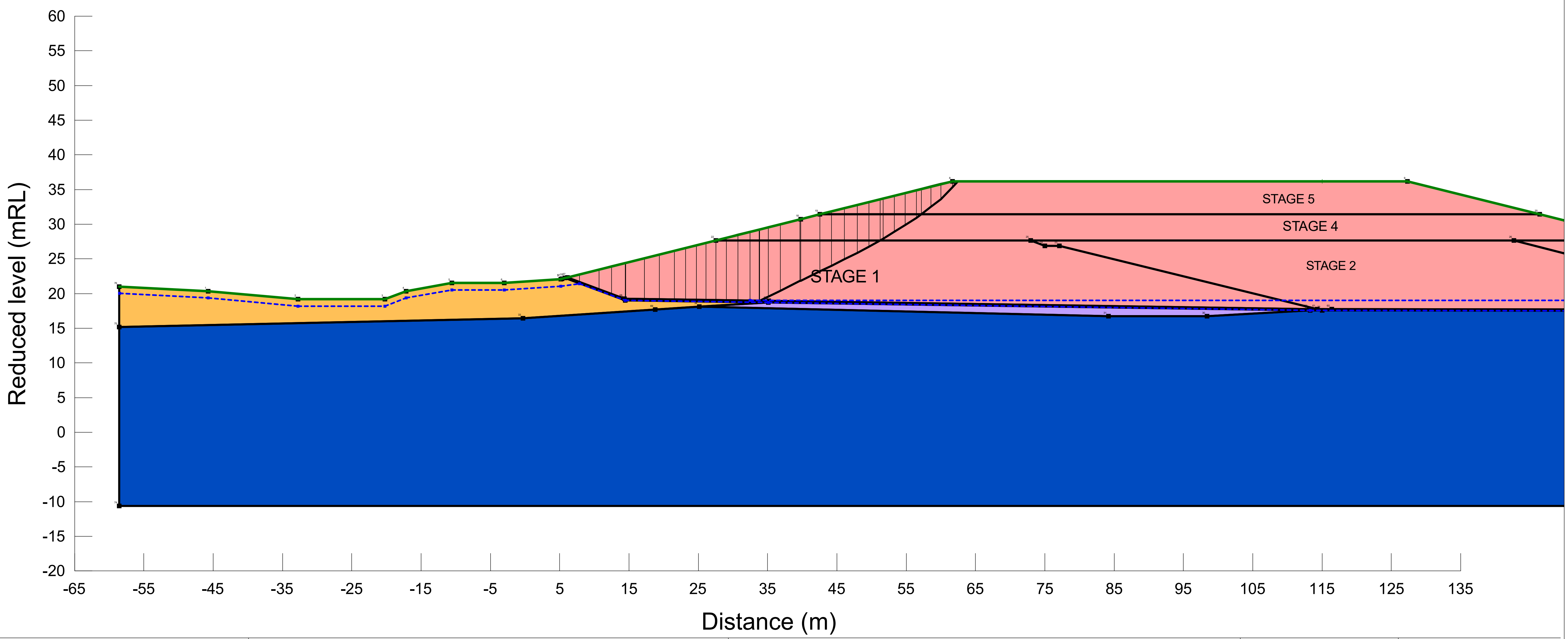
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:45:49 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



WSP	Mt Cooee Landfill Development Plan	2.0 Section C-C' 2.0.2 Static - HGWL + Elevated Leachate	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:45:49 pm

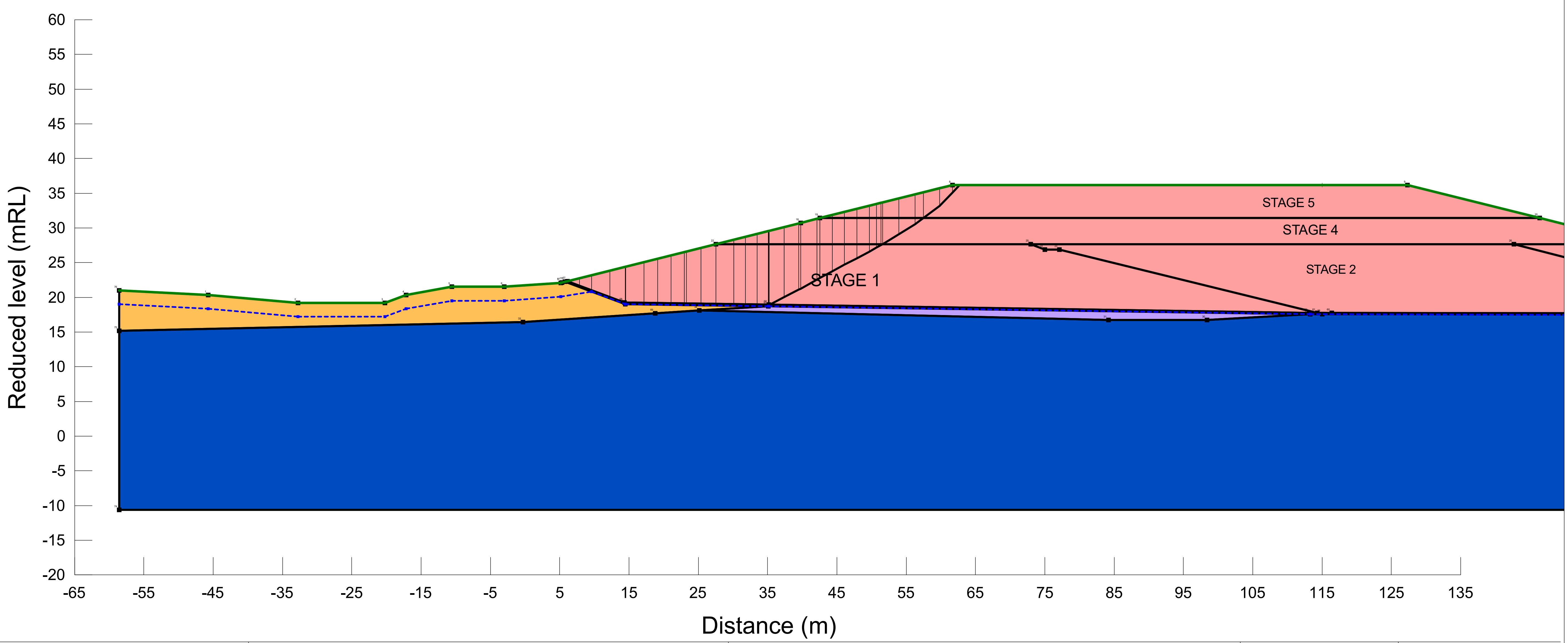
DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

1.4



Mt Cooee Landfill Development Plan	2.0 Section C-C' 2.0.3 Seismic - SLS (1/50yr) MBIE	6-CO082.00	Date: 10/05/2024
		Scale: 1:600	By: B. HARRISON

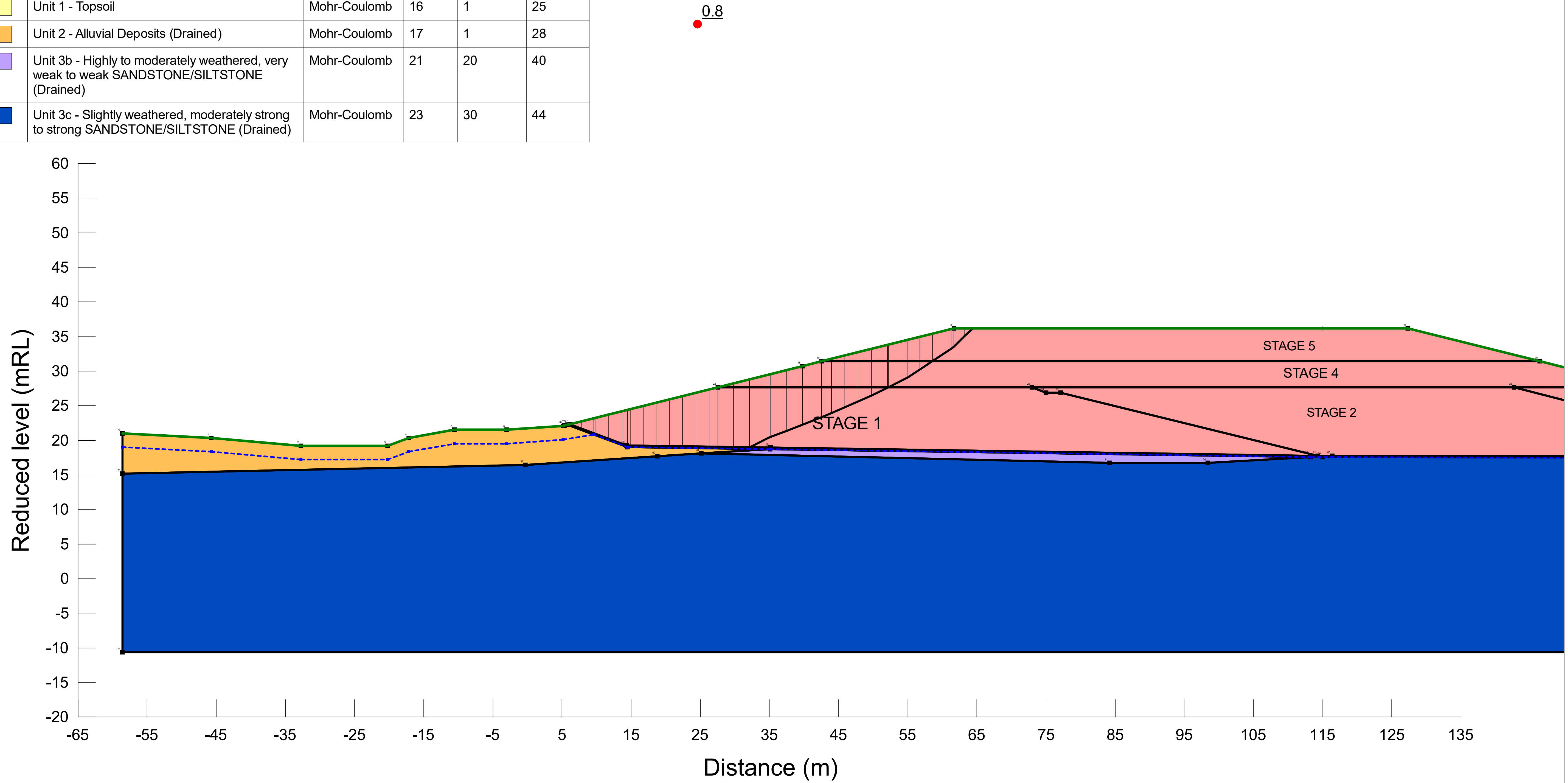
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\.20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,01:45:49 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

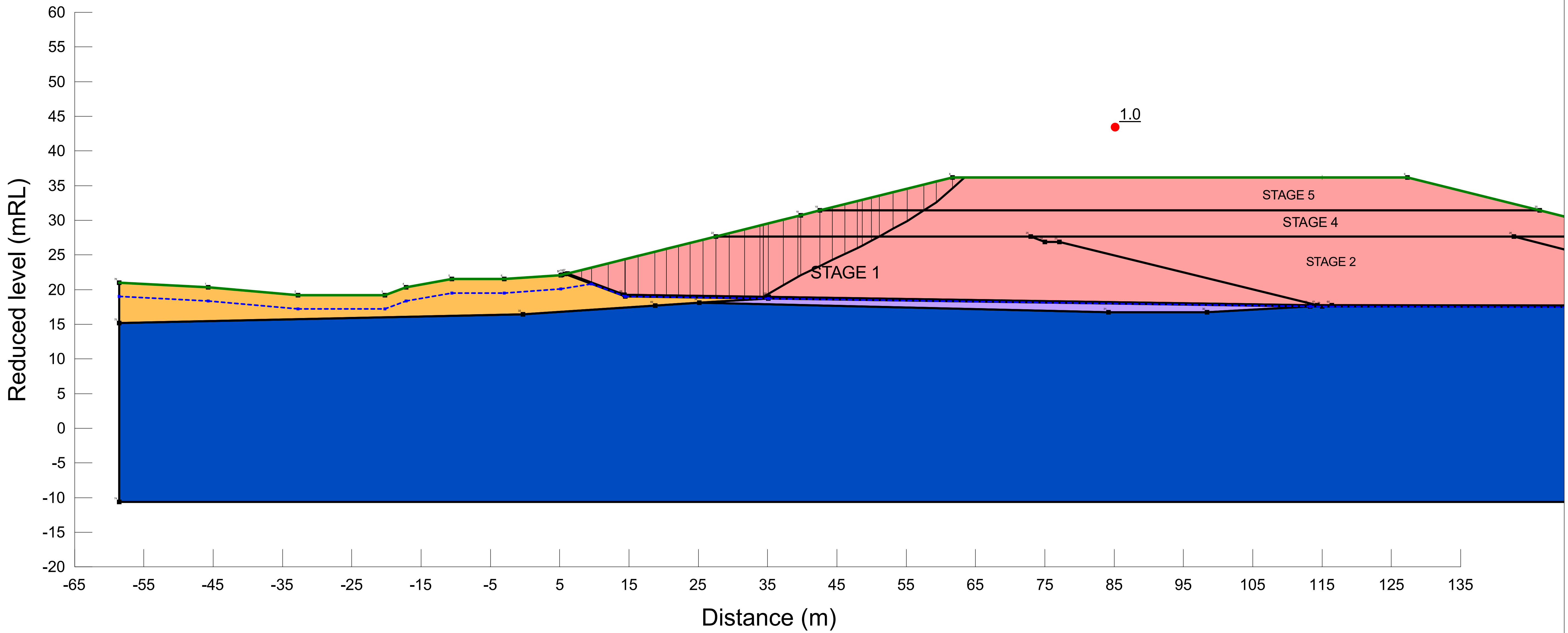


WSP	Mt Cooee Landfill Development Plan	2.0 Section C-C' 2.0.4 Seismic - ULS (1/1000yr) MBIE	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.: 0.2

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

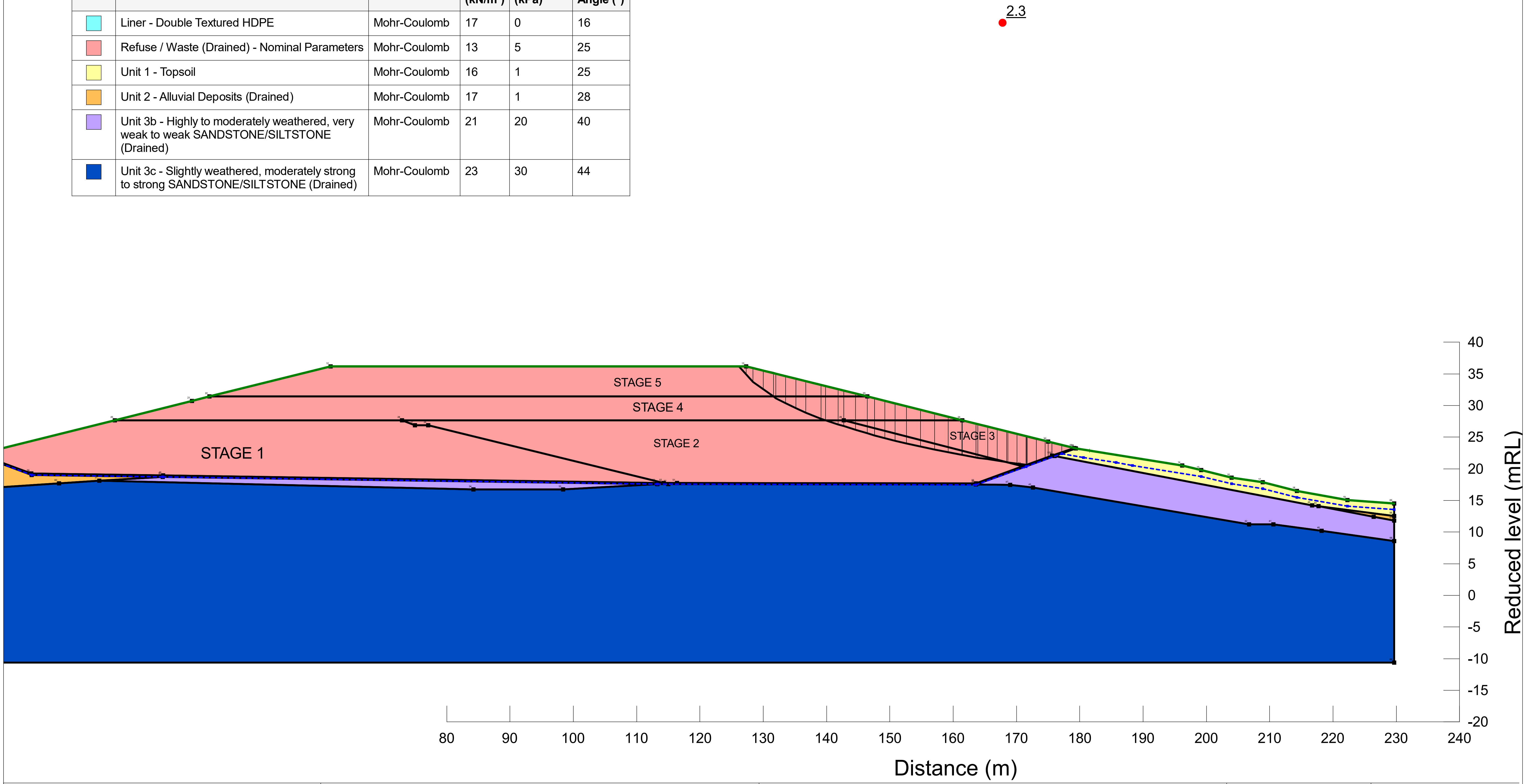


wsp	Mt Cooee Landfill Development Plan	2.0 Section C-C' 2.0.5 Seismic - Yield Acceleration	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

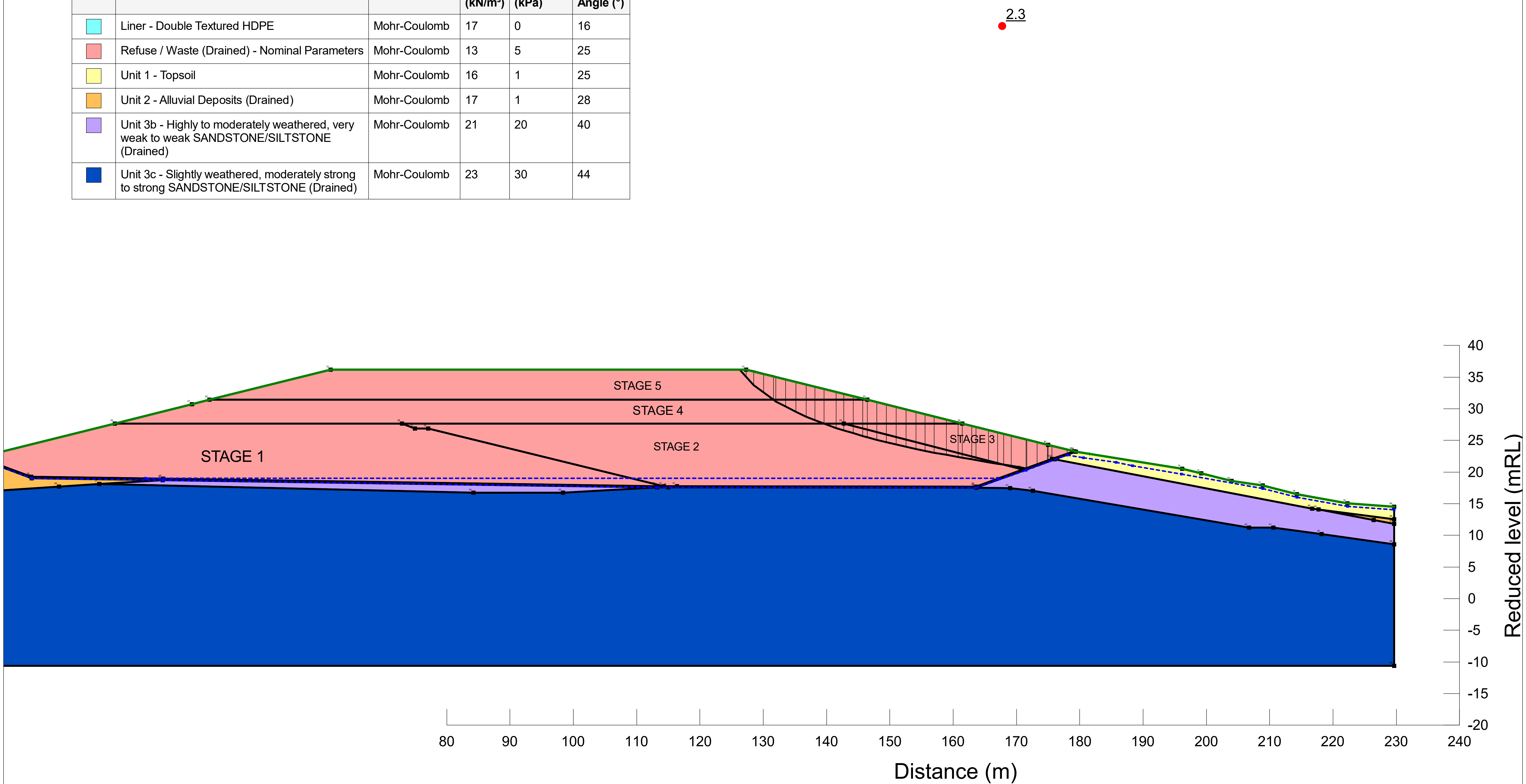


Mt Cooee Landfill Development Plan	2.1 Section C-C' 2.1.1 Static - Long term	6-CO082.00	Date: 10/05/2024
		Scale: 1:600	By: B. HARRISON

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

2.1 Section C-C'
2.1.2 Static - HGWL + Elevated Leachate

6-CO082.00

Date: 10/05/2024

Scale: 1:600

By: B. HARRISON

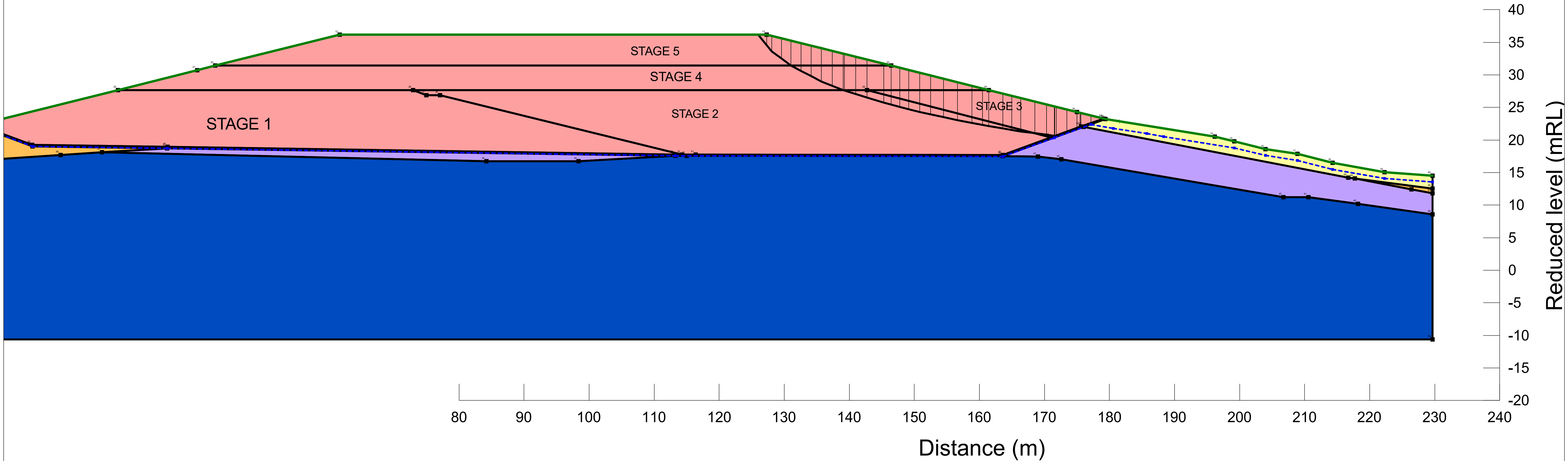
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



	Mt Cooee Landfill Development Plan	2.1 Section C-C' 2.1.3 Seismic - SLS (1/50yr) MBIE	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

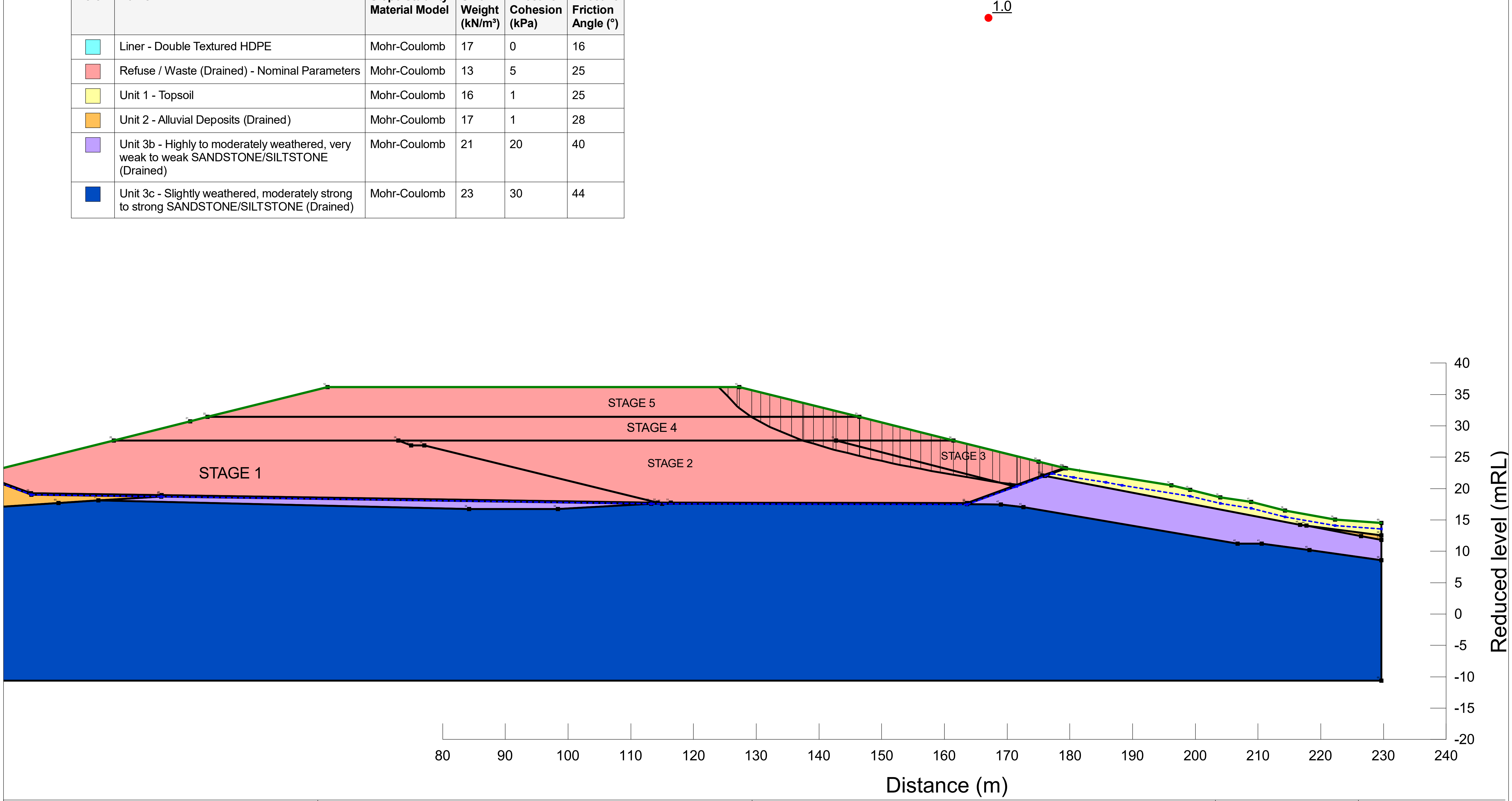
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



	Mt Cooee Landfill Development Plan	2.1 Section C-C' 2.1.4 Seismic - ULS (1/1000yr) MBIE	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

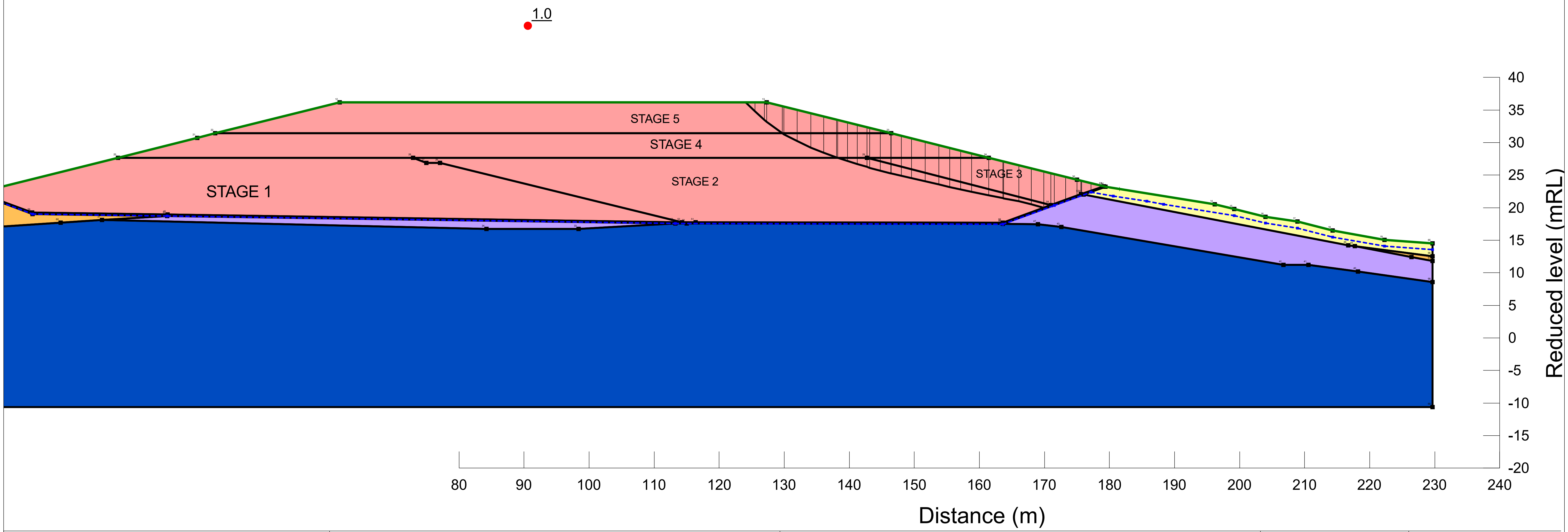
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.3

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

2.1 Section C-C'
2.1.5 Seismic - Yield Acceleration

6-CO082.00

Date: 10/05/2024

Scale: 1:600

By: B. HARRISON

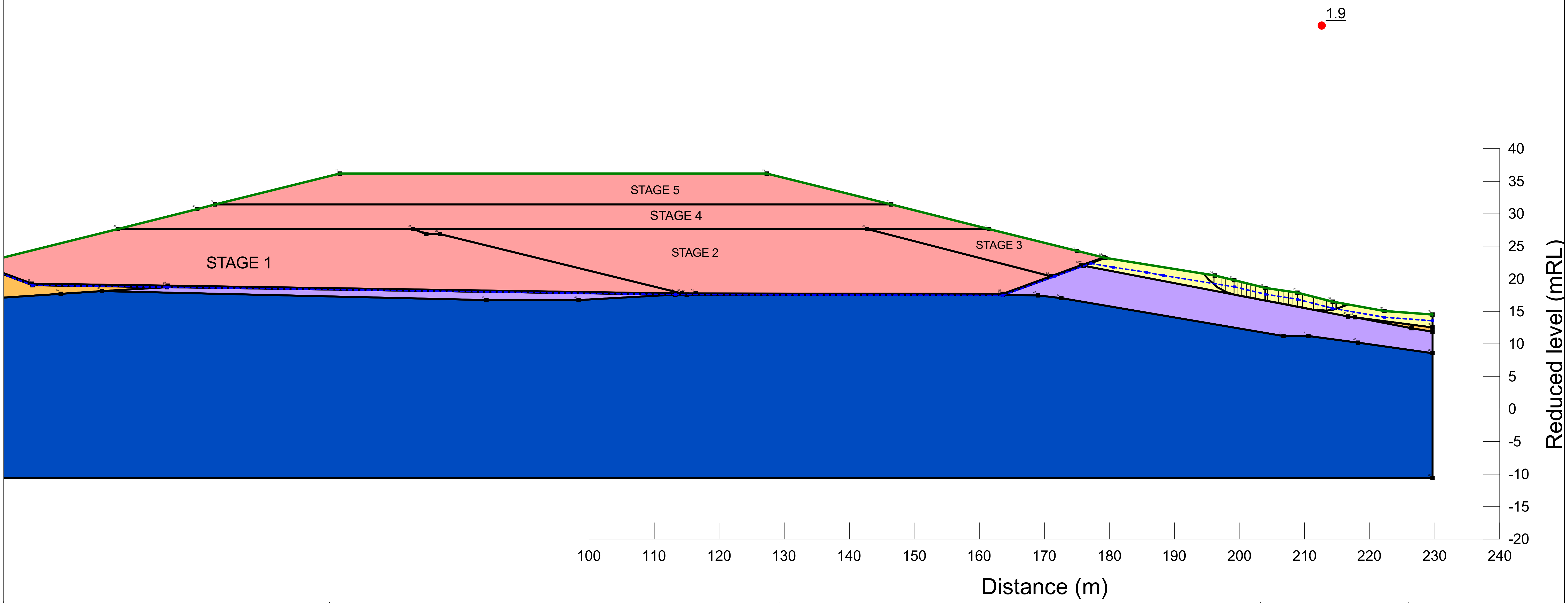
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	2.1 Section C-C' (Lower Slope) 2.1.1 Static - Long term (Lower Slope)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

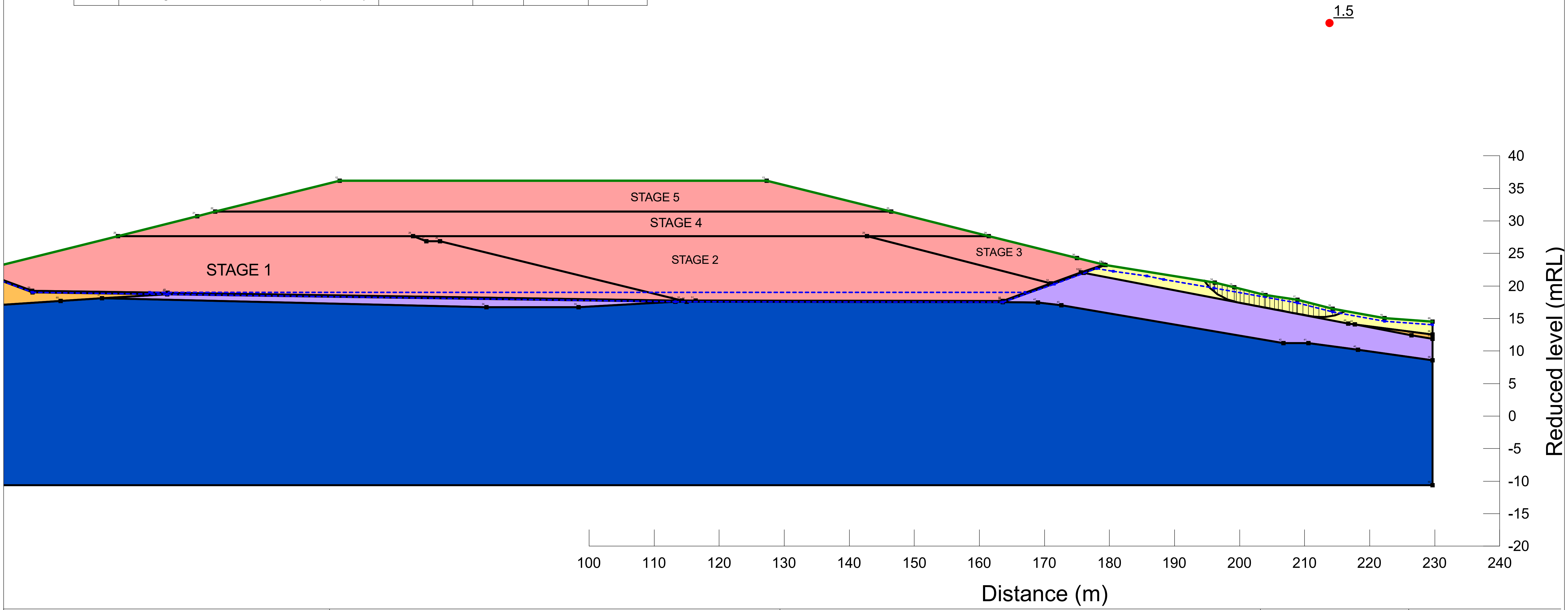
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



WSP	Mt Cooee Landfill Development Plan	2.1 Section C-C' (Lower Slope) 2.1.2 Static - HGWL + Elevated Leachate (Lower Slope)	6-CO082.00 Scale: 1:600	Date: 10/05/2024 By: B. HARRISON

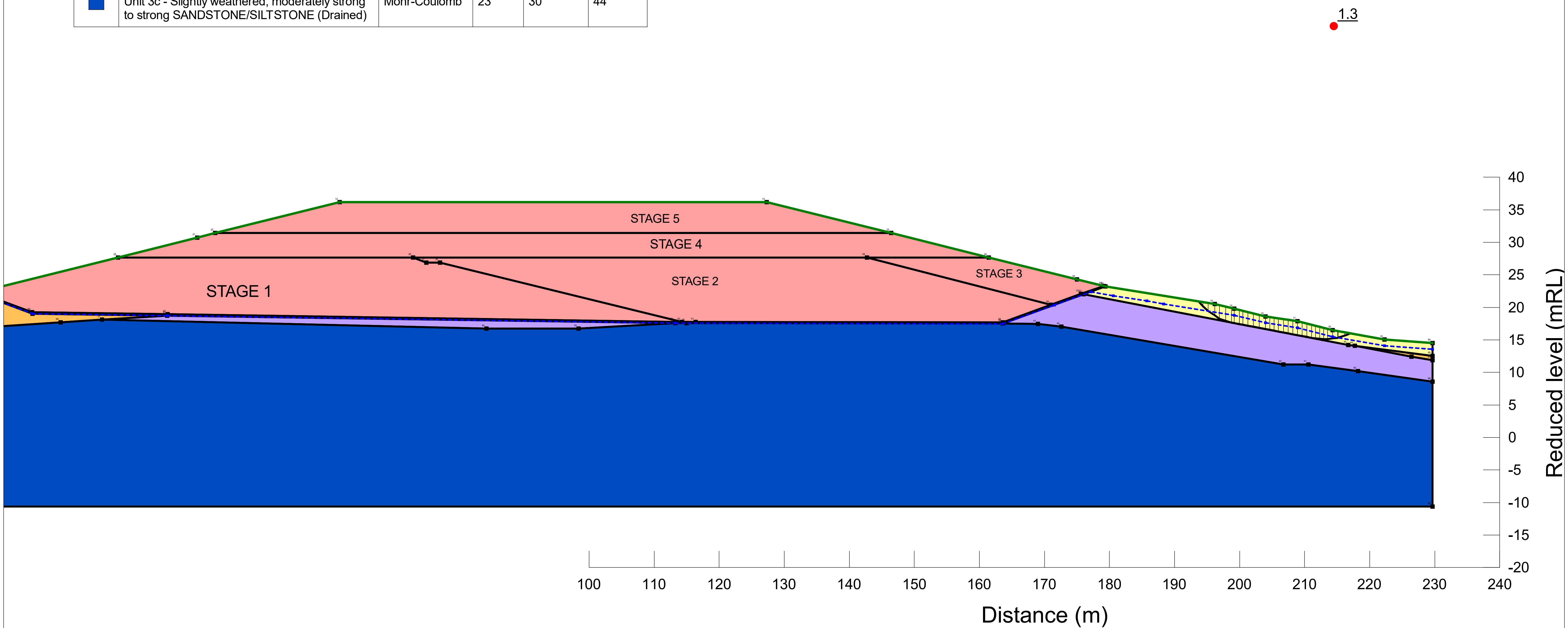
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	2.1 Section C-C' (Lower Slope) 2.1.3 Seismic - SLS (1/50yr) MBIE (Lower Slope)	6-CO082.00	Date: 10/05/2024
			Scale: 1:600	By: B. HARRISON

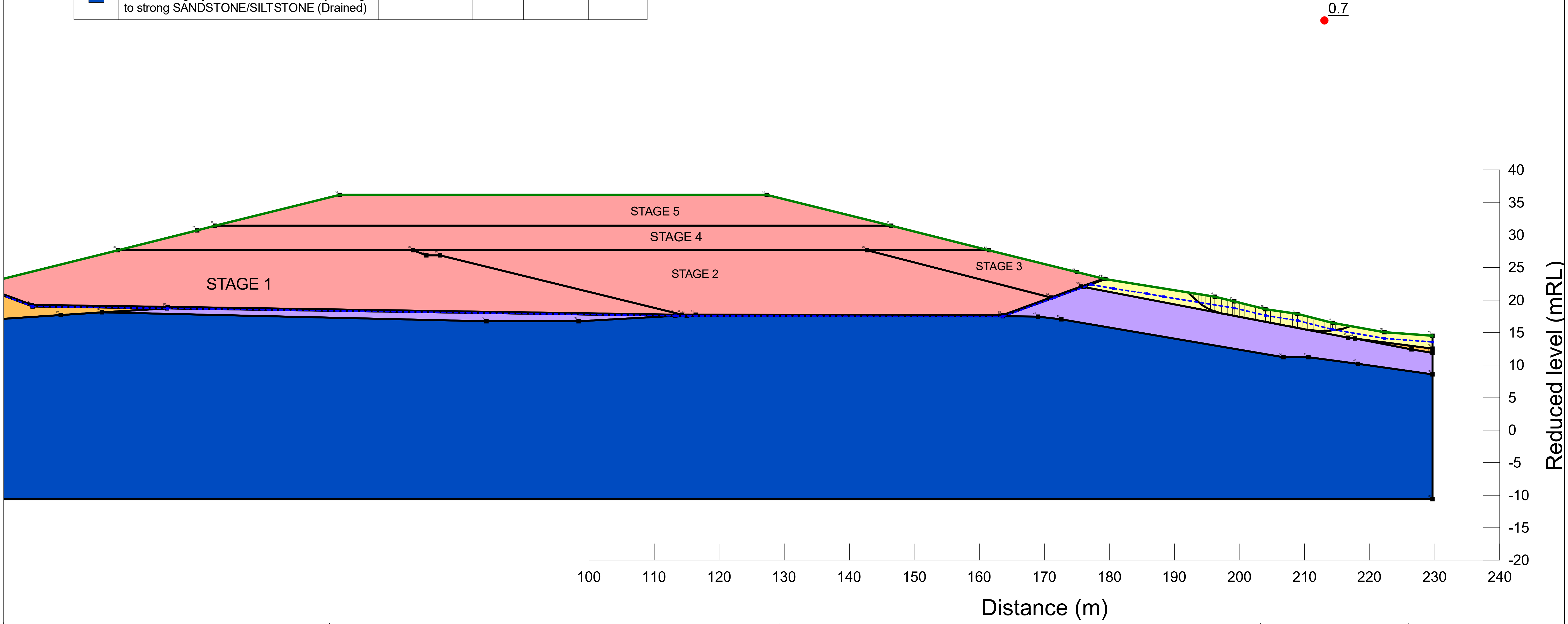
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\,20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

2.1 Section C-C' (Lower Slope)
2.1.4 Seismic - ULS (1/1000yr) MBIE (Lower Slope)

6-CO082.00

Date: 10/05/2024

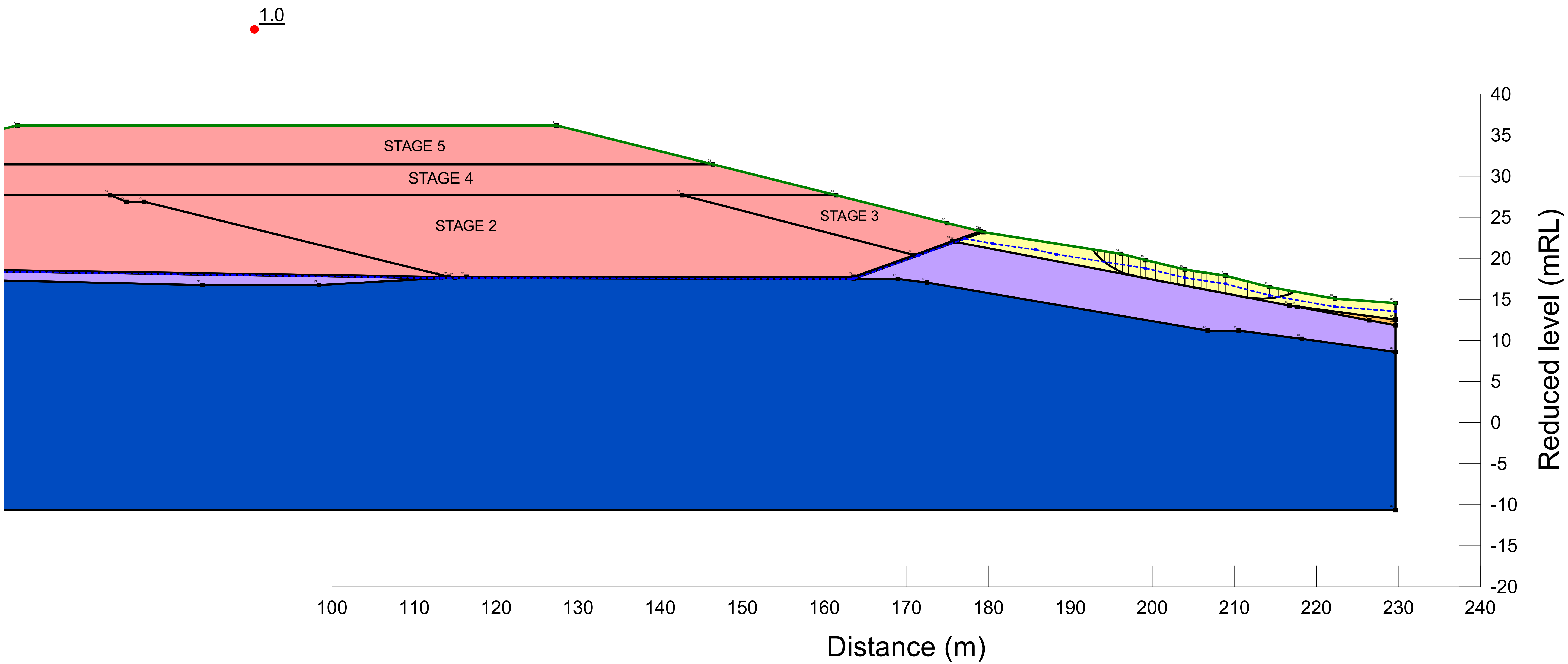
Scale: 1:600

By: B. HARRISON

Horz Seismic Coef.: 0.16

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	2.1 Section C-C' (Lower Slope) 2.1.5 Seismic - Yield Acceleration (Lower Slope)	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

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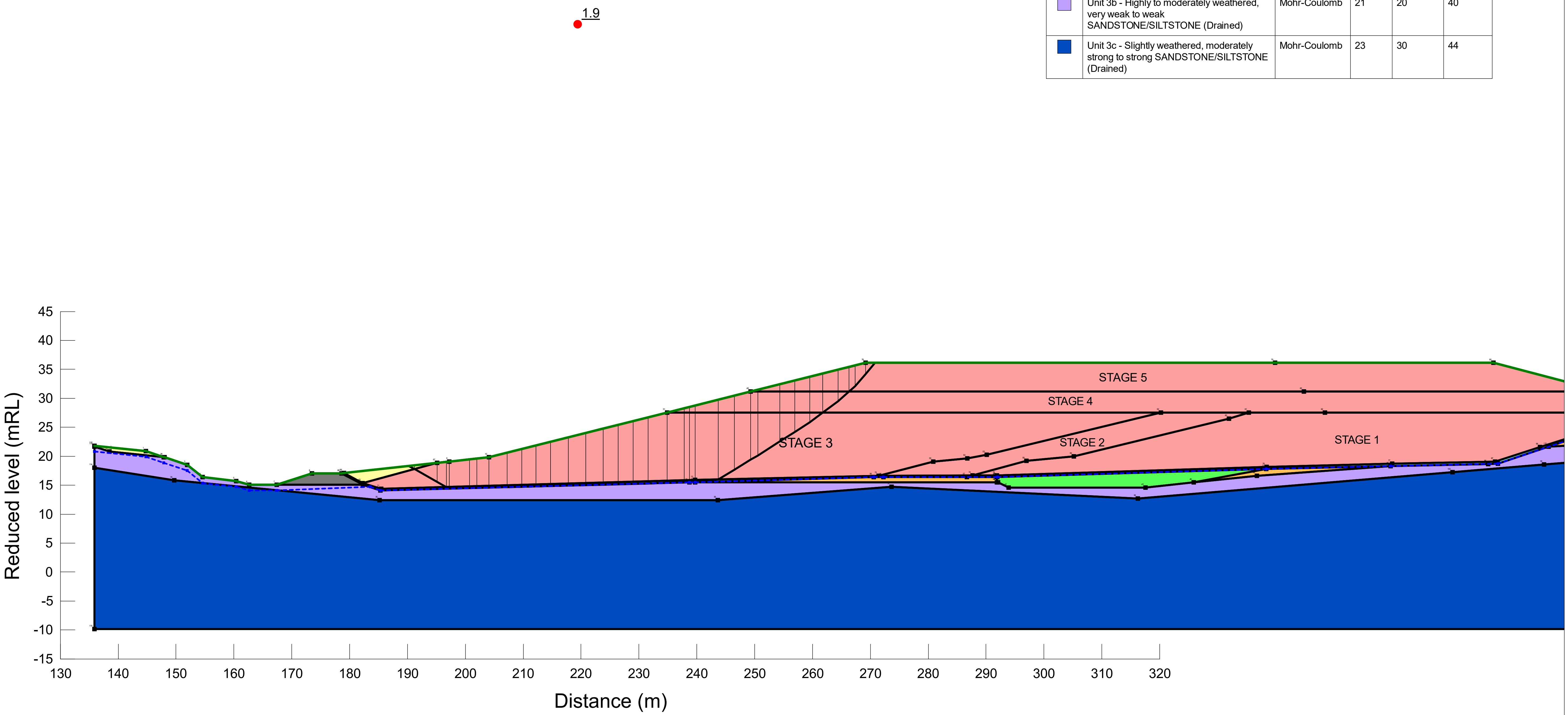
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

3.0 Section D-D'
3.0.1 Static - Long term

6-CO082.00

Date: 10/05/2024

Scale: 1:700

By: B. HARRISON

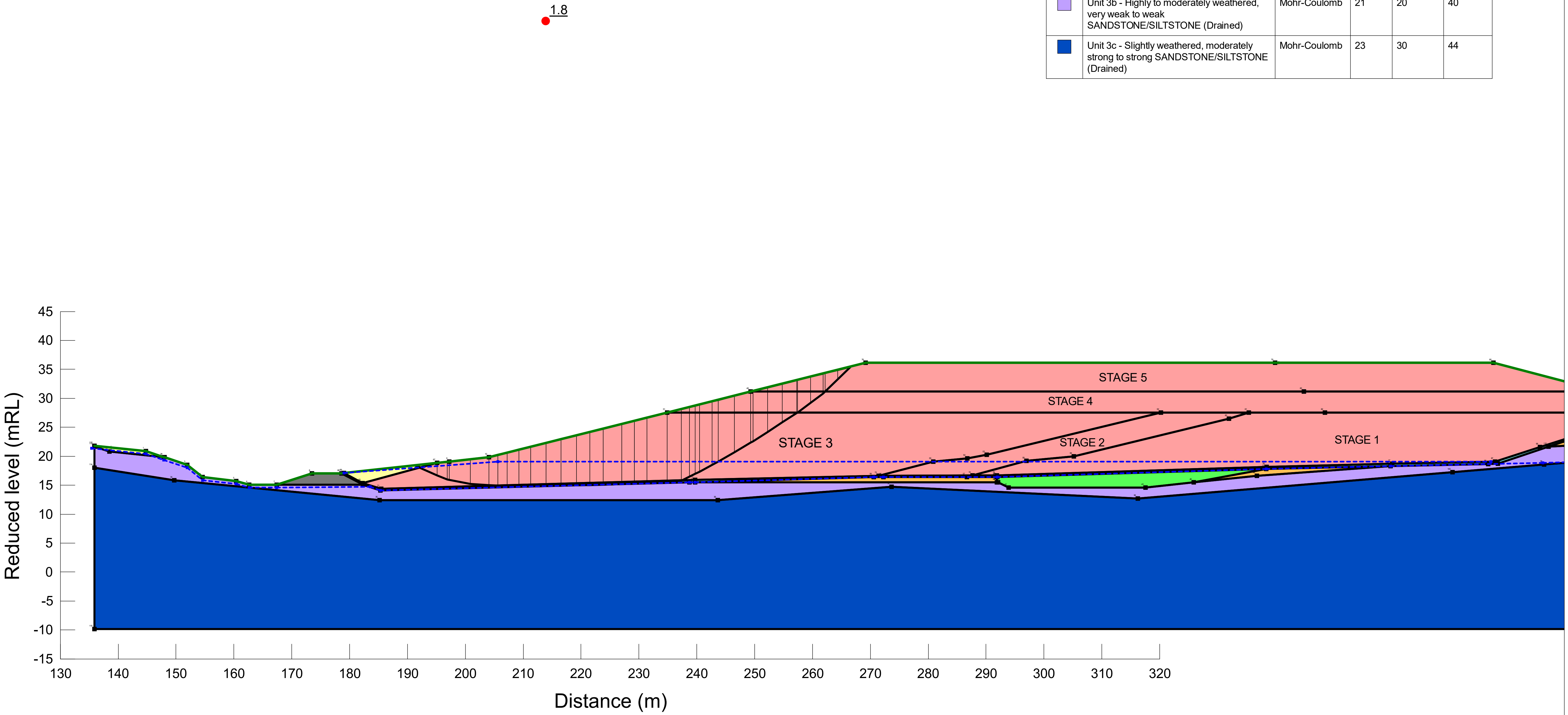
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\.20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



	Mt Cooee Landfill Development Plan	3.0 Section D-D' 3.0.2 Static - HGWL + Elevated Leachate	6-CO082.00	Date: 10/05/2024
			Scale: 1:700	By: B. HARRISON

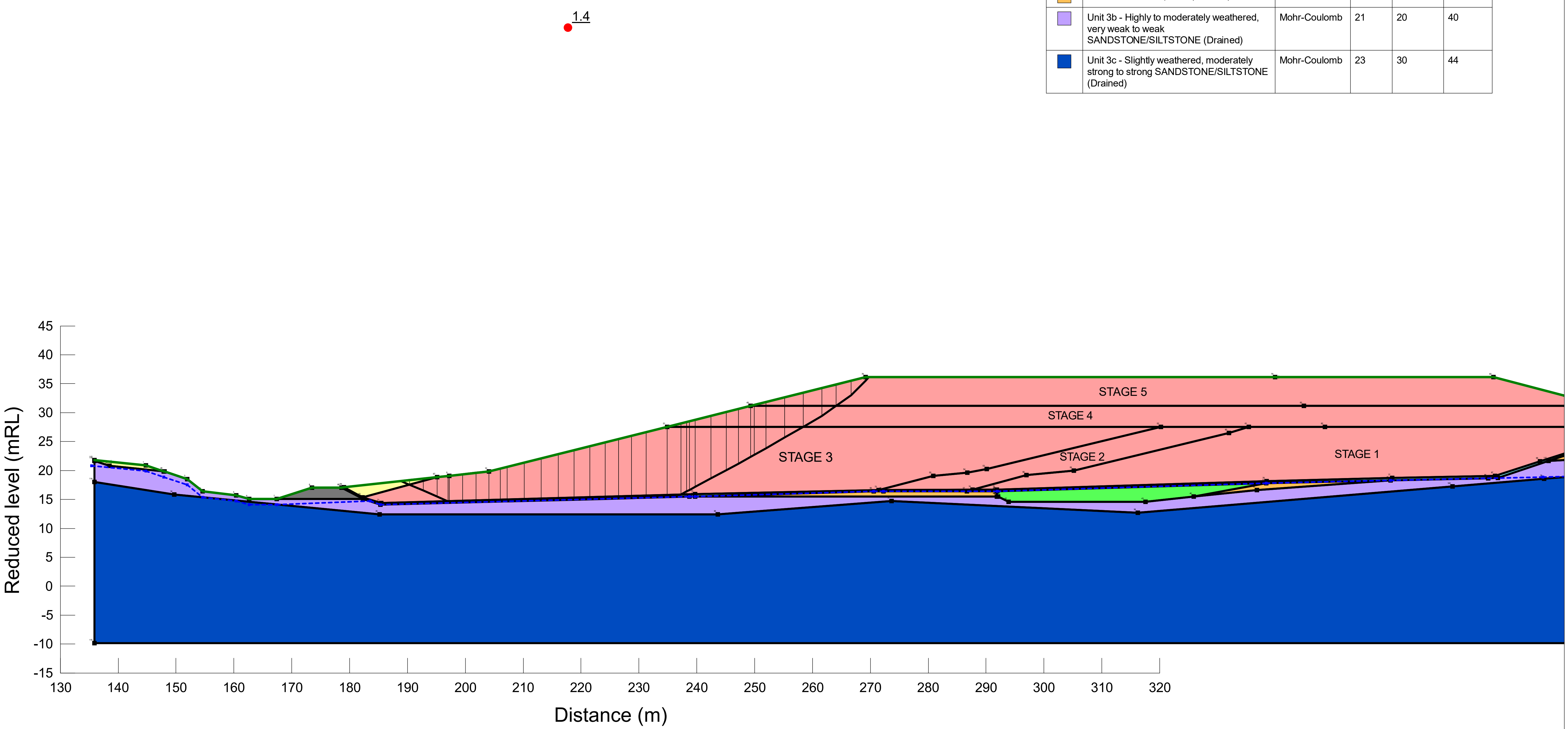
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

3.0 Section D-D'
3.0.3 Seismic - SLS (1/50yr)

6-CO082.00

Date: 10/05/2024

Scale: 1:700

By: B. HARRISON

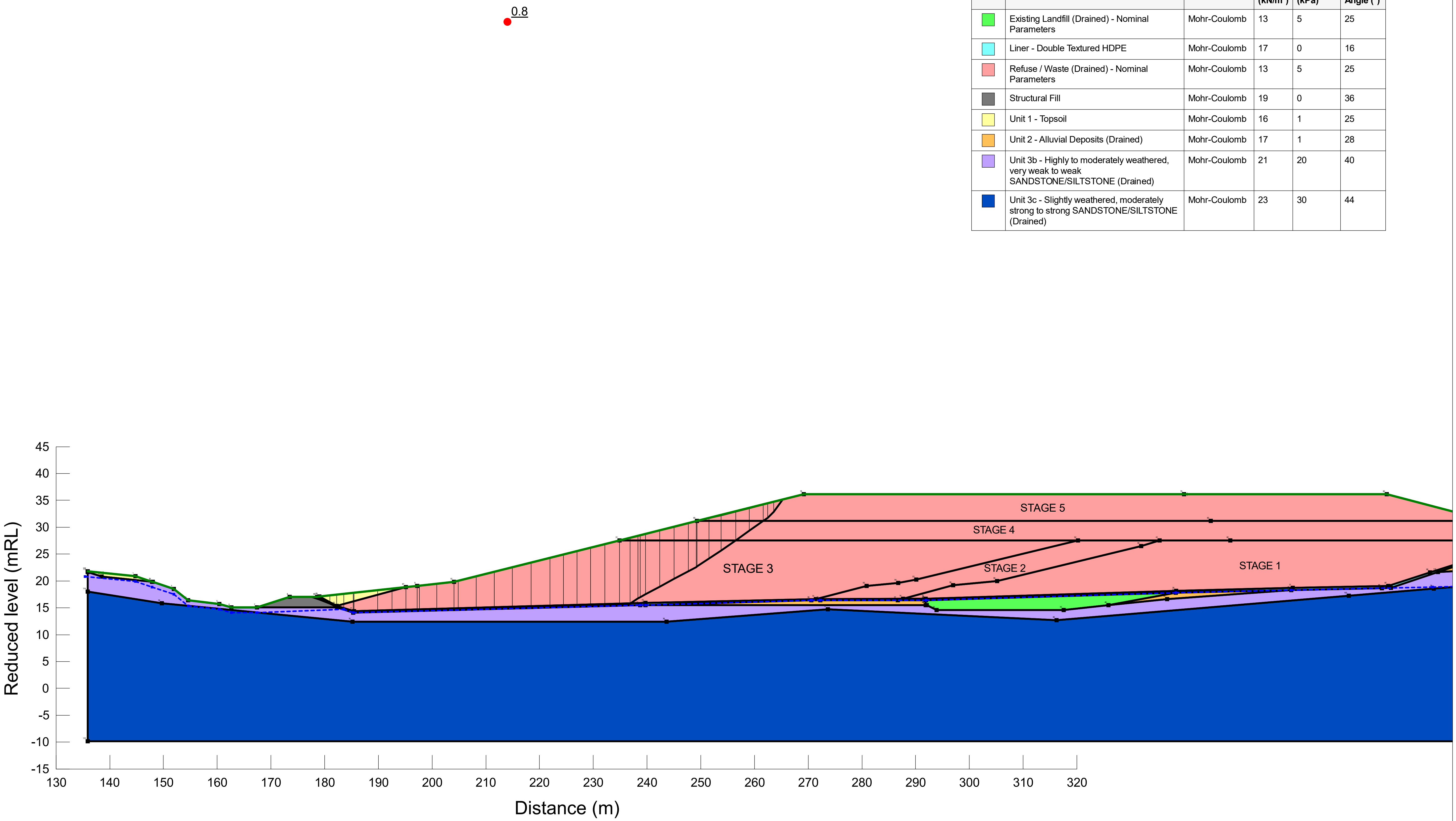
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

3.0 Section D-D'
3.0.4 Seismic - ULS (1/1000yr)

6-CO082.00

Date: 10/05/2024

Scale: 1:700

By: B. HARRISON

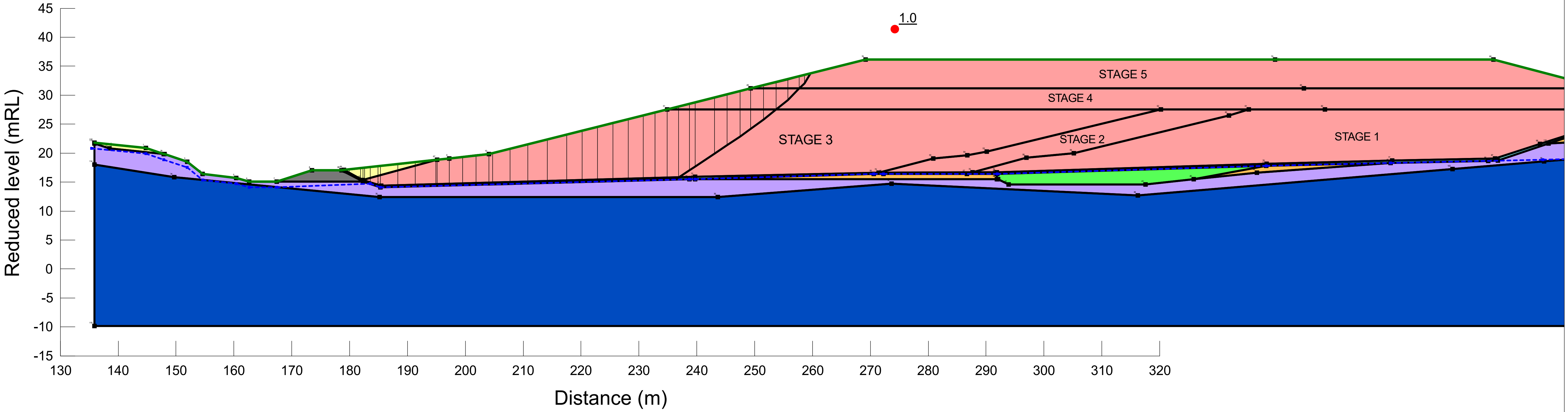
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\.20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.17

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

3.0 Section D-D'
3.0.5 Seismic - Yield Acceleration

6-CO082.00

Date: 10/05/2024

Scale: 1:700

By: B. HARRISON

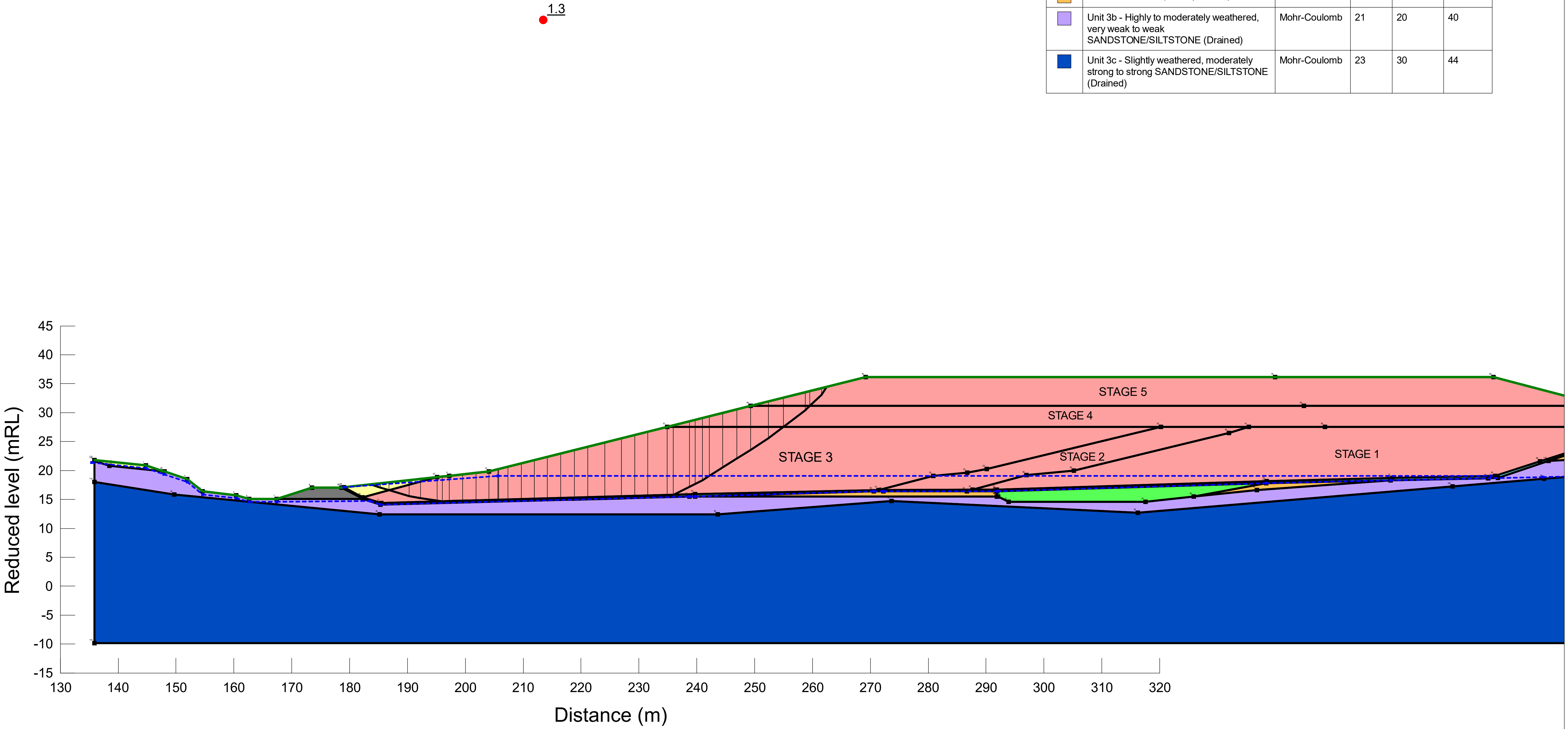
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

3.0 Section D-D'
3.0.6 Seismic - SLS (1/50yr) + HGWL + Elevated Leachate

6-CO082.00

Scale: 1:700

Date: 10/05/2024

By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\.20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

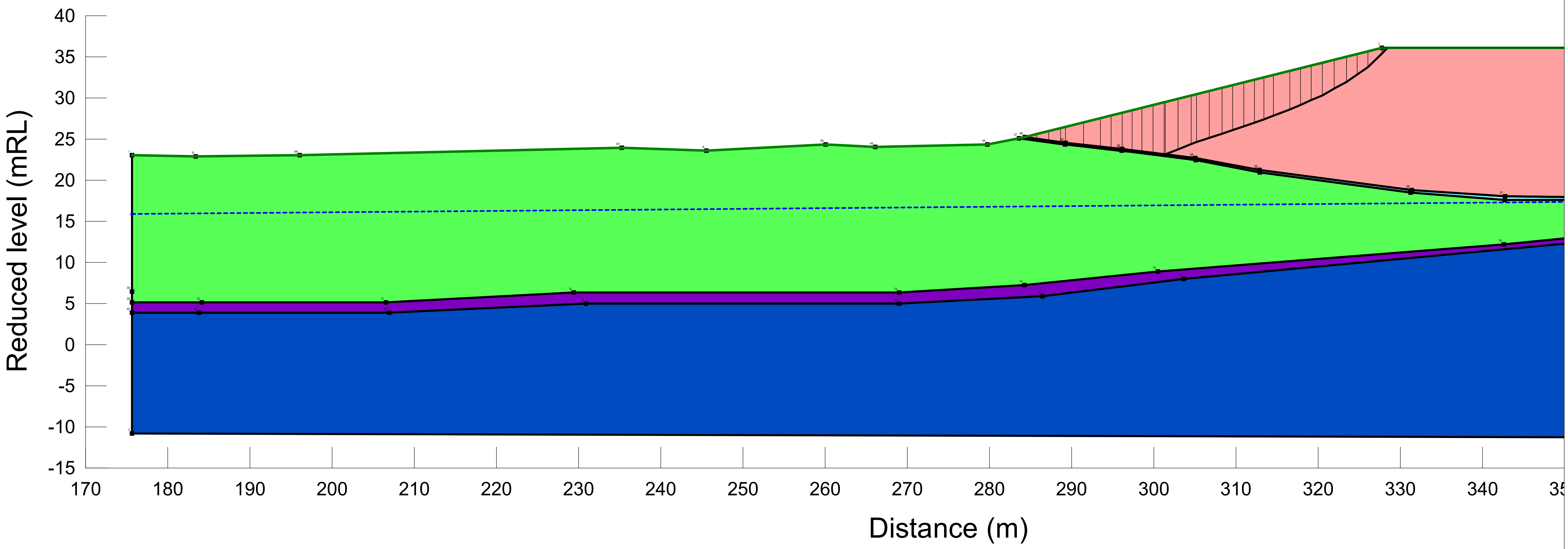
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

2.1

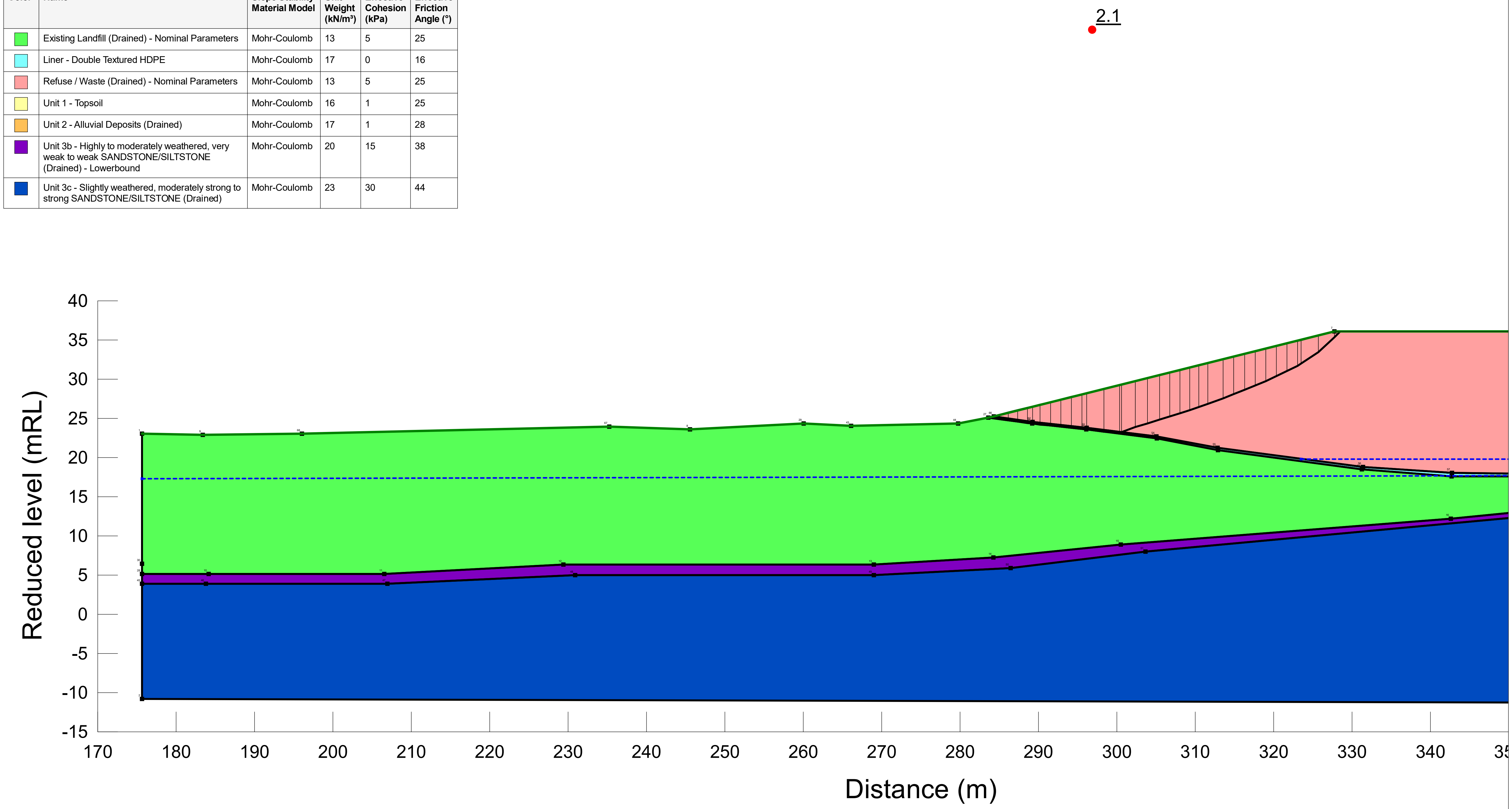


Mt Cooee Landfill Development Plan	4.0 Section A-A' 4.0.1 Static - Long term	6-CO082.00	Date: 10/05/2024
		Scale: 1:500	By: B. HARRISON

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

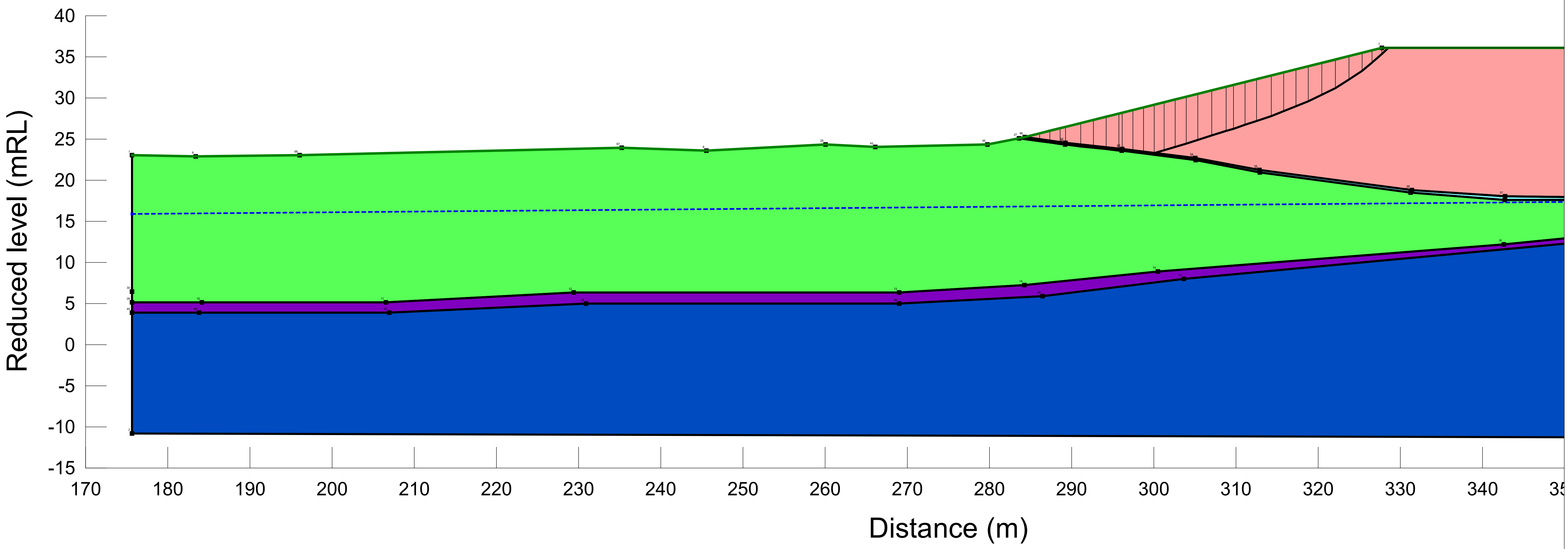


wsp	Mt Cooee Landfill Development Plan	4.0 Section A-A' 4.0.2 Static - HGWL + Elevated Leachate	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

4.0 Section A-A'
4.0.3 Seismic SLS (1/50yr) MBIE

6-CO082.00

Date: 10/05/2024

Scale: 1:500

By: B. HARRISON

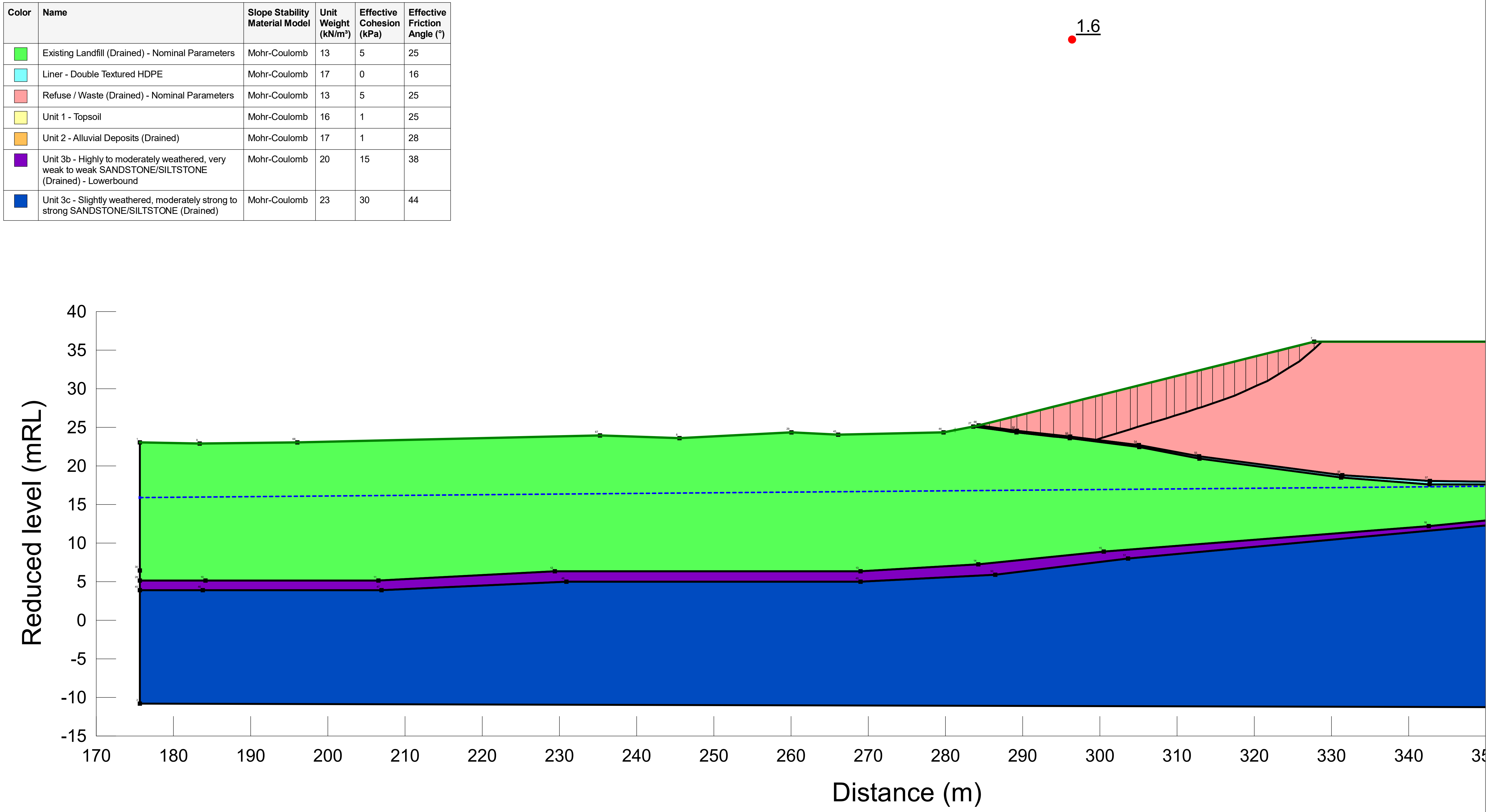
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\.20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



WSP	Mt Cooee Landfill Development Plan	4.0 Section A-A' 4.0.3 Seismic SLS (1/50yr) MBIE (Constrained)	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

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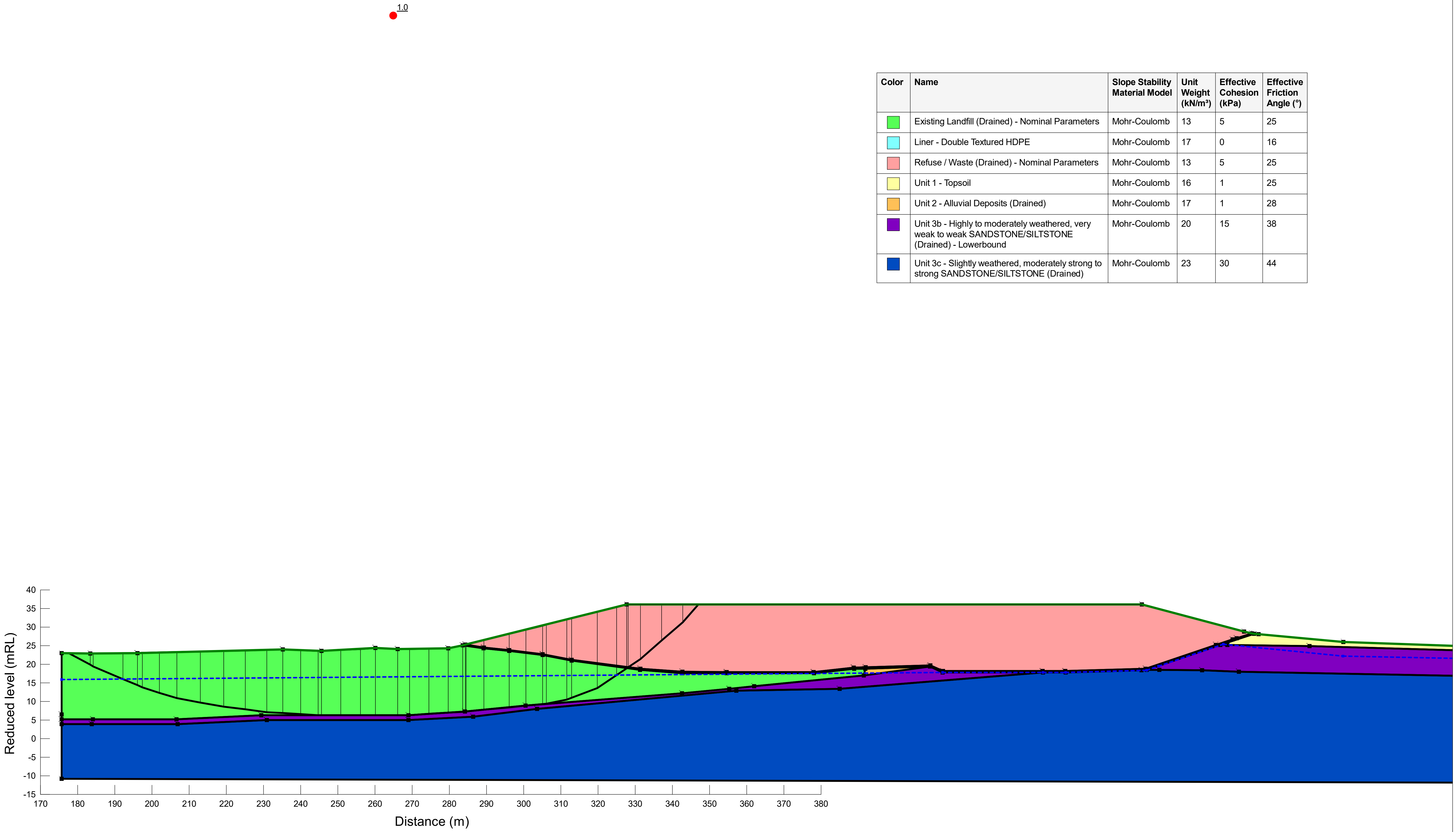
DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

4.0 Section A-A'
4.0.4 Seismic - ULS (1/1000yr) MBIE

6-CO082.00

Date: 10/05/2024

Scale: 1:1,000

By: B. HARRISON

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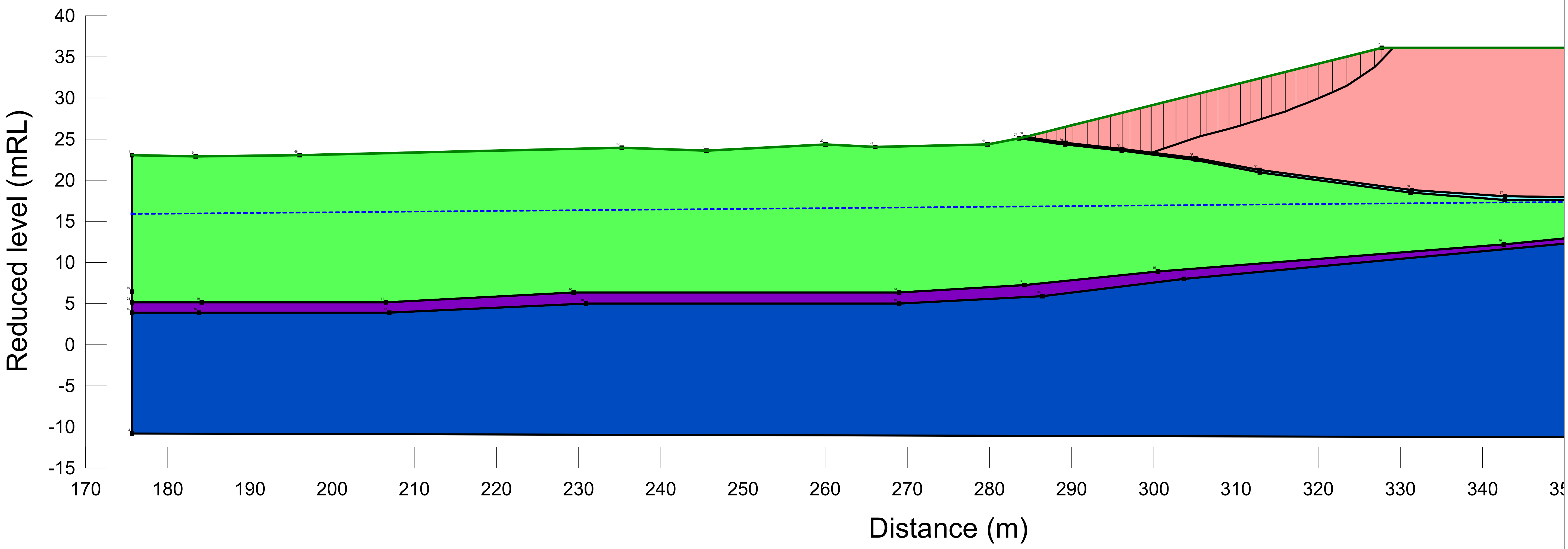
DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

4.0 Section A-A'

4.0.4 Seismic - ULS (1/1000yr) MBIE (Constrained)

6-CO082.00	Date: 10/05/2024
Scale: 1:500	By: B. HARRISON

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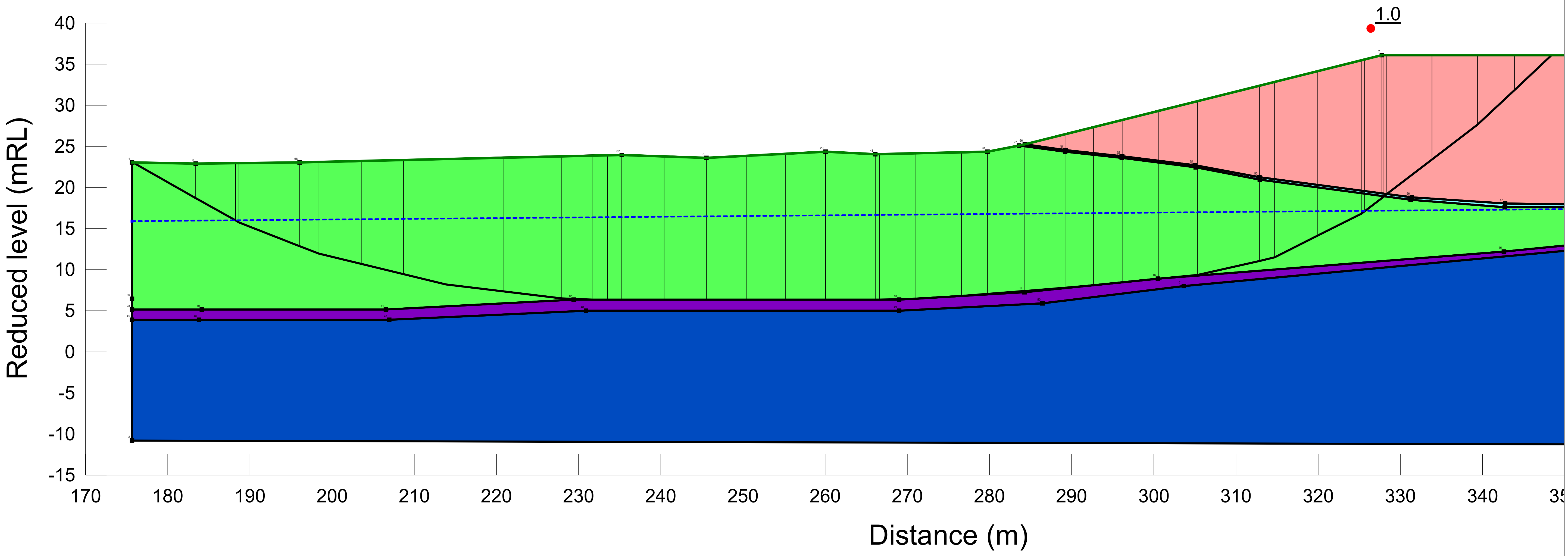
DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

4.0 Section A-A'
4.0.5 Seismic - Yield Acceleration

6-CO082.00

Date: 10/05/2024

Scale: 1:500

By: B. HARRISON

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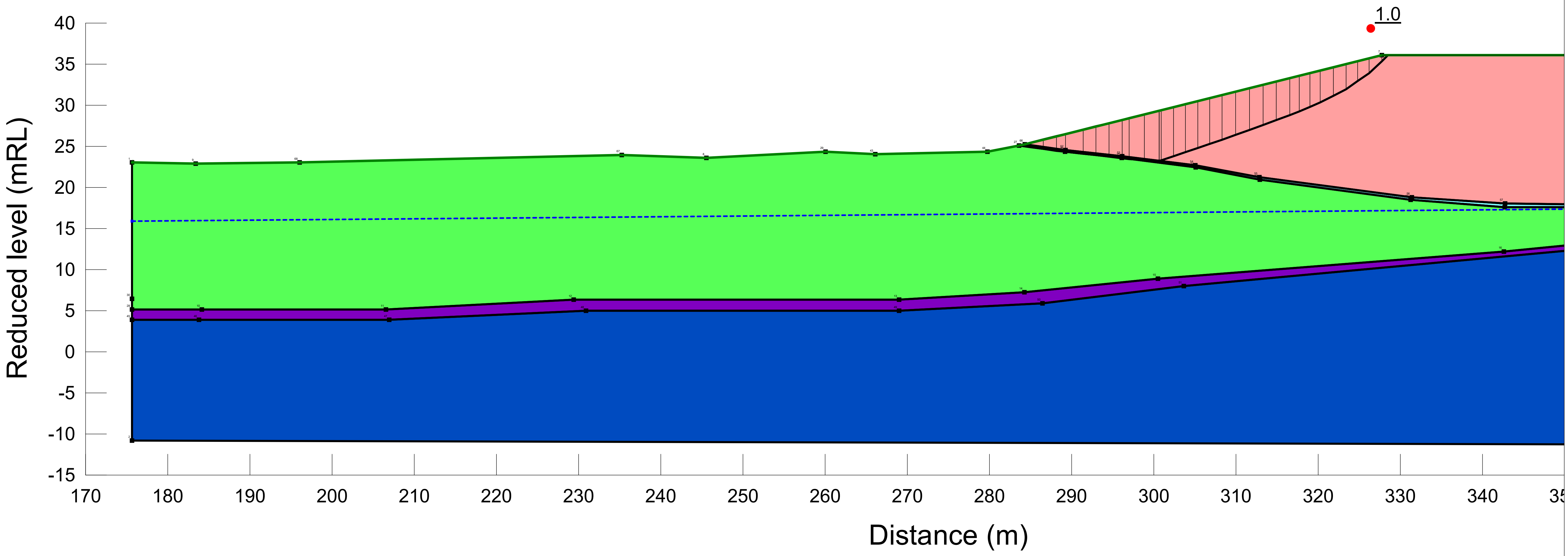
DO NOT SCALE

Horz Seismic Coef.: 0.24

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

4.0 Section A-A'
4.0.5 Seismic - Yield Acceleration (Constrained)

6-CO082.00

Date: 10/05/2024

Scale: 1:500

By: B. HARRISON

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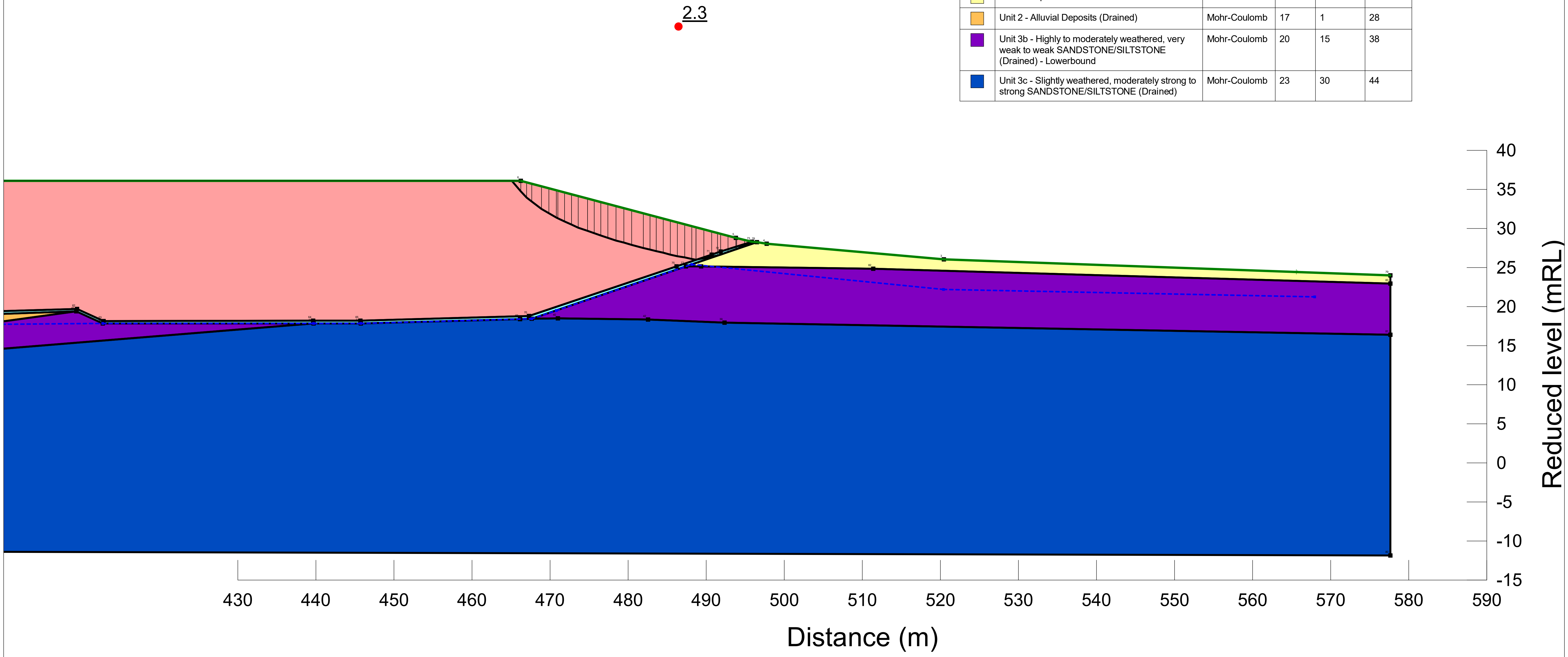
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

4.1 Section A-A'
4.1.1 Static - Long term

6-CO082.00

Date: 10/05/2024

Scale: 1:500

By: B. HARRISON

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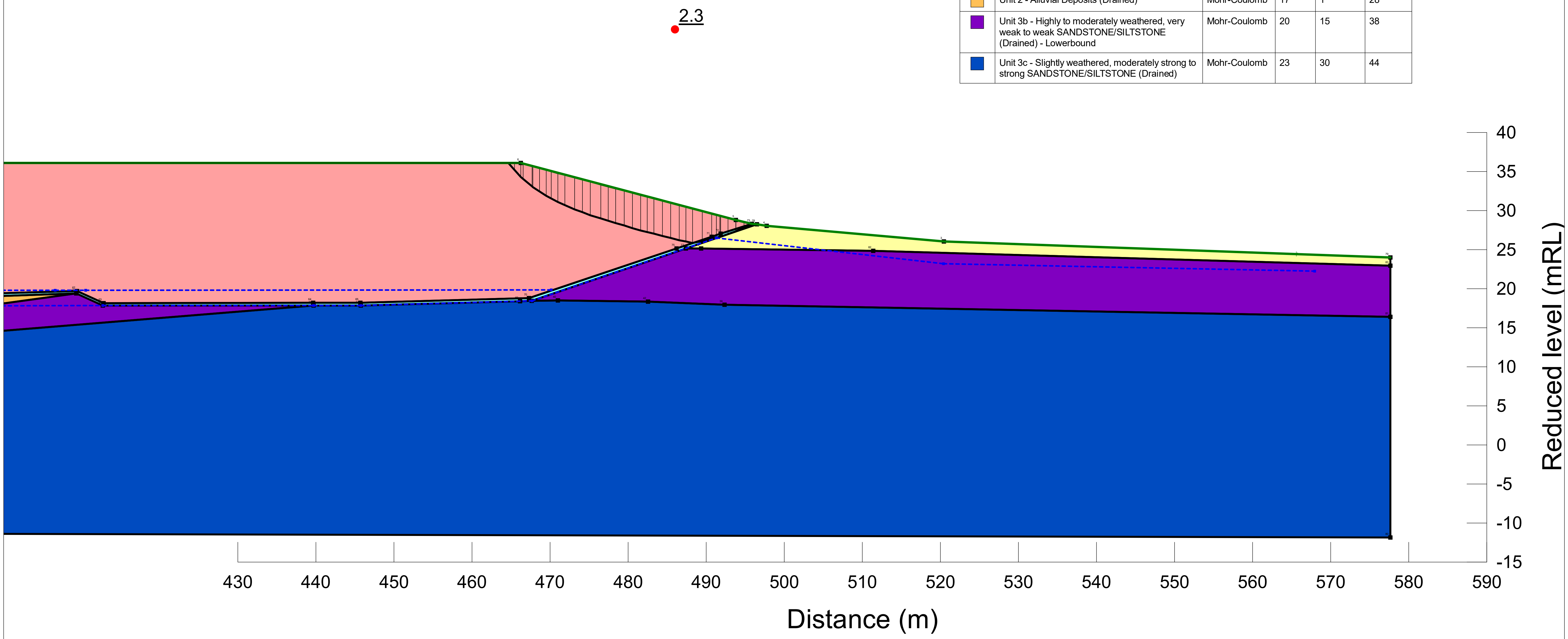
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
Green	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
Cyan	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
Pink	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
Light yellow	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
Orange	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
Purple	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
Blue	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	4.1 Section A-A' 4.1.2 Static - HGWL + Elevated Leachate	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

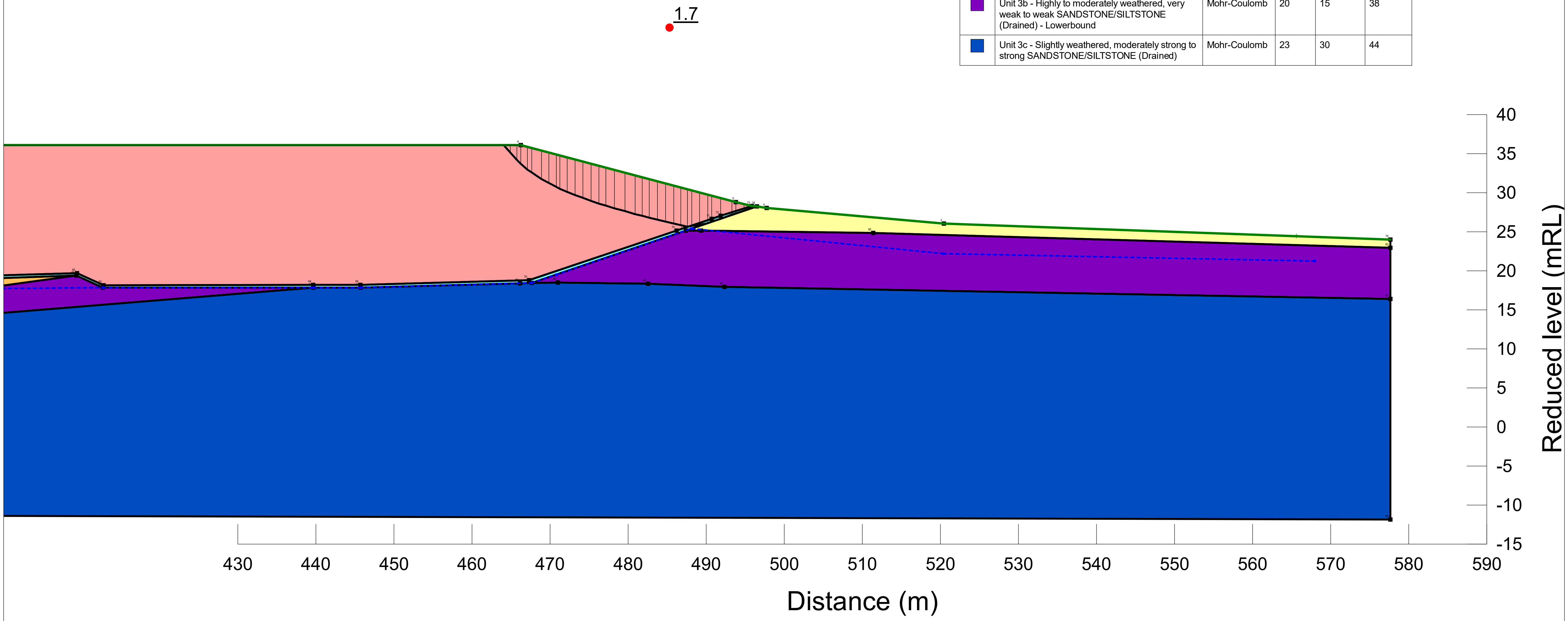
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\,20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.08

Method: Morgenstern-Price

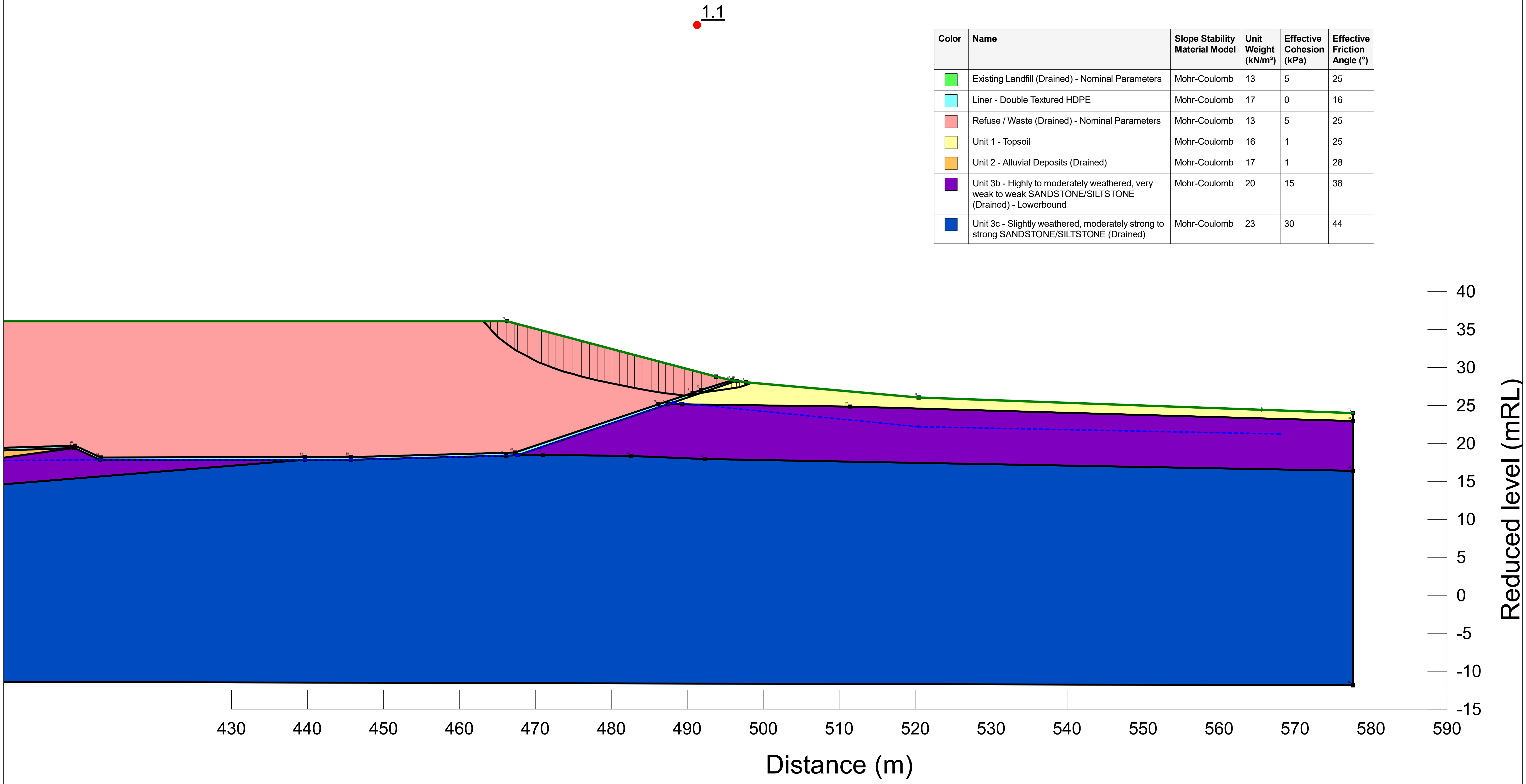
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



WSP	Mt Cooee Landfill Development Plan	4.1 Section A-A' 4.1.3 Seismic SLS (1/50yr) MBIE	6-CO082.00 / Scale: 1:500	Date: 10/05/2024 / By: B. HARRISON

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price



Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

WSP	Mt Cooee Landfill Development Plan	4.1 Section A-A' 4.1.4 Seismic - ULS (1/1000yr) MBIE	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

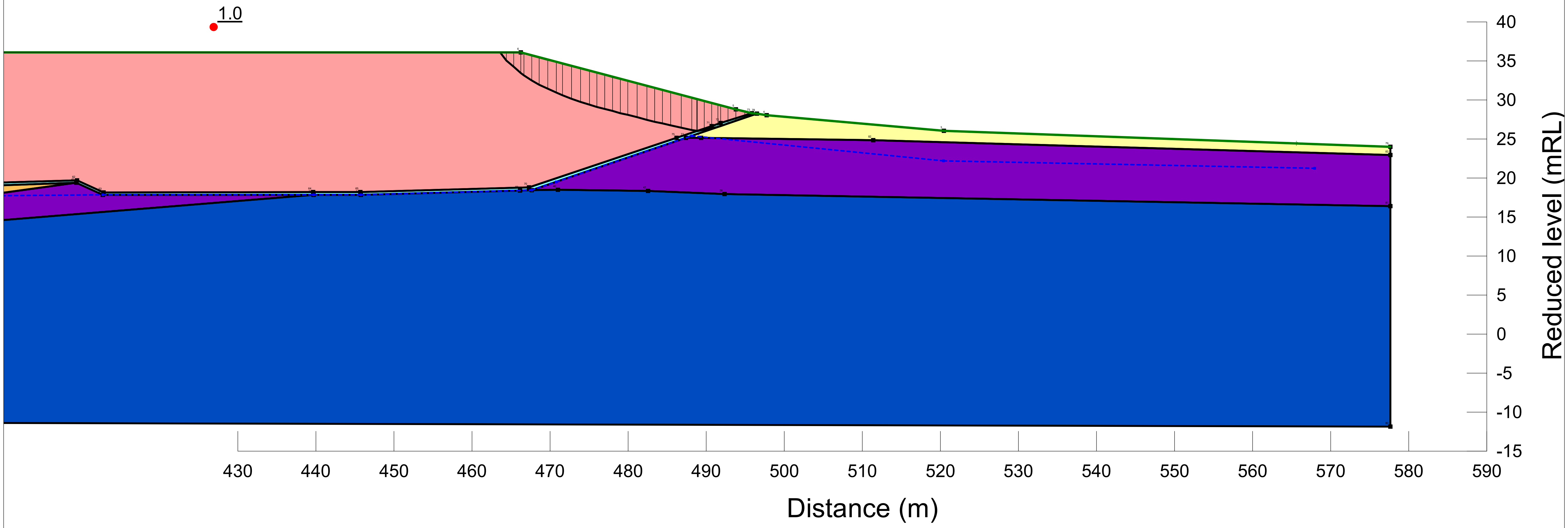
\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

DO NOT SCALE

Horz Seismic Coef.: 0.29

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained) - Lowerbound	Mohr-Coulomb	20	15	38
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	4.1 Section A-A' 4.1.5 Seismic - Yield Acceleration	6-CO082.00	Date: 10/05/2024
			Scale: 1:500	By: B. HARRISON

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DO NOT SCALE

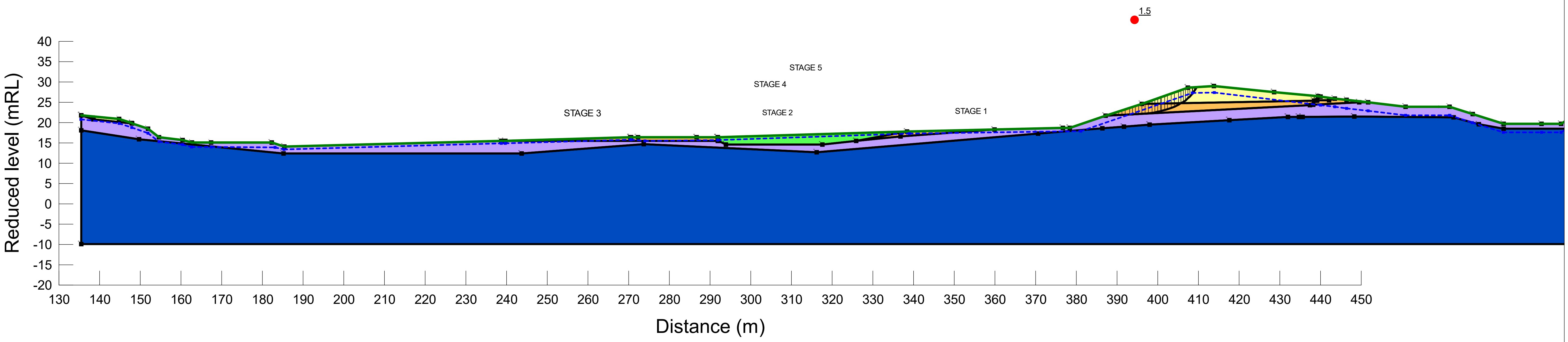
Appendix D

Temporary Stability

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

Stage 1 Excavation
Stage 1 (Excavation) Static

6-CO082.00

Date: 10/05/2024

Scale: 1:1,000

By: B. HARRISON

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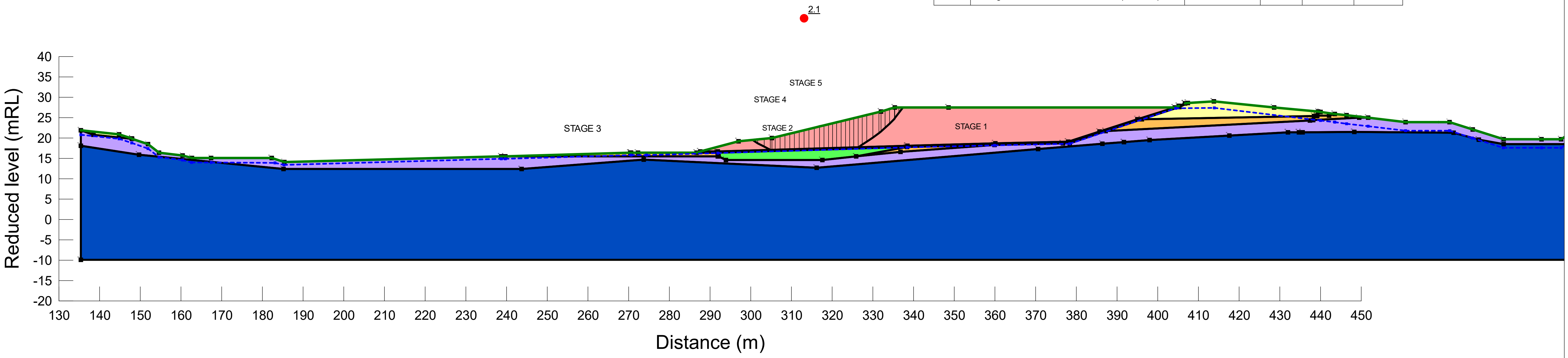
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



wsp	Mt Cooee Landfill Development Plan	Stage 1 Fill Section D-D' Stage 1 Static	6-CO082.00	Date: 10/05/2024
			Scale: 1:1,000	By: B. HARRISON

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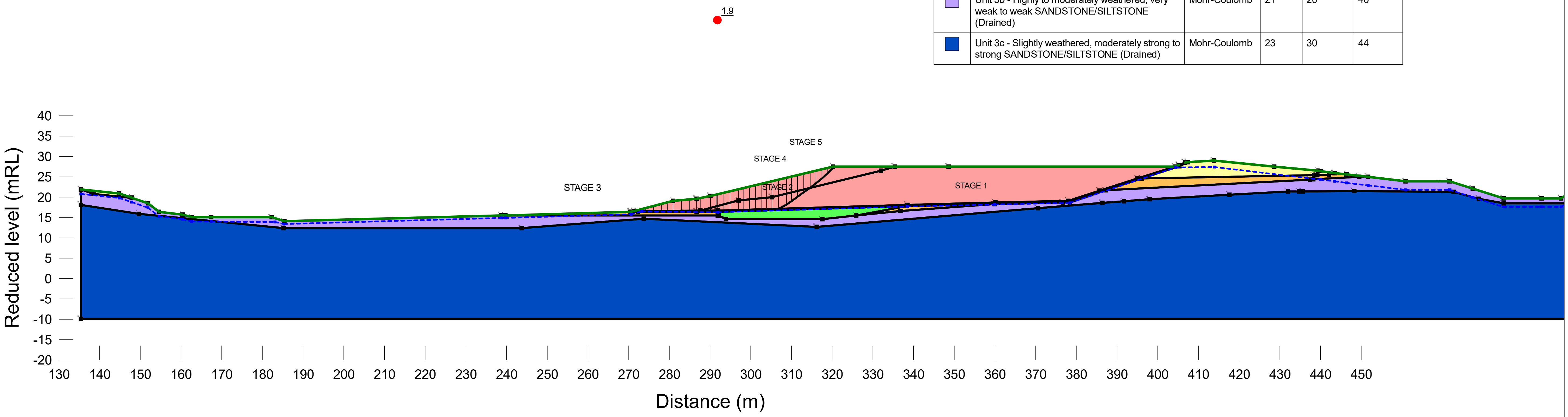
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan

Stage 2 Fill Section D-D'
Stage 2 Static

6-CO082.00

Date: 10/05/2024

Scale: 1:1,000

By: B. HARRISON

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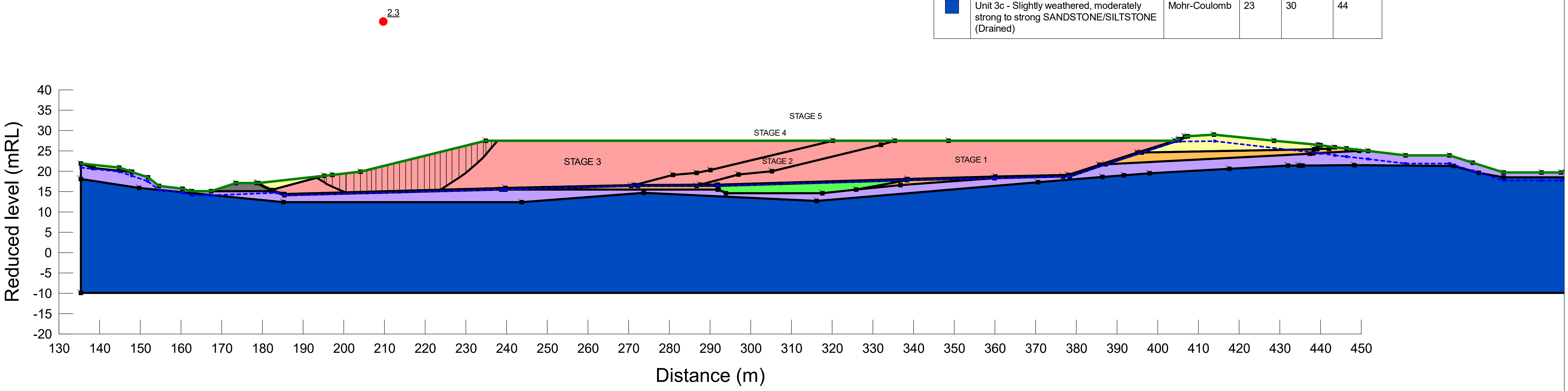
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44



Mt Cooee Landfill Development Plan	Stage 3 Section D-D' Stage 3 Static	6-CO082.00	Date: 10/05/2024
		Scale: 1:1,000	By: B. HARRISON

\\corp.pbwan.net\ANZ\ProjectsNZ\6c\6-CO082.00 Mt Cooee Landfill - Development Plan & R\Home\Stage 2 - Geotech Interpretation\10 Peer Review Analyses\01 Slope Stability\,20240510 Mount Cooee Landfill - WIP 2 - Copy.gsz, Harrison, Bryce, 10/05/2024,02:19:19 pm

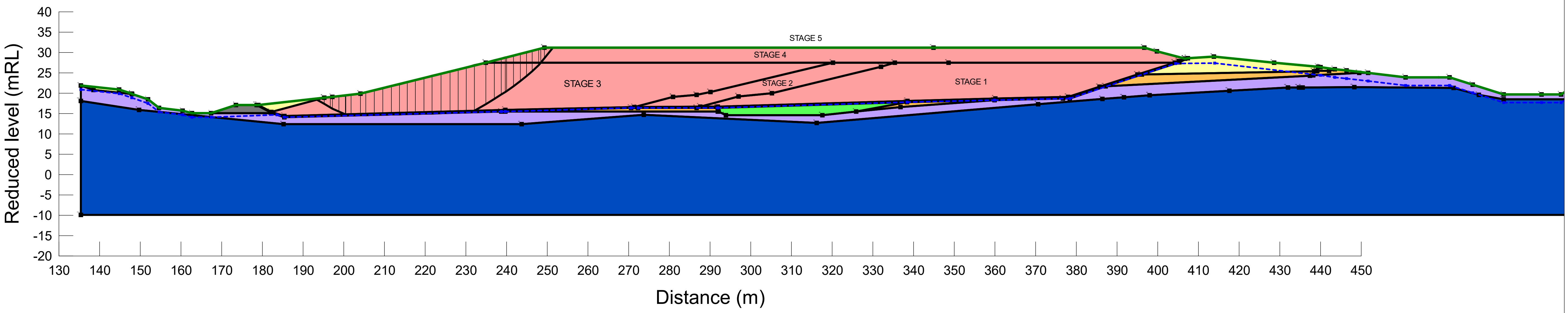
DO NOT SCALE

Horz Seismic Coef.:

Method: Morgenstern-Price

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Existing Landfill (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Liner - Double Textured HDPE	Mohr-Coulomb	17	0	16
	Refuse / Waste (Drained) - Nominal Parameters	Mohr-Coulomb	13	5	25
	Structural Fill	Mohr-Coulomb	19	0	36
	Unit 1 - Topsoil	Mohr-Coulomb	16	1	25
	Unit 2 - Alluvial Deposits (Drained)	Mohr-Coulomb	17	1	28
	Unit 3b - Highly to moderately weathered, very weak to weak SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	21	20	40
	Unit 3c - Slightly weathered, moderately strong to strong SANDSTONE/SILTSTONE (Drained)	Mohr-Coulomb	23	30	44

2.0



Mt Cooee Landfill Development Plan

Stage 4 Section D-D'
Stage 4 Static

6-CO082.00

Date: 10/05/2024

Scale: 1:1,000

By: B. HARRISON

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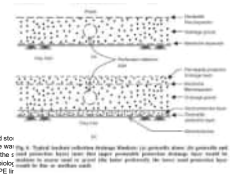
Appendix C Tracking spreadsheet

- **Digital version issued with the letter report**

Geotechnical Peer Review Comment Tracker

Project Name Mt Cooee Landfill
Project No. 6-CO082.00

No.	T&T	Date	WSP	Date	T&T	Date	WSP	Date	T&T	Date	WSP
29	The stability analysis in the Geotechnical Interpretative Report does not appear to consider the geomembrane liner interface shear strengths and translational failure mechanisms on the geosynthetic interfaces. This has the potential to reduce the stability FoS, increase the likelihood of movement of waste and may result in damage to the liner system, which will impact expected leak rates and thus discharge of leachate to groundwater. Please provide technical justification for not considering interface shear strength on the geomembrane interface, and clearly explain if a smooth, mono textured or double textured material is being specified for the lining system on the various liner type areas, as this will impact the waste pile stability and therefore leachate containment.	27/07/2023	Noted. Given the analysis was for the preliminary stage and the exact details of the liner had not been established, the liner was not included in the slope stability analyses. We have revised the analysis by including the liner as a region with lower strength parameters. Based on discussions with the landfill engineer, we have adopted the following lower bound parameters for double textured HDPE liner to be incorporated into the liner: •Friction angle range of 16 degrees to 18 degrees for a double textured HDPE liner. This parameter is mainly based on GRI Report #30 2005. •Unit weight of 17 kN/m3 The revised analysis for both Sections 1 and 2 based on the lower bound friction angle of 16 degrees for the liner indicate the factors of safety are still satisfactory under the static case and seismically induced displacements are small (estimated as 15mm maximum based on methodologies by Ambraseys &Srbulov (1994), Ambraseys & Menu (1988) and Jibson (2007), with possibly up to 30mm (i.e. 2 times) based on the yield acceleration ~0.17g). The analysis outputs are attached to this letter (document titled 'Updated Analyses Outputs – Response to #29'). The Geotechnical Interpretive Report (GIR) will be updated based on the revised analysis outputs and results. Based on discussions with the landfill engineer, we understand that double textured HDPE will be specified for the liner.	22/11/2023	The applicant has now included landfill liner components to the slope stability analysis. However, there is still remaining uncertainty regarding landfill stability, and related the calculated FOS. This primarily relates to issues like the selection critical slope sections, material parameter selection, consideration of the influence of groundwater and leachate levels, and analysis methodology. See recommendation Section 4 below.	22/12/2023	We have revised our global stability analysis so that the sections analysed reflect the crictical slope sections. As per discussion during meeting with T&T on 01/02/2024, we agreed that we would review an elevated leachate case in which the leachate level coinsided with the height of the bund along the western face of the landfill. We have now reviewed this case and with the level elevated an additional 2m above the bund to capture additional uncertainty in the leechate level and to demonstrate the insensitivity of this case. T&T noted that some of our material parameter slection was moderately conservative, particularly in regard to the refuse parameters. Our revised analyses have indicated satisfactory FoS/displacments so we have not revised the parameter selection. We consider the existing parameters appropriate for preliminary analysis given the uncertainty in landfill composition.	6/05/2024	Resolved, pending confirmation landfill design is consistent with that presented in the drawing set	10/06/2024	
30	It is also unclear in the Geotechnical Interpretative Report where the stability analysis section for the new landfill was taken. Please outline how critical sections were selected including consideration of temporary and final slope profiles during the various stages of landfill development.	27/07/2023	The indicative alignments of the cross sections are shown on the concept design drawings in Appendix B – refer Drawing C206 of the Consent Application / AEE. These have been further annotated in the attached document titled 'Response to Item #30'. The critical cross sections were selected in the 'east-west' and 'north-south' directions of the proposed landfill. We acknowledge the sections were not cut perpendicular to the contour lines. However, we manually modified the landfill batters to model the steepest angle of 1(V): 4(H). The level of the crest of the landfill was also manually adjusted to RL36m as the final level of the landfill. The analyses are therefore considered to be representative of the steepest sections of the batters. All temporary slopes are considered to be 1(V): 4(H) max and therefore expected to be stable.	22/11/2023	The analysis outputs presented does not to appear to align with response text, see markups of 'Response Item #30'. It is unclear how what and how the slope sections were manually modified, also how critical slope stability sections were select, taking into account both the basegrade, temporary and final landfill profiles.	22/12/2023	We have revised the global stability analysis so that the sections are now cut perpendicular to the critical slope. We have analysed the following sections: •Section A-A' in the 'east/west' direction, over the piggy-back landfill. •Section B-B' in the 'north/south' direction, over the piggy-back landfill •Section C-C' in the 'north/south' direction, within the landfill expansion area •Section D-D' in the 'east/west' direction, perpendicular to the drainage bund Due to the geometry of the landfill we have had to 'bend' the section lines so that they are perpendicular to the landfill batters.	6/05/2024	Resolved, pending confirmation landfill design is consistent with that presented in the drawing set	10/06/2024	
31	Please confirm whether or not any new direct fault ruptures have been identified during the site investigations.	27/07/2023	The site investigations did not identify evidence of any faults across the site.	22/11/2023			We consider this now closed	6/05/2024	Resolved	10/06/2024	
32	The in-situ soil and rock parameters adopted seem to be average values. Has consideration been given to the sensitivity if lower strength materials occur in unfavourable locations?	27/07/2023	For the purpose of preliminary analysis, we have adopted moderately conservative values for the in-situ soils and rocks. The slope stability analysis indicated the critical slips are contained within the refuse and the liner (refer question 29) as the parameters for the refuse are lower than the in-situ soils and rock. We have carried out a sensitivity analysis for Section 1 using the lower bound parameters for the in-situ soils and rock as specified in the GIR. Please refer to the analysis outputs attached (refer to the document titled 'Updated Analyses Outputs – Response to Question 32). The analysis indicates that the critical slips are still constrained to the landfill refuse / liner and therefore not sensitive to lower in-situ soil and rock parameters. The analysis for Section 2 (refer response Question 29) also considers lower bound parameters for the refuse. We have adopted the lower bound friction angle of 16 degrees for the double-textured HDPE in all the analyses.	22/11/2023	Acceptable response, although noting comments above regarding item 29.	22/12/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024	
33	Further justification is required for the Importance Level 2 (IL2) selection in the seismic stability analysis. Landfills are typically considered as IL3 facilities, as a minimum, due to containing hazardous materials (reference NZS1170 Table 3.2), and resultant changes to seismic loading parameters adopted in the stability analysis. Does the council consider the facility as a post disaster critical site?	27/07/2023	Noted. As you are aware, there are no specific standard currently in New Zealand to assess design earthquakes for a landfill. We had initially considered the landfill to be an IL2 facility but acknowledge that it can fall under the IL3 criteria. We have therefore revised the analysis based on IL3 seismic loads to assess the impacts on the analyses, mainly the slope stability and liquefaction assessments. The revised PGA under the DCLS/ULS case is calculated as 0.29g (in comparison with 0.23g for IL2). The findings based on the revised analysis indicate the following: •The seismically induced displacements at the landfill expansion location are still small (typically < 30mm) - refer to the Slope/W outputs in response to Question 29. •Liquefaction of an approximately 0.5m thick layer of alluvial deposits is anticipated at depths ranging between 4.0m and 4.5m bgl. The seismically induced displacements affecting the existing landfill are expected to range between 60mm and 330mm (and 150mm on average) based on the three adopted methodologies (refer to response to Question 36). Based on discussions with CDC, the facility is not considered to be a post disaster critical site as there are two other landfills in general vicinity of Balclutha. We will revise the GIR based on IL3.	22/11/2023	Acceptable response, although noting comments above regarding item 29.	22/12/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024	
34	The application of two different seismic loads for different soil classes on one relatively small site area requires additional justification. Has the sensitivity of the higher seismic load been considered?	27/07/2023	Bedrock was encountered at shallow depths across the majority of landfill, with the exception of the western section, where thicker alluvial deposits were encountered. Therefore, we have separated the site into Site Subsoil Class C for the western section and B for the remainder of the site. We have now assessed the seismically induced displacements based on the PGA of 0.29g associated with site subsoil class C (and IL3) and the results indicate the displacements are still small (<30mm). The liquefaction triggering assessments have also been based on the PGA of 0.29g for site subsoil class C.	22/11/2023			We consider this now closed	6/05/2024	Resolved	10/06/2024	
35	With the recent release of the National Seismic Hazard Model (NSHM) has the impact of this been considered due to the potential for this model to be incorporated into design standards within the design life of the landfill. Due to the critical performance requirements of a landfill has a Probabilistic Seismic Hazard Analysis (PSHA) been considered?	27/07/2023	We had not assessed the impact of the National Seismic Hazard Model (NSHM), given this guideline is in draft form and the preliminary stage of the project. There is an opportunity to incorporate this as part of the detailed design stage, if agreed with CDC. Given the relatively small seismic loads, we do not consider the higher PGA (estimated as 0.35g based on the NSHM) would make a material difference in the findings from the geotechnical assessments. A Probabilistic Seismic Hazard Analysis (PSHA) has been outside the scope of the project at this preliminary stage. Given the relatively low seismicity of the region, we do not consider that a PSHA is warranted.	22/11/2023	Given the design life of a landfill and likelihood of the NSHM being adopted in some form during the landfills operational consented life, along with the uncertainty associated with seismic loading parameter we believe some form of consideration of seismic loading sensitivity would be recommended as part of the slope stability assessment. Also noting item 29 above and concerns regarding the existing slope stability analysis that when updated could highlight the criticality of seismic loading parameters.	22/12/2023	NSHM PGAs have been assessed for the landfill location assuming a Vs_30 of 150m/s for the landfill development area. The increase in PGA sourced from the current MBIE guidelines compared to the NSHM translates to approximately a 25% increase for both SLS and DCLS/ULS events in terms of PGA and corresponds to about a 100% increase in ULS displacements. These displacements are still tolerable despite the increase.	6/05/2024	Resolved	10/06/2024	
36	Is there any impact to the liquefaction assessment from the seismic load condition changing? Liquefaction assessment appears to be related to BH01 with only one plasticity test result used as justification for determining material as non-liquefiable. How does this relate to the landfill site as it appears to be founded on a different geological profile?	27/07/2023	We appreciate the preliminary liquefaction analyses are based on limited investigation data (mainly BH1) and laboratory testing at this stage. We have assessed the liquefaction susceptibility of soils based on the borehole log descriptions and laboratory testing results – refer to the attached document titled 'Annotated BH1 Log'. We have revised the liquefaction analysis based on an increased PGA of 0.29 g (refer to revised analysis outputs). Please note the outputs presented in the current GIR had the incorrect SPT depth intervals and these will be revised in the final issue of the GIR. The findings from the revised liquefaction analysis are as follows: •Liquefaction of an approximately 0.5m thick layer of alluvial deposits is anticipated at depths ranging between 4.0m and 4.5m bgl. •Seismically-induced displacements are estimated to range between 60mm and 330mm (and 150mm on average) based on the three adopted methodologies and the yield acceleration of 0.05g. We consider these displacements to be moderately conservative as they do not consider any pinning effect from the existing sheet pile wall and therefore the actual displacements on site are expected to be smaller. These displacements are not expected to result in releasing landfill contaminants, but may cause some cracking of the capping soils that may need to be re-profiled/topped up. We consider the estimated settlements to be moderately conservative due to the following reasons: •The alluvial deposits are likely to be highly variable and interbedded and therefore liquefiable layers are unlikely to be laterally or vertically continuous across the site. We have currently allowed for a continuous layer in the models., which is likely to be conservative. •Any pinning effect from the sheet pile cut off wall has been ignored in the stability analyses. The relevant sections of the GIR (namely liquefaction and slope stability) will be updated to reflect the above changes.	22/11/2023			We consider this now closed	6/05/2024	Resolved	10/06/2024	
37	There appears to be sufficient detail on the new site access/resource recovery centre in the design drawings. The conceptual design detail on the landfill liner and drainage system however are absent from the drawings. Please provide information on the subsoil drainage system, landfill liner, leachate drainage system and capping details, and present these in the application drawings so that the landfill design concepts, that would be required to assess the proposed liner performance, can be evaluated and potentially be included in the consent conditions. These concept details would typically include: a.Liner typical details for landfill base, side slope and piggy back over existing landfill. b.Liner connection detail between liner types and landfill stages. c.Preparation of rock surface to receive the liner components. d.Subsoil drainage concepts and general layout, if required. e.Leachate collection system layout plan. f.Any typical liner penetrations such as leachate outlet if gravity draining. g.Design measures to manage the risk of translational failures on the geomembrane interface, for both intermediate and final waste footprint. h.Landfill final capping typical details, including capping layers, stormwater drainage on waste. i.Overall stormwater drainage around the new lined extension, and connection into the existing system, around eastern and southern portion of the new extension.	27/07/2023	Please refer to the attached design plans (Sheet Numbers C209 – C212) which show the concept details requested.	22/11/2023			We consider this now closed	6/05/2024	Some details, key to long term landfill performance, are sill absent from the drawings, these include -Piggy back liner section detail -Subsoil drainage details/plan. Groundwater assessment letter dates 27 February 2024 stated that "The floor will be graded to a central low point under the centre leachate drain. A groundwater drain will be constructed into the subgrade rock at this point running under the landfill and exiting out at the western / downhill end past the toe bund. This will serve two functions by: a) providing a preferential flow path for any leakage trapped between the clay liner and the subgrade rock; and b) intercepting any flow from the north-eastern corner of the landfill that tracks along the surface of the subgrade rock. Any discharge from this drain would be to surface water into the wetland area, unless water quality monitoring dictates otherwise, in which case it would be directed to the leachate system. " -Overall stormwater management plan for extension -Leachate drainage blanket extents, specifically related to the floor details and toe bund slope to minimise risk of leachate breakouts -Confirm liner transition for the piggy back liner section and subgrade preparation requirements -Details showing connection/leachate outlet arrangements, currently shows a cap end flange with no outlet?	10/06/2024	
38	Fill over an existing section of landfill with a new lined landfill will likely result in differential settlement which will likely place the composite liner in the piggy back area under both tensile and compressive strains. How are tensile strains being limited on the GCL/HDPE composite liner in the piggyback slope sections of the landfill? This could impact the liner containment and potential for leachate discharge from the new landfill development.	27/07/2023	There are a number of aspects to this question. Yes, differential settlement could occur on the batters of old refuse leading to localised "scallops" or depressions in the formation. We acknowledge that organic material (of which there is likely to be plenty) can experience considerable secondary consolidation, which can cause settlements that exceed that due to primary consolidation. The new liner would then potentially have to bridge these areas. Our comments in this regard are: (a)The consequences of liner damage on the old batters are low. Any leakage through that liner is into existing refuse and becomes part of the existing leachate collection system contained by the sheet pile wall. The consequences of leakage through the "piggy back" liner sections are much less than for leakage through the new landfill floor. Equally, leachate from the old cells could flow the other way through any defect and into the new cell and be captured by the new cell leachate collection system. In fact, if seeps from the old refuse were identified during construction that would be tapped and brought into the new cell. (b)We considered whether it was even necessary to line the existing refuse batters. However, we opted for a conservative approach to lessen the leachate flowing through the existing fill. (c)There are two distinct zones of the side batters. Adjacent Stage 3 (Section 06 Sheet C212), the refuse fill is relatively old (5-10 years). It has intermediate capping in place. A degree of settlement will already have taken place. (d)Adjacent Stage 1 the batter is more irregular and waste is still to be placed (Section 05 Sheet C212). Filling in this area will be managed to ensure a uniform consistency of waste without pockets of segregated organic wastes. (e)Prior to placing liner, these batters will be trimmed to shape, intermediate cover placed (if not already done) and then track rolled with heavy plant. Any soft spots which are identified by the track rolling would be backfilled with additional soil. (f)If there are any soft spots identified during proof rolling, then we can determine sizing of a geosynthetic reinforcement that is appropriate for the given site conditions. If there are soft spots identified, then we would be looking to extend reinforcement elements well beyond the localised area. The extent and size of reinforcement would be determined in detailed design. (g)With the above treatment, the strains imposed on the liner due to settlement are expected to be within the tolerance of the liner. (h)We have had a high level look at the empirical methods provided within the Asadi et al. paper (email of 4th October from Tonkin & Taylor's Jonathan Shamrock). The calculation methodology relies upon a number of assumptions and inputs that we cannot accurately quantify at this stage, particularly the diameter of the soft spots. Therefore, it is speculative to design for them at this stage.	22/11/2023	Given the surcharge loading that will be applied by the new waste to be placed in the extension, and the uncertainty of the differential settlement that would occur under this load in the old waste, potential differential settlement areas will not likely be visible from just conducting surface works and addressing surface soft spots. This potential will be driven by the waste at depth in the old landfill which will not be evident/exposed on surface. Consideration should be given at the consent stage for the inclusion of a geogrid layer below the full extension piggyback liner in the drawing details to control potential tensile strains in the liner system.	22/12/2023			A geogrid layer, below the liner system, is considered necessary in the piggyback section, unless a substantial thickness of subliner fill, > 2m, is used to transition the expected differential settlements in this area of liner.	10/06/2024	
39	Landfill gas (LFG) will be generated by the old waste under the piggyback liner sections. How will this be captured and where will this drain/be emitted to? Similarly, how will LFG pressures below the liner system, and related tensile strains in the geosynthetics, be managed until waste is in place?	27/07/2023	Please refer to the Staging plans. Fill is initially taken to the top of the existing landfill platform for Stages 1, 2 and 3. A specific assessment of gas flows from the existing batters will be made at the time of final design for these stages. At this stage, we envisage the following construction procedure: •Strip off existing vegetation from batter. •Track roll and fill any irregularities in the batter surface with intermediate cover soil as necessary to leave a smooth surface. •Place gas drainage strip on a 5 m grid. •Place GCL. •Place HDPE. Until the Stage 4 overlay is built, the gas drainage can vent to atmosphere at the top of the slope. As the waste comes up, the surcharge load will confine any gas pressure. Once Stage 4 is built, the liner and drainage metal will confine the waste and act in the same manner as a GCL layer in a landfill cap. Note that Stage 4 is a long time in the future and that gas flows will have largely diminished by that stage.	22/11/2023			We consider this now closed	6/05/2024	Resolved	10/06/2024	
40	Has the impact of PFAS in leachate, and future acceptance of leachate for disposal at the WWTP been investigated? Is there a limit as to how much leachate can be discharged into this system? Is there a requirement for continued on site attenuation storage capacity, and if so, will the existing 770 m3 pond be lined? This is highlighted as the site will continue to generate leachate, even if the leachate can't be disposed of to sewer, and if that happens it could spill into the environment if there is no attenuation storage/treatment capacity on site. The existing pond is located downstream of the cut-off wall, so any leachate stored in it will seep to groundwater as the pond is currently only clay lined.	27/07/2023	The existing pond is in the process of being lined with an impermeable geomembrane.	22/11/2023			We consider this now closed	6/05/2024	Resolved	10/06/2024	
41	Are the any monitoring results for PFAS/PFOA compounds in the existing leachate?	27/07/2023	The existing leachate has not been monitored for PFAS. We expect that PFAS will be present in the leachate given its ubiquitous presence in municipal refuse. PFAS / PFOA in New Zealand fall under the umbrella of the National Environmental Plan for PFAS (NEMP). This is a joint Australia / New Zealand document. Version 2 has been adopted by MfE. Version 3 contains more specific provisions for the wastewater industry. Version 3 is currently in draft format and is undergoing a review and adoption process. At such time as Version 3 is adopted on a national basis, we expect that the wastewater consent and leachate discharge from Mt Cooee will be reviewed for consistency with Version 3. We agree that PFAS in the leachate may prove at some future point to be a constraint on disposal to the Balclutha WWTP. But this would also be the case in every other WWTP in New Zealand and where else the leachate would go would become the question. At that point, the options for the site will need to be assessed. These could include closure of the site or a specific PFAS treatment step for the leachate. In the meantime, it is proposed that CDC take a proactive stance and monitor for PFAS in the leachate on a six-monthly basis. ORC will need to provide guidance on testing. NEMP Version 3 Section 15.4.1 (Lines 3163-3168) does flag some issues around testing methodologies. "Details of biosolids sampling requirements to ensure characterisation is representative should be determined by each jurisdiction" (Line 3153).	22/11/2023			We consider this now closed	6/05/2024	Resolved	10/06/2024	
42	Please provide a plot of the estimated groundwater level superimposed on the base of liner level (top of liner less liner thickness). This is required to demonstrate separation of groundwater to the base of liner, and the need or not for a subsoil drainage system in the new lined extension. Elevated groundwater could impact liner construction and potentially damage the liner system if the groundwater level is above base of the liner.	27/07/2023	This response will be addressed as part of the wider Groundwater Report updates which are currently being undertaken and will be provided to the ORC as soon as possible.	22/11/2023			We consider this now closed	6/05/2024	No plot of expected GW levels vs base of cell levels has been provided, and no details for layout and details of the subsoil drainage system has been provided (see above regarding need for subsoil in the groundwater assessment response). If there is any uncertainty about the groundwater level relative to the liner then design measures to prevent build up of groundwater below the liner should be shown, both to assist with liner construction, and long term to manage any risk of a build up of groundwater pressure below the liner and stress on the liner.	10/06/2024	
43	The groundwater report uses an assumed maximum leachate leakage rate of 0.1 mm/year. This equates to an estimated leak rate of 2.7 l/ha/day, with the site being 3.23 ha, a total leak rate of 8.8 l/day. In terms of expected leak rate, this does not appear to take account of the impact of liner wrinkles and measured leak rates from operational facilities described in the research literature. Please provide technical justification for this. Additionally, what construction quality assurance and control is proposed for the landfill liner material and installation, as this can have a significant impact on the expected leak rates?	27/07/2023	This response will be addressed as part of the wider Groundwater Report updates which are currently being undertaken and will be provided to the ORC as soon as possible	22/11/2023			We consider this now closed	6/05/2024	As noted above, the subsoil drain, which would intercept any leachate through the liner, needs to be shown on the design plan and details.	10/06/2024	
44	Please provide justification for not including a separation geotextile layer over the leachate drainage stone. Not including this will result in physical clogging of the leachate drainage aggregate by fines from the waste disposed of over the drainage stone and thus blockage of the drainage layer, leading to a leachate phreatic head build up in the landfill, which will impact waste pile stability and liner leak rate.	27/07/2023	The definitive assertion above that "..will result…" is arguable. Providing a separation geotextile over the drainage aggregate is not a universal practice in New Zealand. It is not done at Broadlands Road (Taupo), Puwera (Whangarei), Bonny Glen or Hampton Downs landfills, as examples. Leachate drainage systems at these large sites continue to function well after 20-25 years. The counter argument to including the geotextile is that it adds another layer with fine pore size that can potentially clog due to biological or chemical processes and therefore impede drainage in the fill. More important is the type of waste placed initially against the drainage layer. This should be kerbside or bagged refuse.	22/11/2023	It is NZ standard practice for a 300mm leachate drainage layer to be included in the design of a Class 1 waste facility and to maintain operations such that the leachate phreatic head does not exceed 300mm. The main purpose of this design is to reduce the phreatic head (driving force) on the underlying HDPE liner in order to minimise leakage of the liner system. The inclusion of a separation geotextiles, placed between the leachate drainage aggregate and overlying waste, increases the ability of the landfill to maintain these operational conditions over time and has been proven by international research. Although not a universal practice in NZ we believe the inclusion of a separation geotextile layer in a landfill leachate drainage system represents standard landfill design practice based on current research understanding. We are aware that the inclusion of the separation geotextile layer over the leachate collection layer in landfills is required in, as examples, Australia, in both the BEPM guidelines in Victoria and the NSW guidelines, and in the South Africa landfill design regulations. The inclusion in these requirements is largely due to the research conducted by Kerry Rowe at Queens university in Canada in 2005, using mesocosm studies to evaluate the performance of leachate collection systems over time and the beneficial long-term performance including a separation geotextile with resultant reduced leakage potential. As stated in Rowe, R.K., (2005) – Geotechnique 55, No. 9, 631-678, Long term performance of contaminant barrier system, "Thus, while recognising that geotextiles will clog, theoretical considerations, mesocosm studies and field observations all indicate that an appropriately selected geotextile used to protect gravel in a blanket drain will improve performance and the service life of the drainage gravel and not cause excessive perched leachate mounding."  An unprotected sto… …n into the layer as the net flux of flow is from the wa… …s will build up in the voidsbetween the s… …which will be accelerated by chemical and biolog… …us phreatic pressure on the underlying HDPE li… A geotextile layer forms a filter, and thus reduces the physical clogging of the stone layer over time. Although chemical and biological clogging of the geotextile will occur over time, this is unlikely to ever become a totally impermeable layer. If a phreatic head does build up on this geotextile layer it will do so up to a point that flow will be able to get through the geotextile, where it will encounter an relatively unclogged underlying stone drainage layer and thus not cause a built up of phreatic head on the landfill liner (the main containment barrier), and in turn result in the reduced leakage potential/rate from the facility. It is for these reasons that we believe it is good practice to include a geotextile separation layer as part of the proposed landfill concept design leachate collection system. If required we would be happy to provide example sites in NZ where this separation geotextile has been included, including historic and recently consented facilities.	22/12/2023	Section B.2 Leachate Management of the WasteMINZ Disposal to Land Guidelines Rev3.1 (2023) provides guidance on the installation of leachate blankets, including the addition of a Geotextile (if necessary). While we agree with the commentary regarding the value of a separation Geotextile, it is not appropriate to require this additional control universally, especially considering the current NZ design guidance and given the geofabric can become clogged. The Guidelines provide a general design approach which is to ensure 'design leachate head does not exceed 300mm, with appropriate allowance for long-term performance of the leachate blanket', this section goes on to state: 'The design of the drainage blanket needs to take into account the required hydraulic conductivity, the overburden load from the waste and the protection required for the underlying geomembrane, if provided. The media should be free of fine material and comprise of a non-calcareous stone (less than 10% CaCO3)'. When describing the liner configuration, the use of a separation geotextile is only referred to "if required' (e.g. due to filter incompatibility with the landfill materials), as shown in Figure 5-2 liner types:  	6/05/2024	As per the quoted research into the aspect of leachate drainage system design, and inclusion of a separation/filtration layer in worldwide landfill design standards/regulations , the lack of a separation geotextile over the leachate collection blanket drain is seen as a risk to the long term capacity of the layer to drain leachate generated in the landfill.	10/06/2024	

45	What basis will be used to specify the protection geotextile, as the report only states that this will be "specified accordingly" What basis will be used to determine the geomembrane strains from the leachate drainage stone at the expected waste pressures? What cut-off maximum strain for the HDPE geomembrane will be deemed allowable?	27/07/2023	We have not yet confirmed the source and specification (size and angularity) for the drainage metal. If a rounded aggregate in the general 20-40mm range is available, we would use the standard calculation methodology as described by Koerner in Section 5.6.7 of Designing with Geosynthetics (2012), applying a factor of safety of 3.0. If the aggregate is a more angular material, then we would use physical testing. We typically use the ASTM D5514 test method (Standard Test Method for Large-Scale Hydrostatic Puncture Testing of Geosynthetics). TRI Australasia (Gold Coast, Australia) commercially provide this testing using the "Pizza method" where the proposed aggregate stones (use the actual site delivered aggregate) are set into a resin and the strains are measured off a thin metal disk by laser scanning of the disk to allow calculations of the strains. Geofabrics Australia can also do the testing at their laboratory. Acceptance criteria are based on the type of geomembrane and for PE type, we consider the limits proposed by Peggs 2003 and apply factors (we have used 2.0) as per Brachman 2018 (J Geotech and Geoenviron 144(6)). The Peggs 2003 strain values are adopted by the NSW and Victoria EPA landfill guidelines (and likely others in Australia). Strain values are given in the table below. 	22/11/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024
46	It is not clear if LFG monitoring is being undertaken around the perimeter of the existing landfill, and if new monitoring wells are being considered for the new expansion? Are additional perimeter landfill gas migration monitoring points being considered to monitor the impact of the existing, unlined, landfill and to address the risk of lateral gas migration from this when it is capped or when sections of the old site is covered by the piggyback liner of the new landfill? Please explain your answer.	27/07/2023	As part of the Gas management plan, a monitoring regime will be established. The main risks for migration we see are in the new transfer station area and against the landfill boundary against the property to the east. Provisionally, we propose two bores on the eastern boundary and 1-2 in the transfer station area. The surrounding ground to the new landfill cells is in situ greywacke with a generally low permeability. Therefore, we assess the risk from gas migration offsite to be low.	22/11/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024
47	Have the subsoil pipes below the existing landfill been incorporated into the existing pumped leachate manhole? Are these being monitored for quality and flow?	27/07/2023	Yes, they drain to the leachate system. The subsoil pipes are not accessible and are not monitored. The overall leachate flow is monitored for quality and quantity. Note that the pump station flow includes both the original subsoil pipes and the diverted old stormwater line (now in effect a leachate pipe).	22/11/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024
48	As the leachate pump manhole is located in the area identified for possible inundation/flooding in large storm events is consideration being given to raising and sealing this manhole so that it is higher than the expected inundation level? Will the power supply/pump control panel also be raised? Is there a contingency plan in place to have a standby generator/power supply in order to allow the pump to work if there is a protracted period of power failure?	27/07/2023	The leachate pump station is in the process of being reconstructed. The top of the chamber and the control panel will be above 1% AEP flood level.	22/11/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024
49	What is the long-term planning for ongoing leachate management during the post closure phase of the existing, and new facility. As leachate will gravity drain to the pump manhole from the new extension, is the intension to maintain this as an active pumped system after closure until deemed acceptable to stop operation or in perpetuity?	27/07/2023	Leachate will be pumped to the Balclutha WWTP until such time as testing determines it to be benign for direct discharge to the river. This will be many years into the future. This situation is no different to most other landfills in New Zealand.	22/11/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024
50	The selection of a design life of 50 years needs further justification. The landfill will need to perform acceptable containment for a period significantly longer than 50 years, and this will have resultant changes to the seismic loading parameters adopted in the stability analysis.	27/07/2023	Apologies for an incorrect statement. The design life of all the landfill liner and drainage components will be 100 years plus. The materials used will be to normal landfill specifications as used on other landfills in New Zealand.	22/11/2023	We consider this now closed	6/05/2024	Resolved	10/06/2024