

APPENDIX D

Risk Register

	CLIENT:	FULTON HOGAN LAND DEVELOPMENT LTD	DESIGNER:	CR
	PROJECT:	MILLDALE STAGES 14-17 - RESERVOIR	CHECKED:	SG
	TITLE:	GEOTECHNICAL RISK REGISTER	JOB NO:	AK26-027
			DATE:	6/07/2026
			ISSUED FOR:	GIR

Item	Geotechnical Hazard	Description	Relevant Standards*/Guidance Documents	Area Assessed	Assessment Outcome	Existing Risk of Damage to Land / Structures			Mitigation Measure	Residual Risk of Damage to Land / Structures		
						Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
1	Earthquake	Seismicity	New Zealand Dam Safety Guidelines – Module 3: Investigation, Design and Analysis NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in New Zealand, Module 1: Overview of the Guidelines	Entire Site	Site subsoil class = Class C due to depth of soils OBE PGA = 0.06g, SEE PGA = 0.15g			0				
		Fault Rupture	GNS Science, New Zealand Active Faults Database, retrieved from https://data.gns.cri.nz/af/	Entire Site	Nearest active fault = Wairoa North Fault, approximately 60km from the site. Recurrence interval of 13,000 years.	2	4	8	Not required	2	4	8
		Liquefaction	MfE and MBIE (2017), Planning and engineering guidance for potentially liquefaction-prone land NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 1: Overview of the Guidelines New Zealand Dam Safety Guidelines – Module 3: Investigation, Design and Analysis NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 3: Identification, assessment and mitigation of liquefaction hazards MBIE (2012) Repairing and rebuilding houses affected by the Canterbury earthquakes, Part A: Technical Guidance Robertson, P. K. (2015) Comparing CPT and Vs Liquefaction Triggering Methods, J. Geotech. Geoenviron. Eng. Bray, J. D. & Macedo, J. (2017) Simplified procedure for estimating liquefaction-induced building settlement Auckland Council Geomaps	Entire Site	Maps show the site is within a very low to unlikely hazard zone for liquefaction vulnerability. Intrusive investigations including laboratory testing suggests the underlying soils are generally cohesive and therefore at low risk of liquefaction. Specific analysis using CLIQ software suggests low liquefaction risk and associated settlements are expected to be low (maximum 10mm). Refer to Section 8.2 of the report.	2	4	8	Mitigation not required.	2	4	8
		Lateral Spread	NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 3: Identification, assessment and mitigation of liquefaction hazards MBIE (2012) Repairing and rebuilding houses affected by the Canterbury earthquakes, Part A: Technical Guidance	Entire Site	No lateral spread anticipated as no liquefaction expected.	1	4	4	Mitigation not required.	1	4	4
		Cyclic Softening	NZGS and MBIE (2021) Earthquake Geotechnical Engineering Practice in NZ, Module 3: Identification, assessment and mitigation of liquefaction hazards	Entire Site	Cyclic shear strength of 80% of peak shear strength for stiff alluvium.	2	3	6	Mitigation not required.	2	3	6
2	Slope Instability / Landslide	Global Instability	New Zealand Dam Safety Guidelines – Module 3: Investigation, Design and Analysis	Entire site	Slope stability analysis results show that proposed landforms do not achieve target factors of safety. Refer Section 8.4 for calculation package and detailed results.	4	4	16	Mitigation in the form of shear keys and over excavation of rock mass and replacement of engineered clay cap recommended.	1	4	4
		Soil Creep		Entire site	Soil creep on slopes steeper than 1V:4H within upper 1m of ground surface.	4	1	4	Mitigation not required, no structures planned on these slopes.	4	1	4
		Cut / Fill Batter Stability		Entire site	Slope stability analysis suggest that 1V:3H batters are stable in long term case. Potential for instability due to rapid drawdown events.	3	4	12	Mitigation in the form of shear keys and over excavation of rock mass and replacement of engineered clay cap recommended.	1	4	4

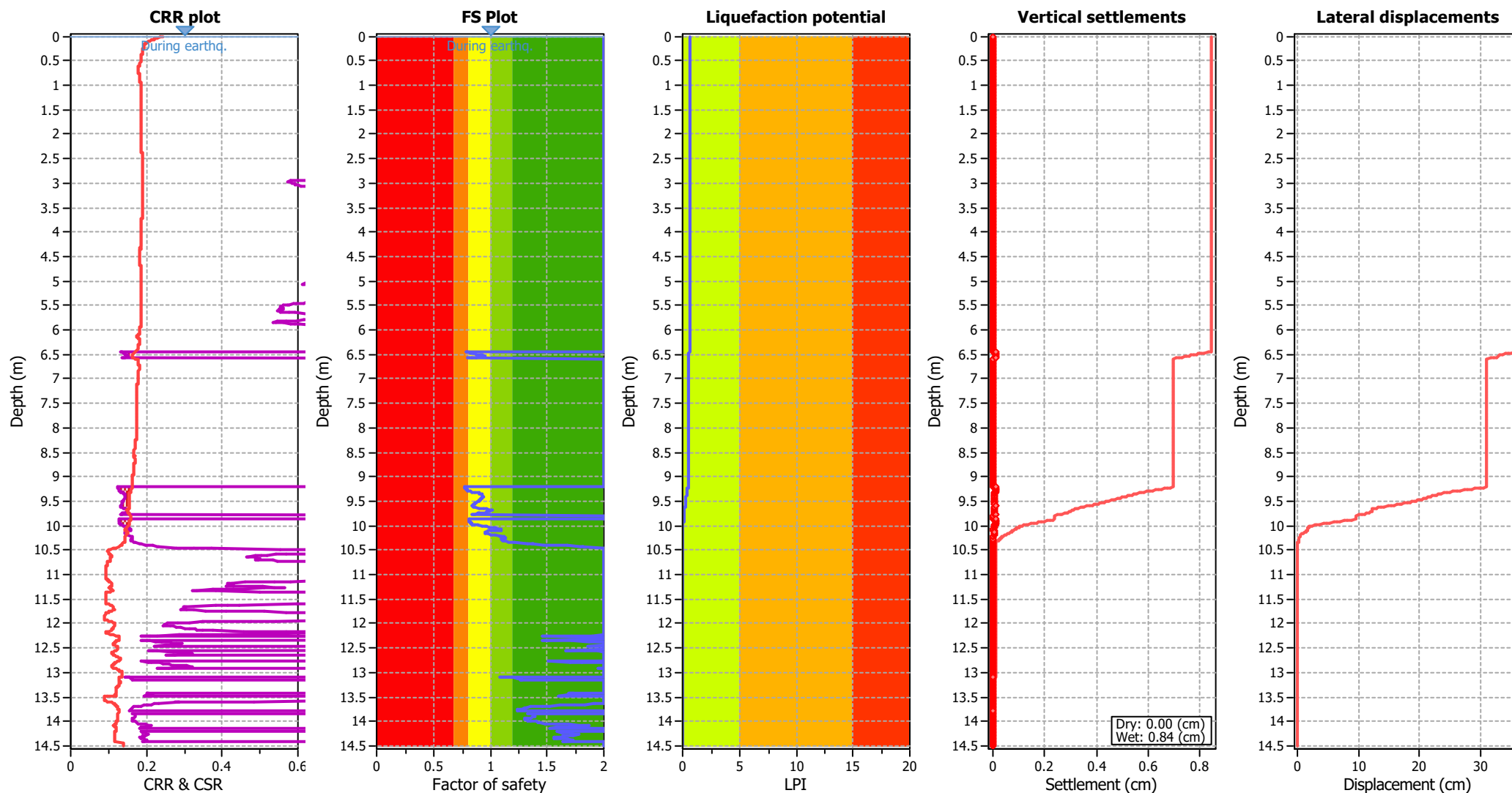
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		Stream bank instability and erosion		Slopes adjacent to Orewa River	Refer to global stability analysis in respect to development near Orewa River and gullys. Stability models meet factor of safety requirements in these areas.	1	4	4	Mitigation not required	1	4	4
3	Problematic Soils	Pumice Soil Exposure	N/A	Not in this geology								
		Rockmass Exposure	N/A		Earthworks will expose weathered Northland Allochthon rock at reservoir subgrade level. Bedrock unit with open defects have high rates of permeabilities and are susceptible to rapid erosion and contributing to land instability and potential seepage pathways	1	3	3	Where exposed cap rock units with 1m clay capping, refer to 9.4.1.	1	3	3
		Expansive Soils	MBIE (2021) Acceptable Solutions and Verification Methods For New Zealand Building Code Clause B1 Structure, Amendment 20 NZS 3604:2011 AS 2870-2011 NZS 4402:1998 Test 2.1, 2.4 and 2.6 Fraser Thomas Ltd, Brown, B.J., Goldsmith, P.R., Shorten, J.P.M. & Henderson, L (2003) Soil Expansivity in the Auckland Region. BRANZ, Study Report SR 120	Entire Site	Not an issue for this development	4	1	4	Mitigation not required.	4	1	4
		Sensitive Soils	NZGS Field Description of Soil and Rock (NZGS, 2005)	Entire Site	Hand shear vane testing suggests that natural soils are unlikely to be sensitive.	3	1	3	Mitigation not required.	1	3	3
		Acid Sulphate Soils		Not in this geology								
		Collapsible / Dispersible Soils	N/A	Not in this geology								
		Uncontrolled Fill	N/A	Entire Site	Not anticipated based on aerial photography	1	4	4	Uncontrolled fill is to be excavated and replaced during construction.	1	4	4
		Contamination	Ministry for the Environment (2021) Contaminated land management guidelines	Entire Site	By others							
4	Settlement	Compressible Soils	Mesri G, Kwan Lo D, Feng T (1994) Settlement of Embankments on Soft Clays, Chapter of Vertical and Horizontal Deformation of foundations and Embankments, A.T.Yeung & G.Y.Felio, ASCE, New York, 8-56 Mesri G, Ajlouni N (2007) Engineering Properties of Fibrous Peats, Journal of Geotechnical and Geoenvrionmental Engineering, Vol. 133:7. ASCE	Firm and soft alluvium	Total settlements of 60 to 160mm based on dam embankment height. Likely to be 'built out' during fill placement.	5	2	10	Monitor settlements during construction, refer to Section 9.3	2	2	4
		Bearing Capacity	MBIE (2021) Acceptable Solutions and Verification Methods For New Zealand Building Code Clause B1 Structure, Amendment 20, B1/VM4	Entire Site	No buildings proposed							
		Effects of Dewatering			By Others.							
		Settlement Behind Retaining Wall – Boundary Effects			No boundary walls in scheme							

APPENDIX E

CLIQ Outputs

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.15	Use fill:	No	Limit depth applied:	No
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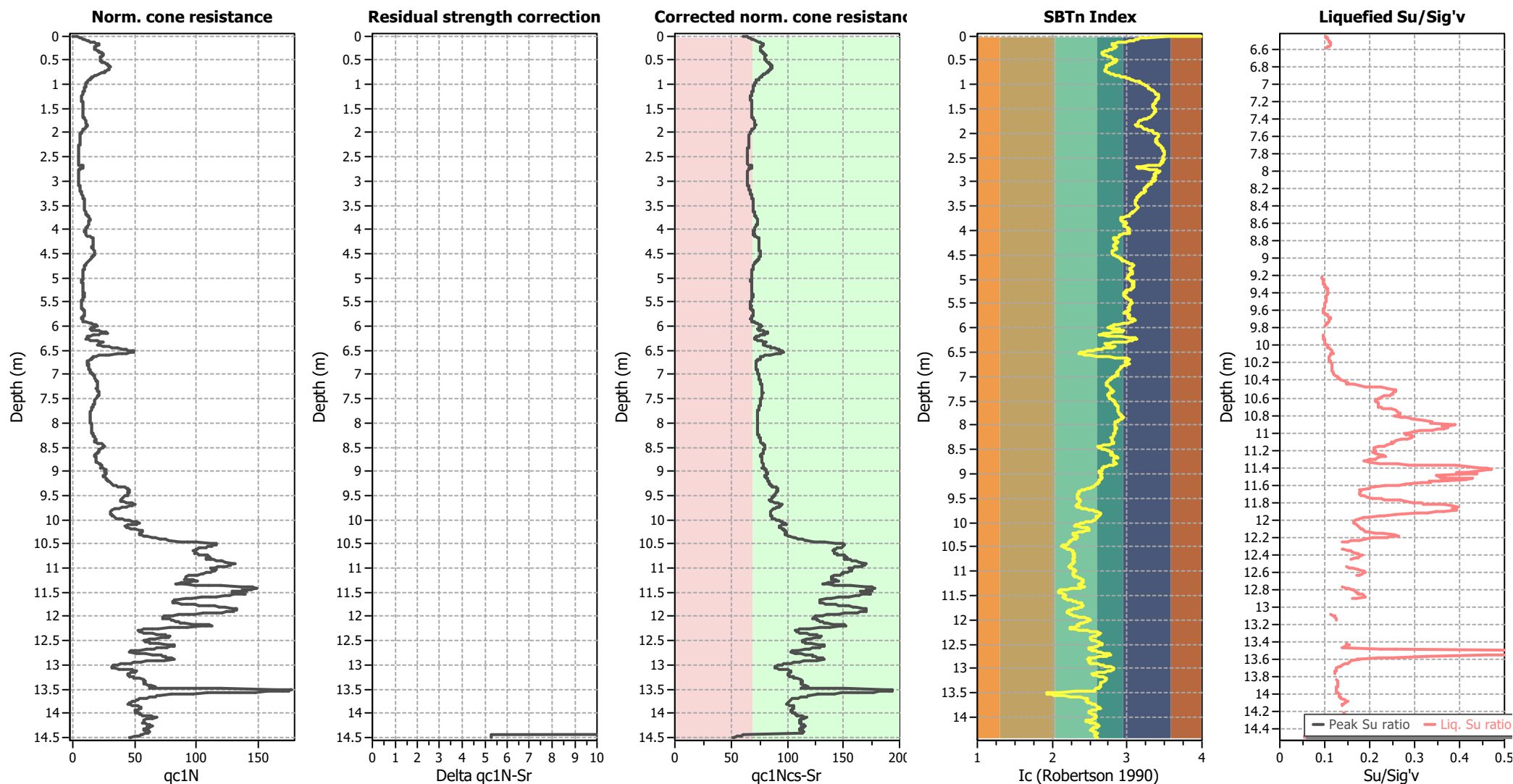
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
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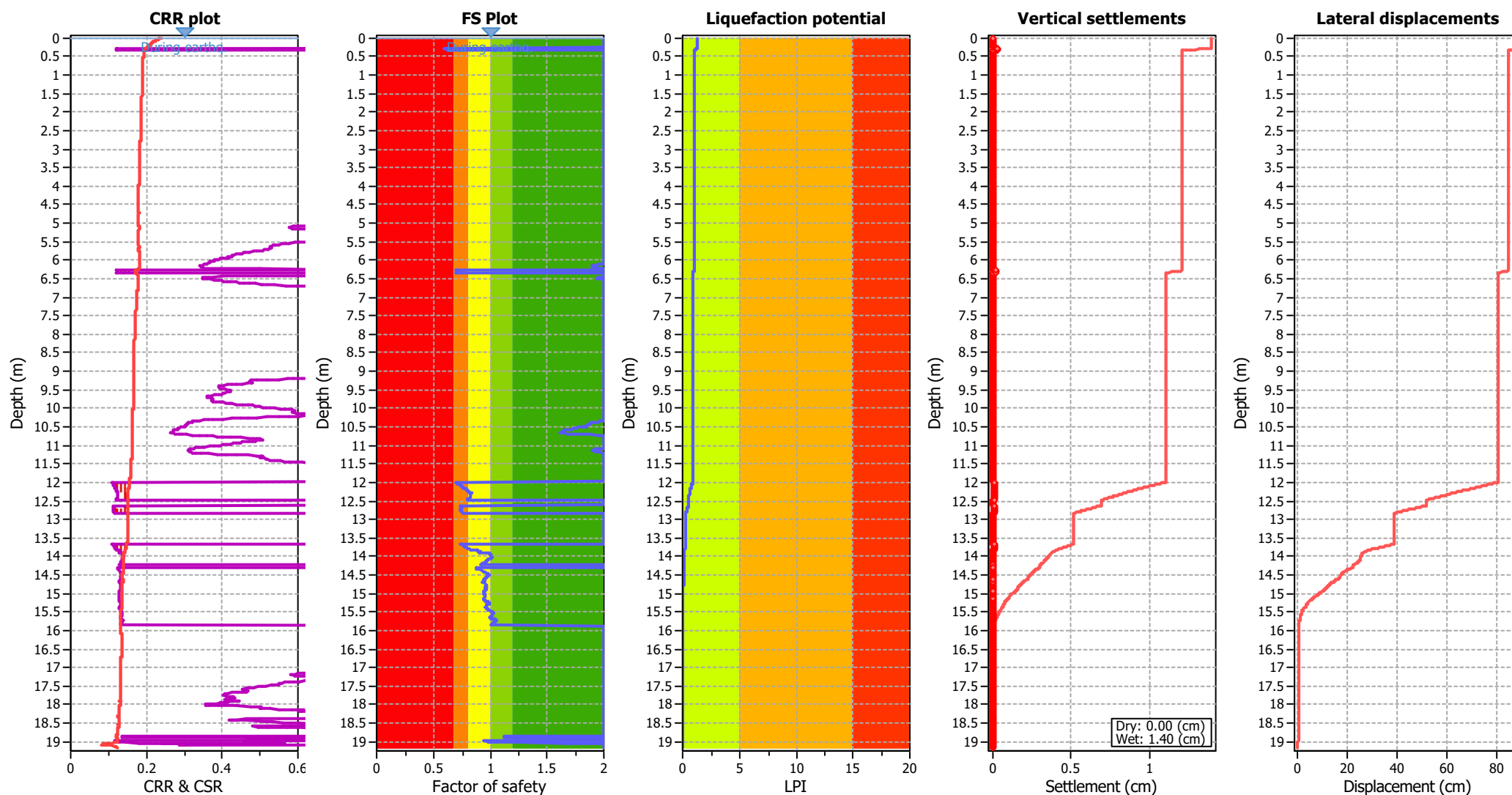
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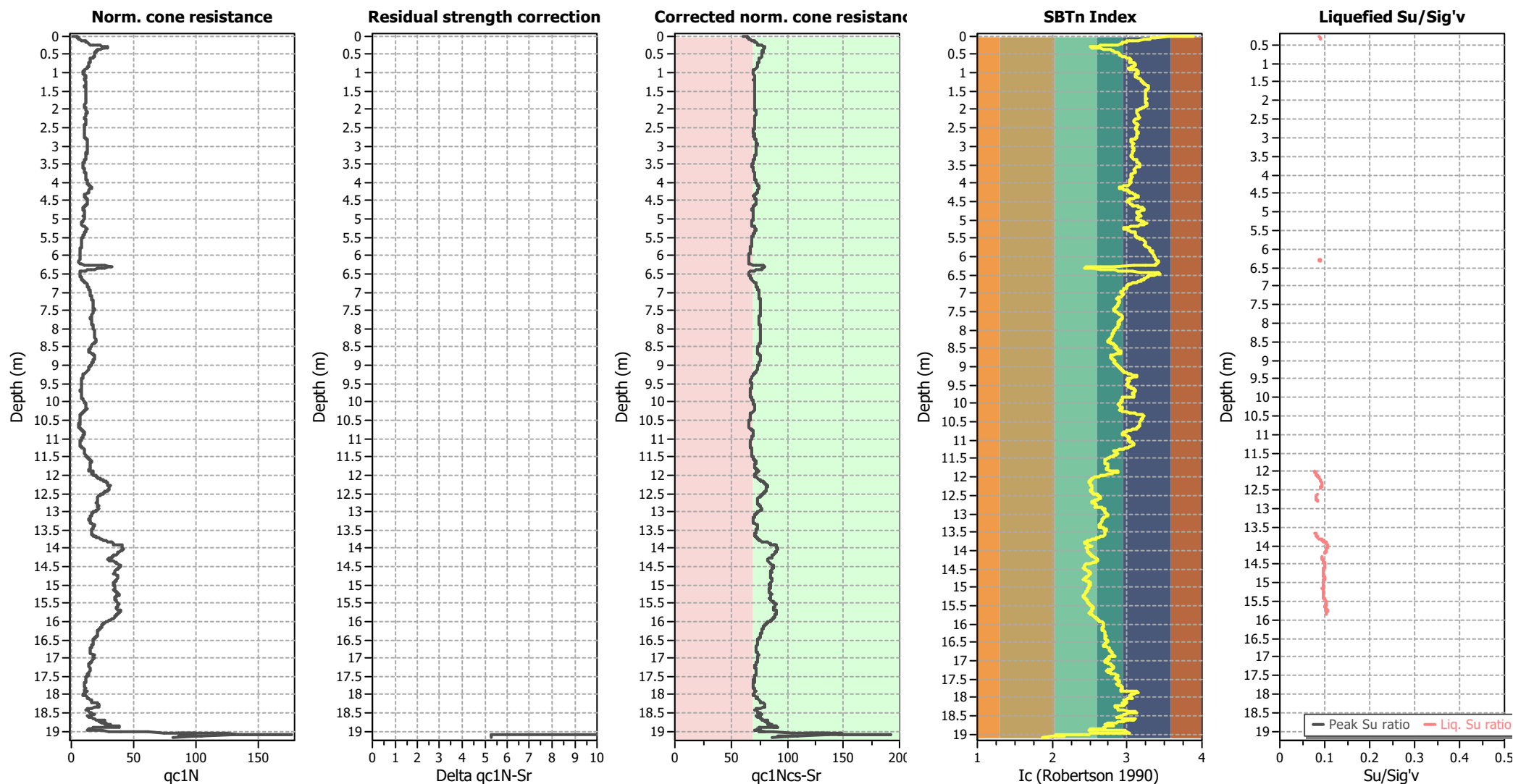
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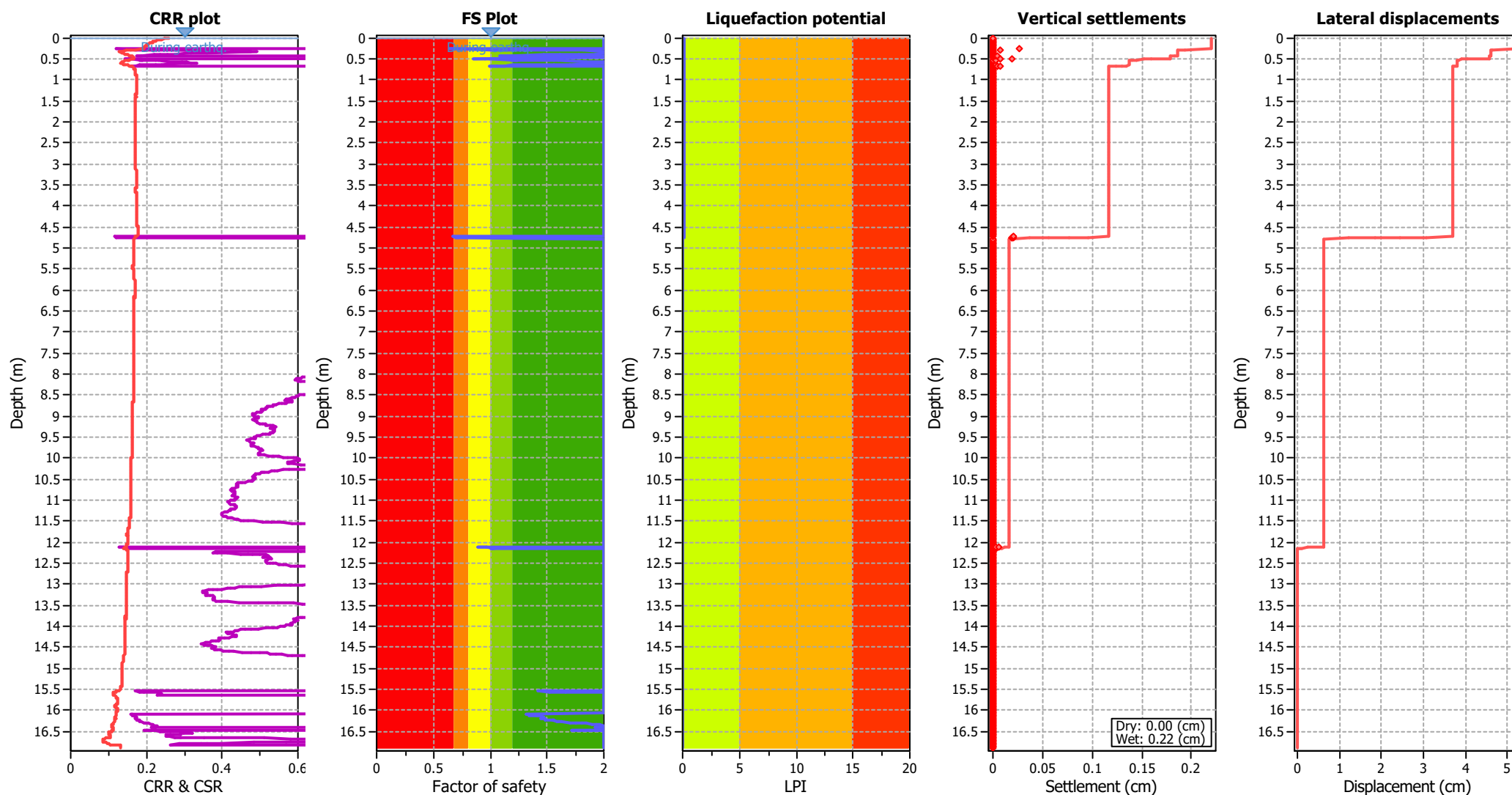
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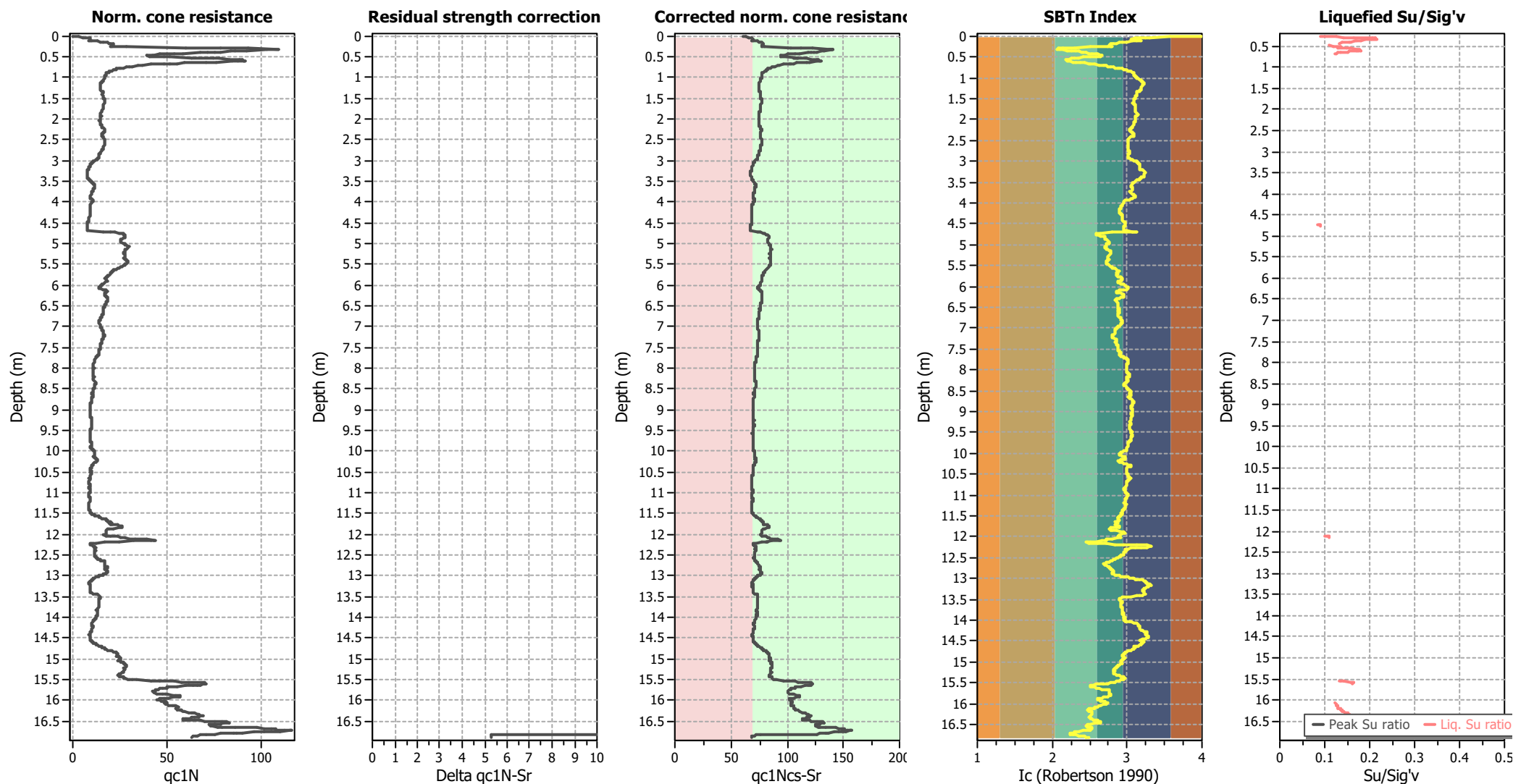
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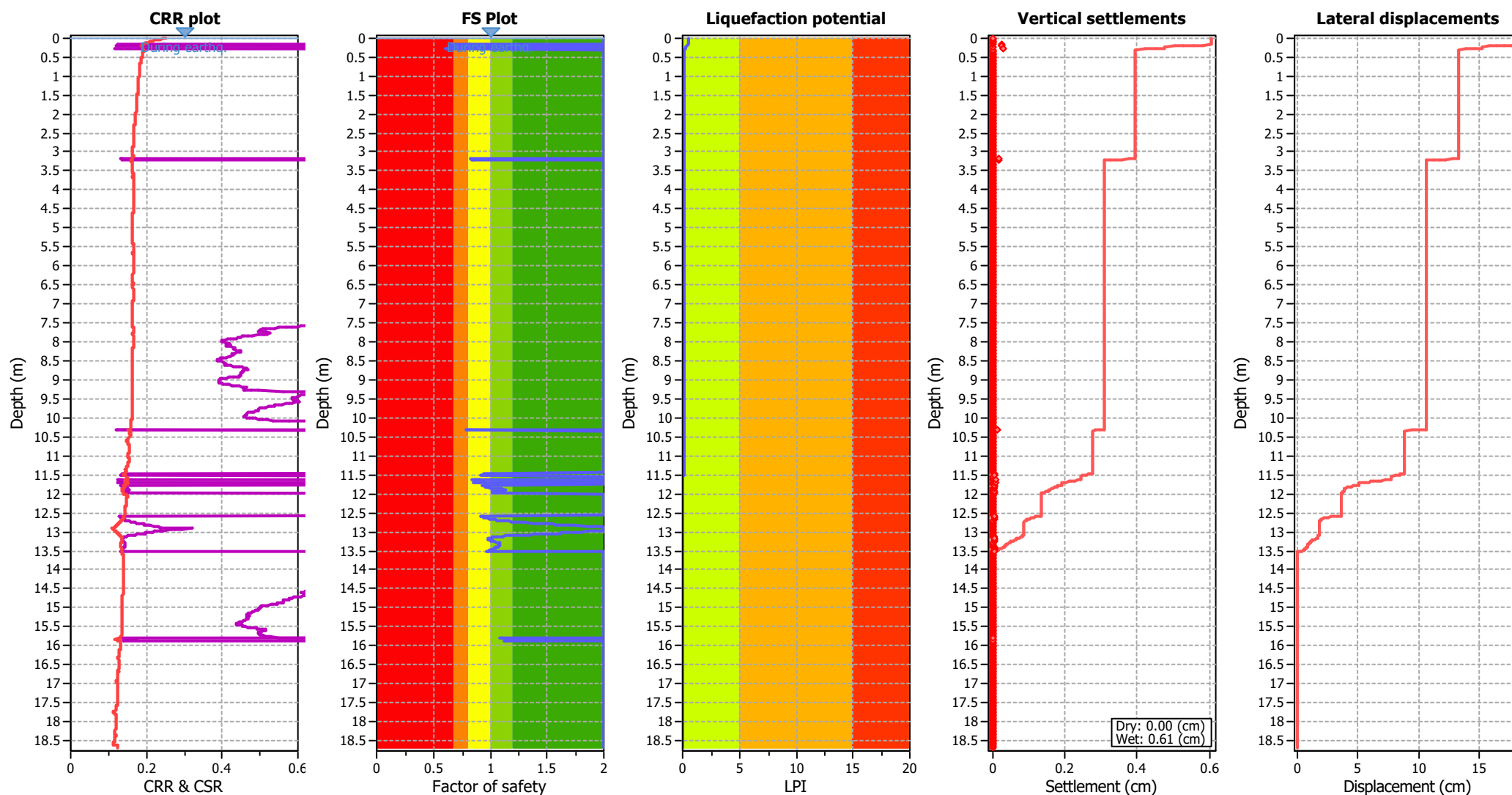
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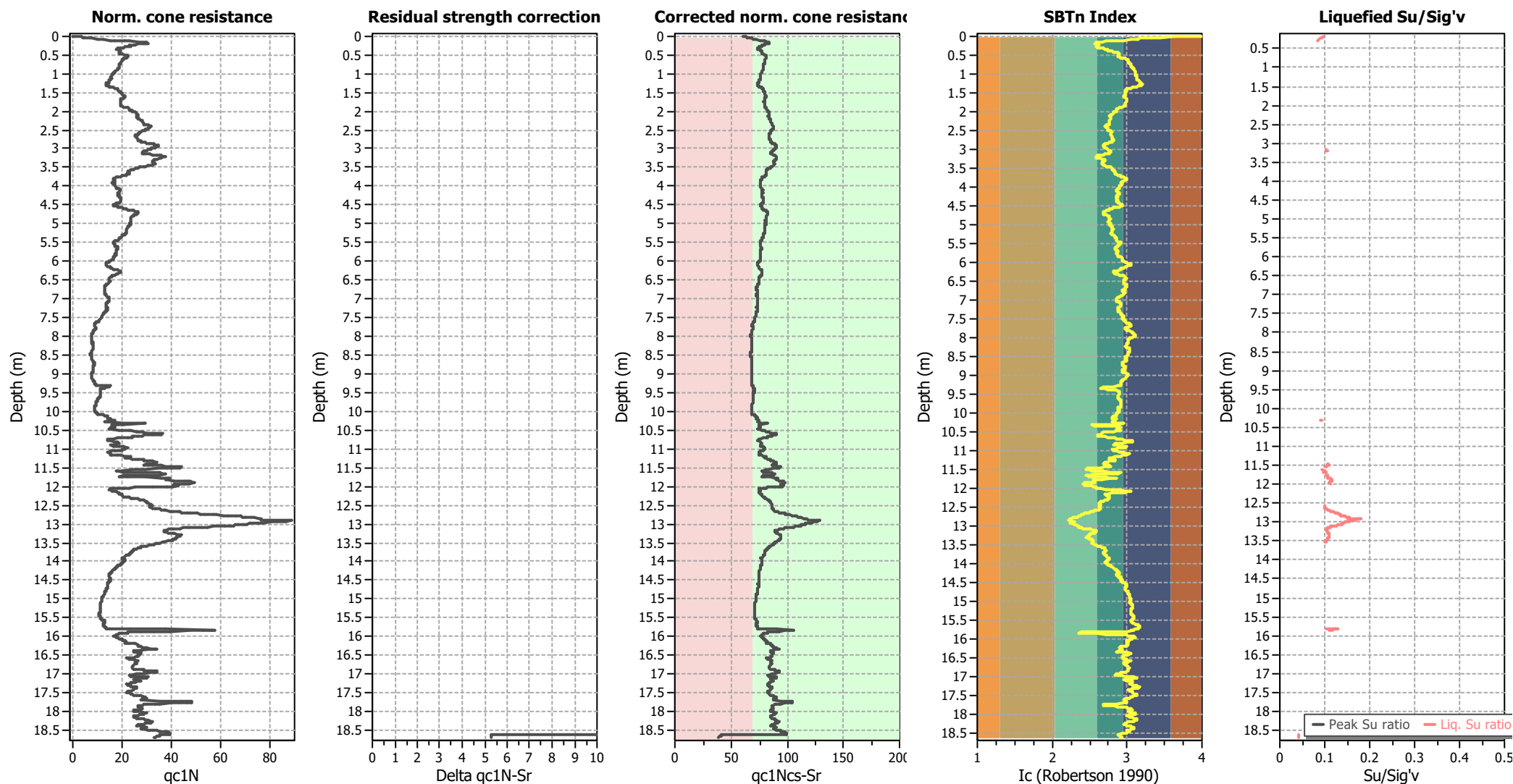
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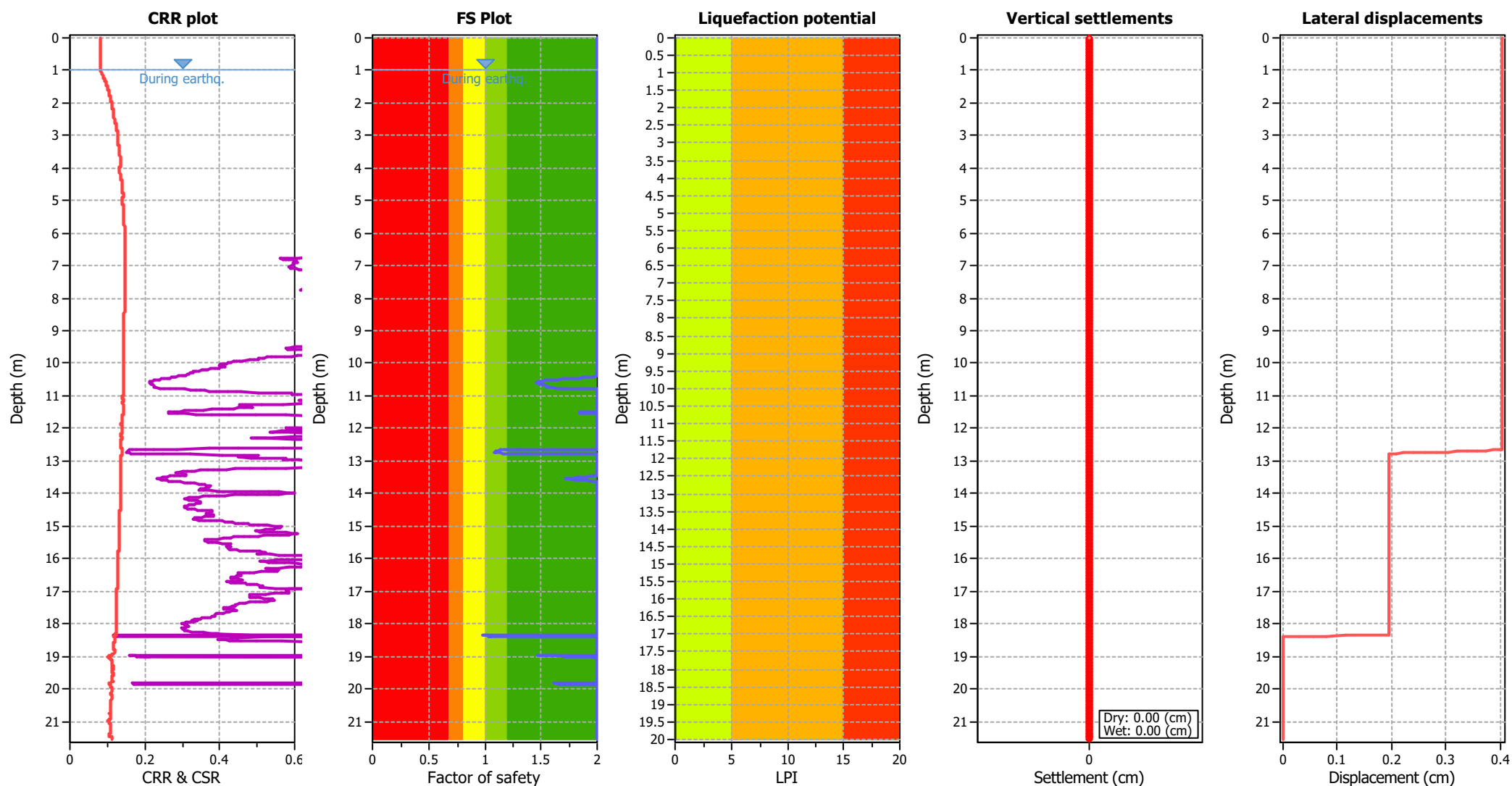
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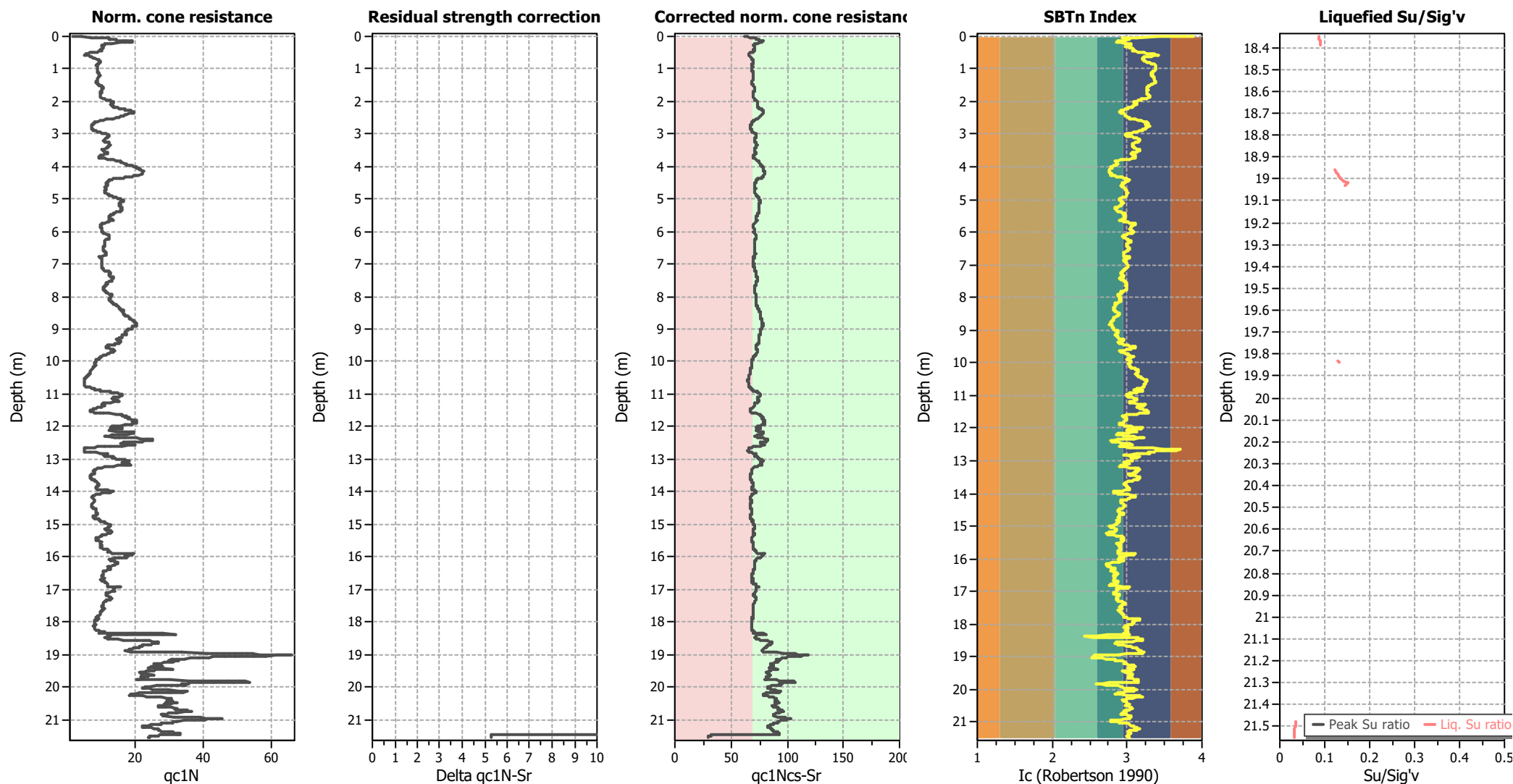
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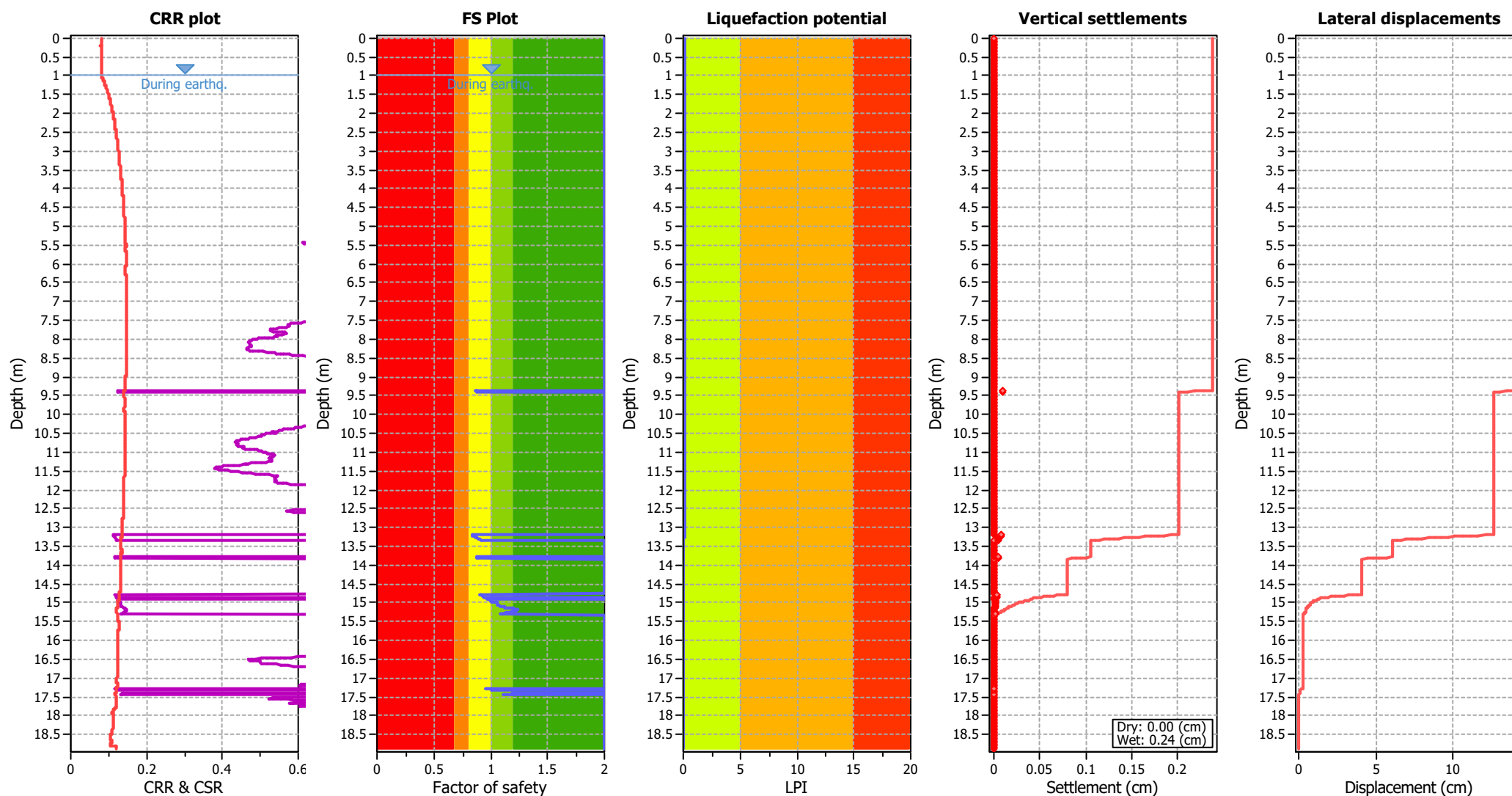
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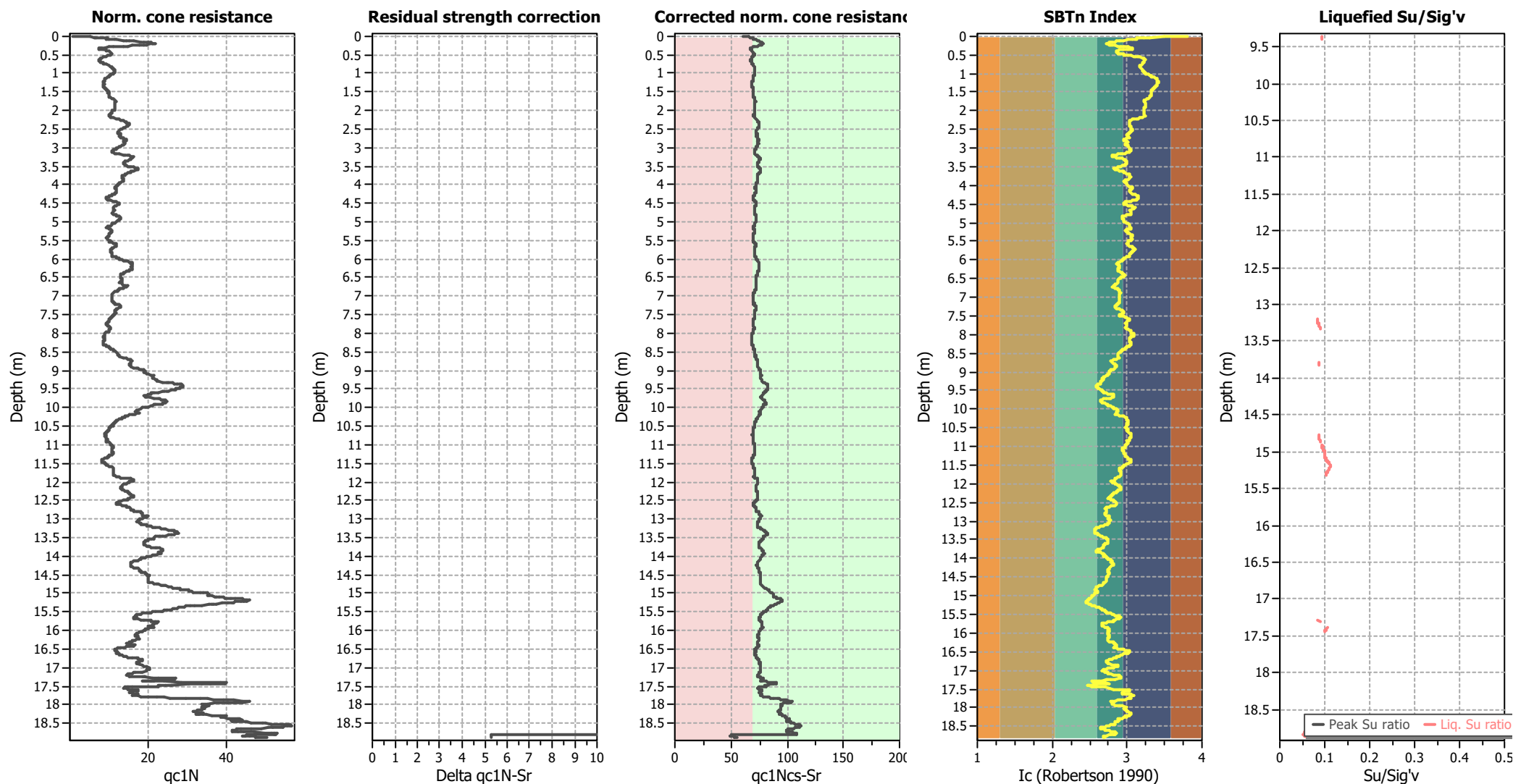
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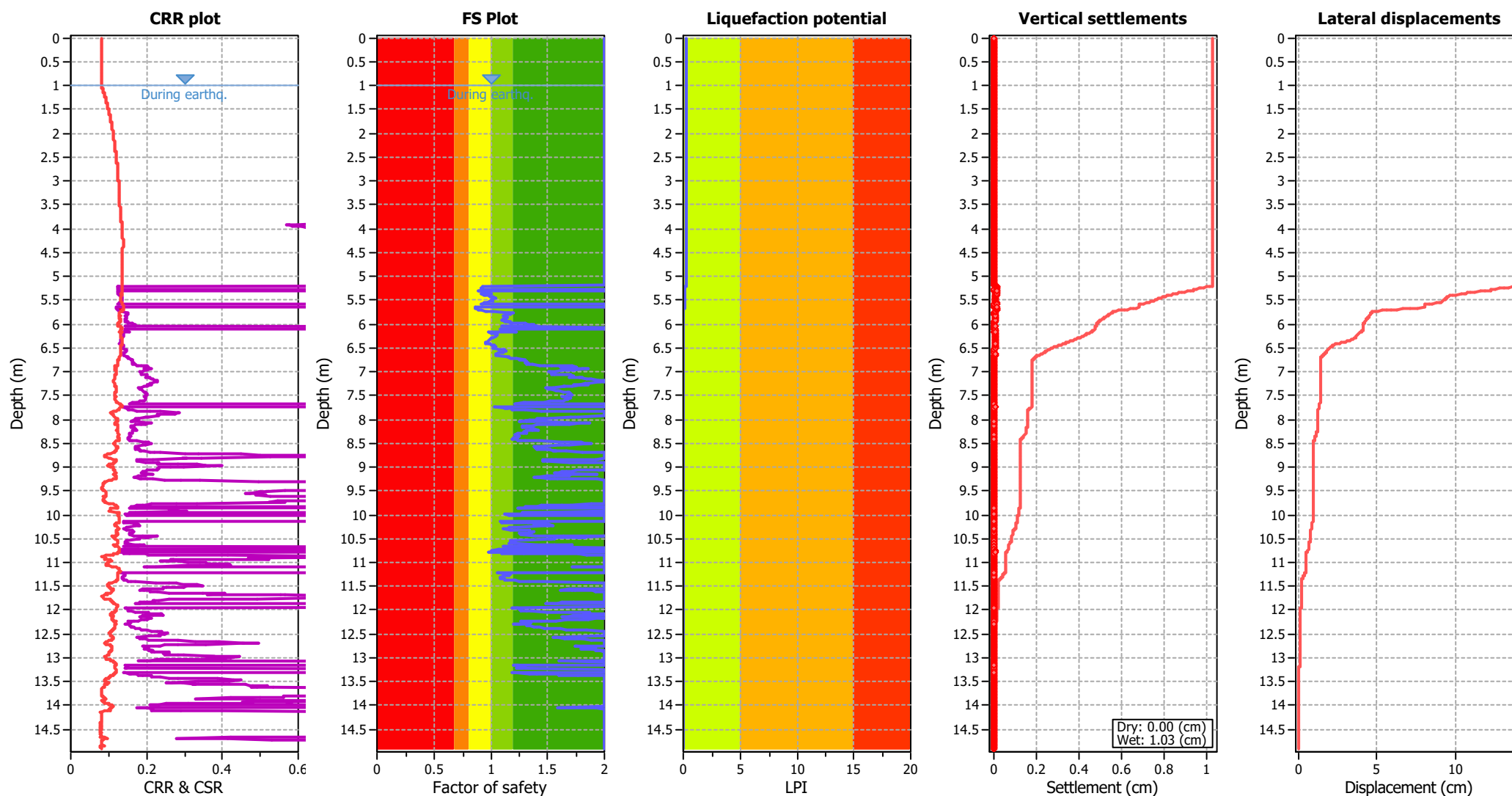
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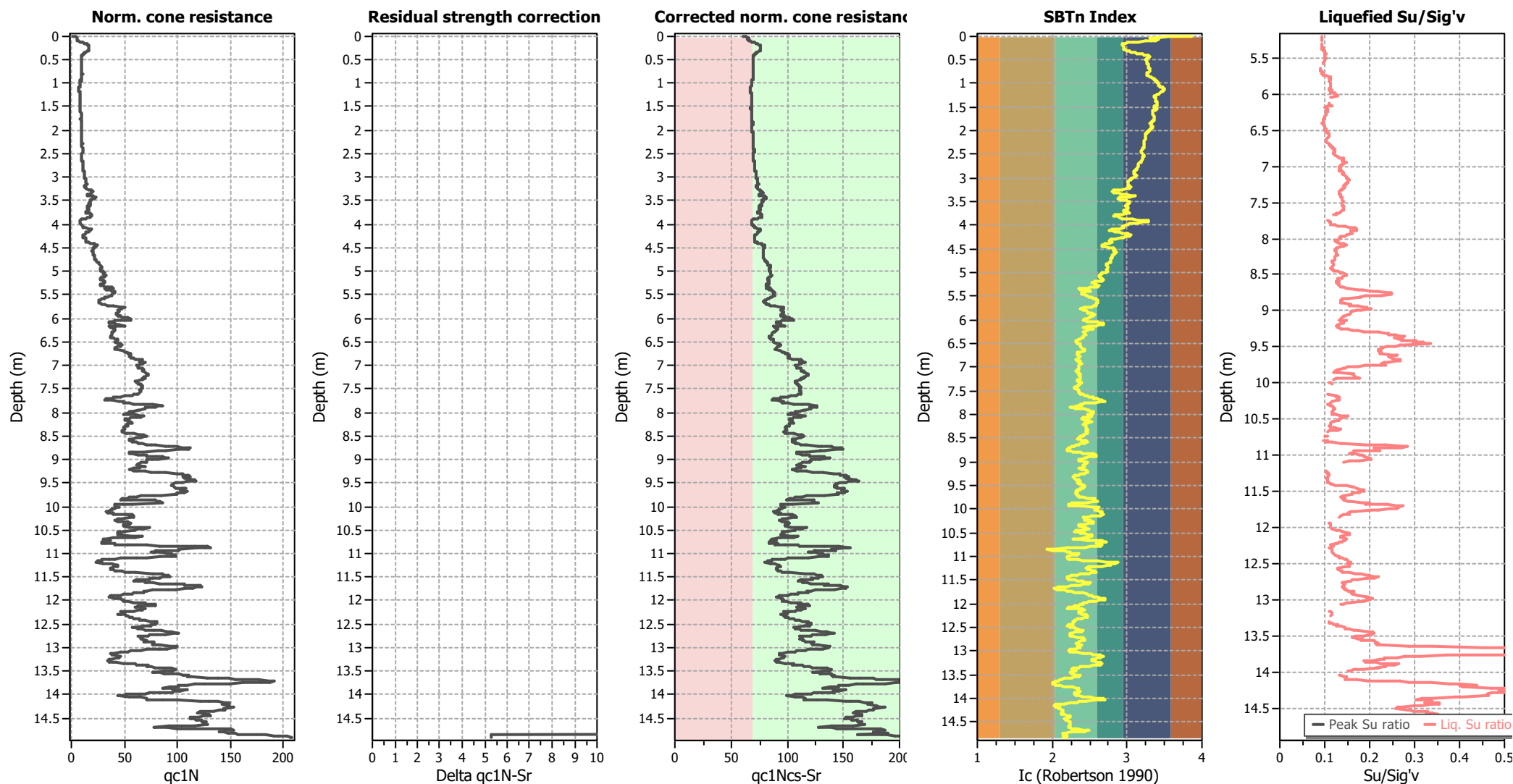
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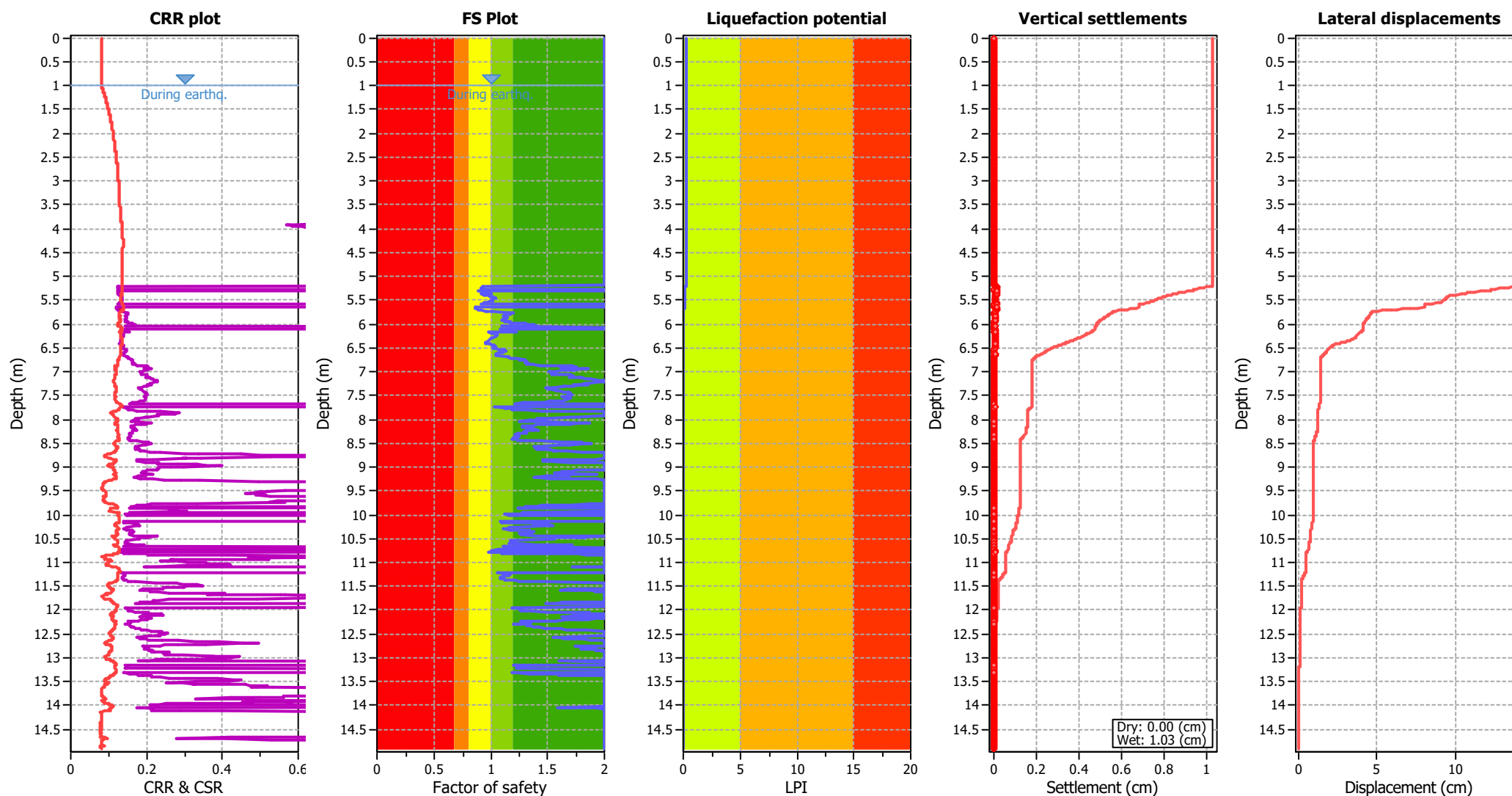
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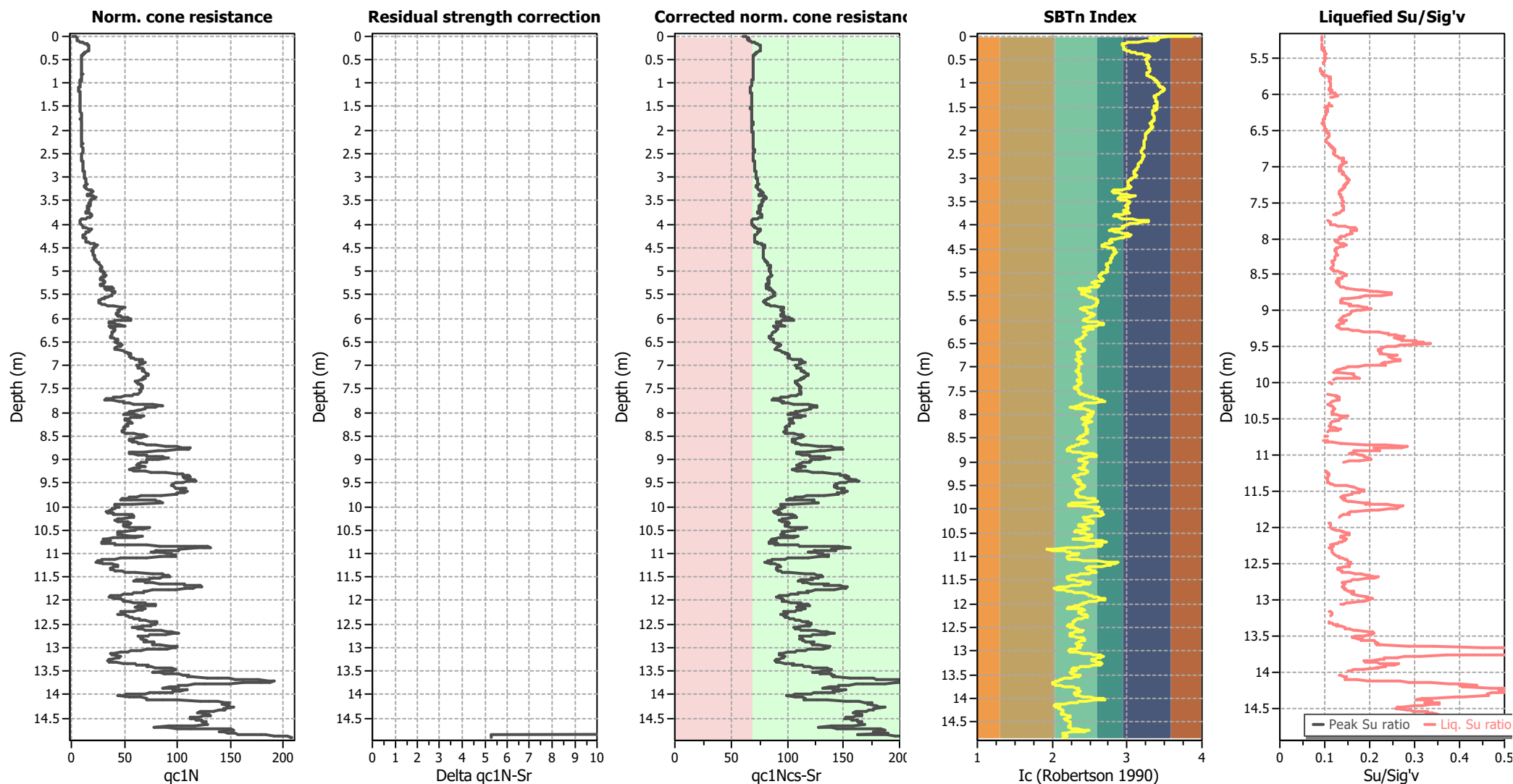
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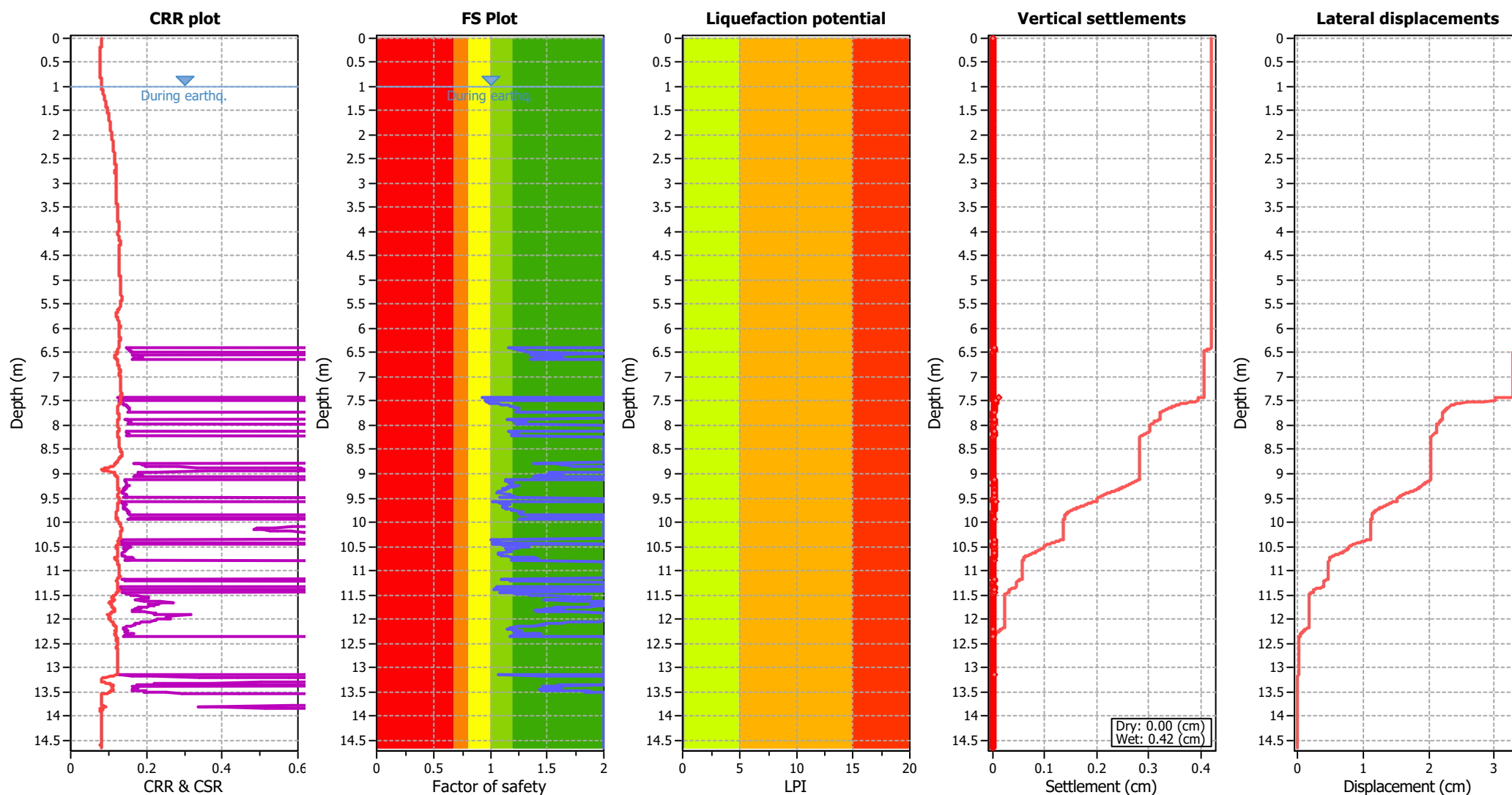
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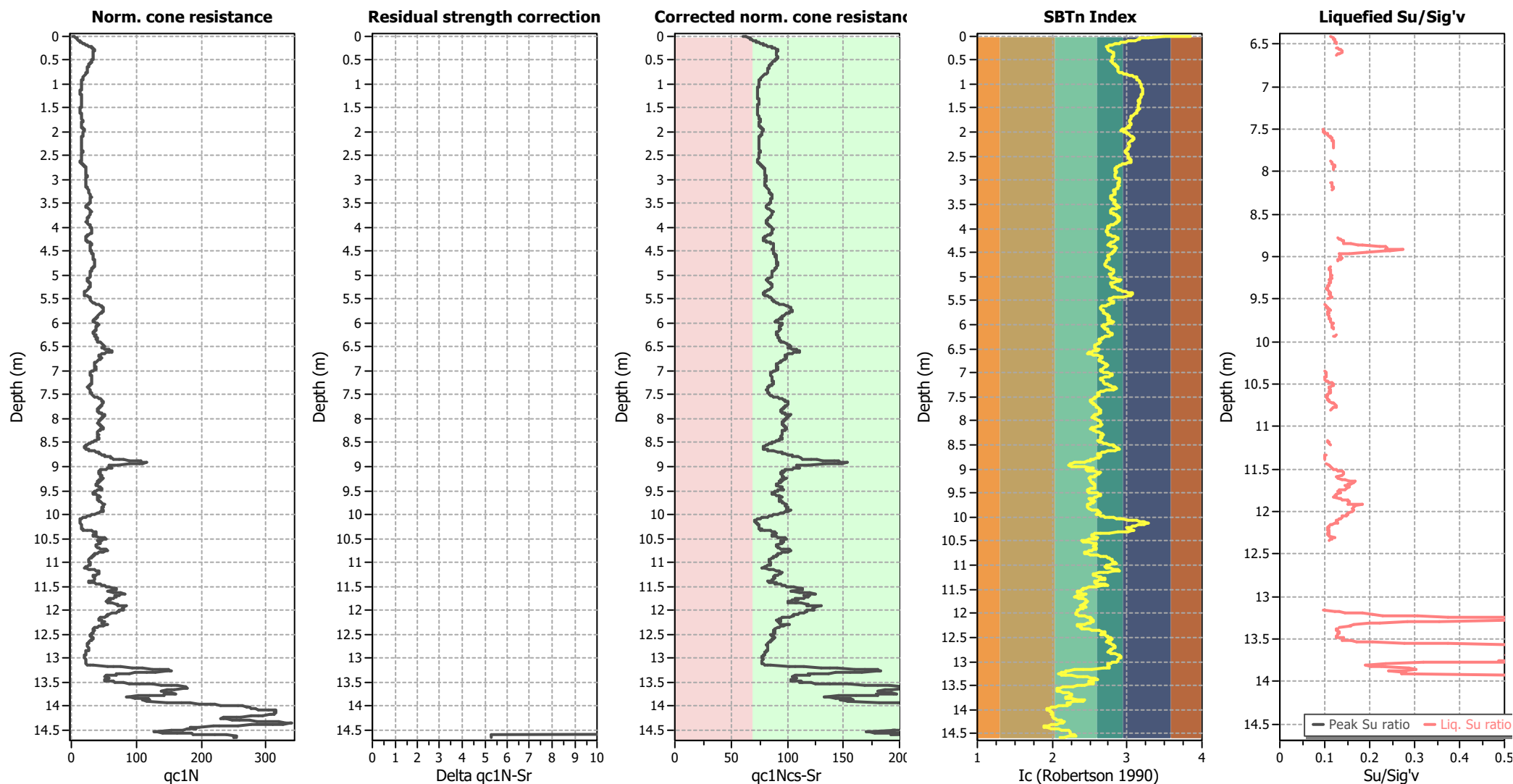
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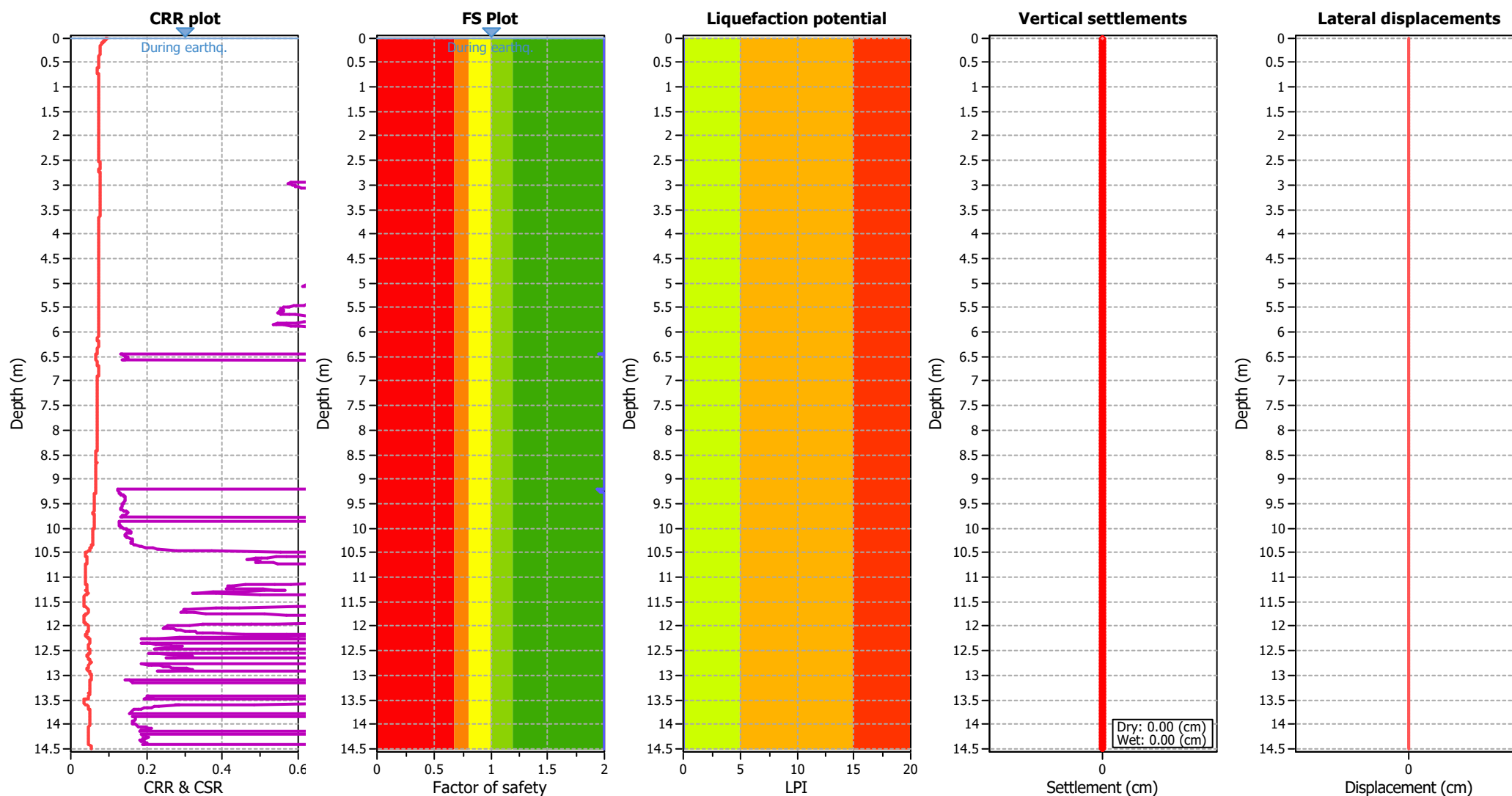
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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.15	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

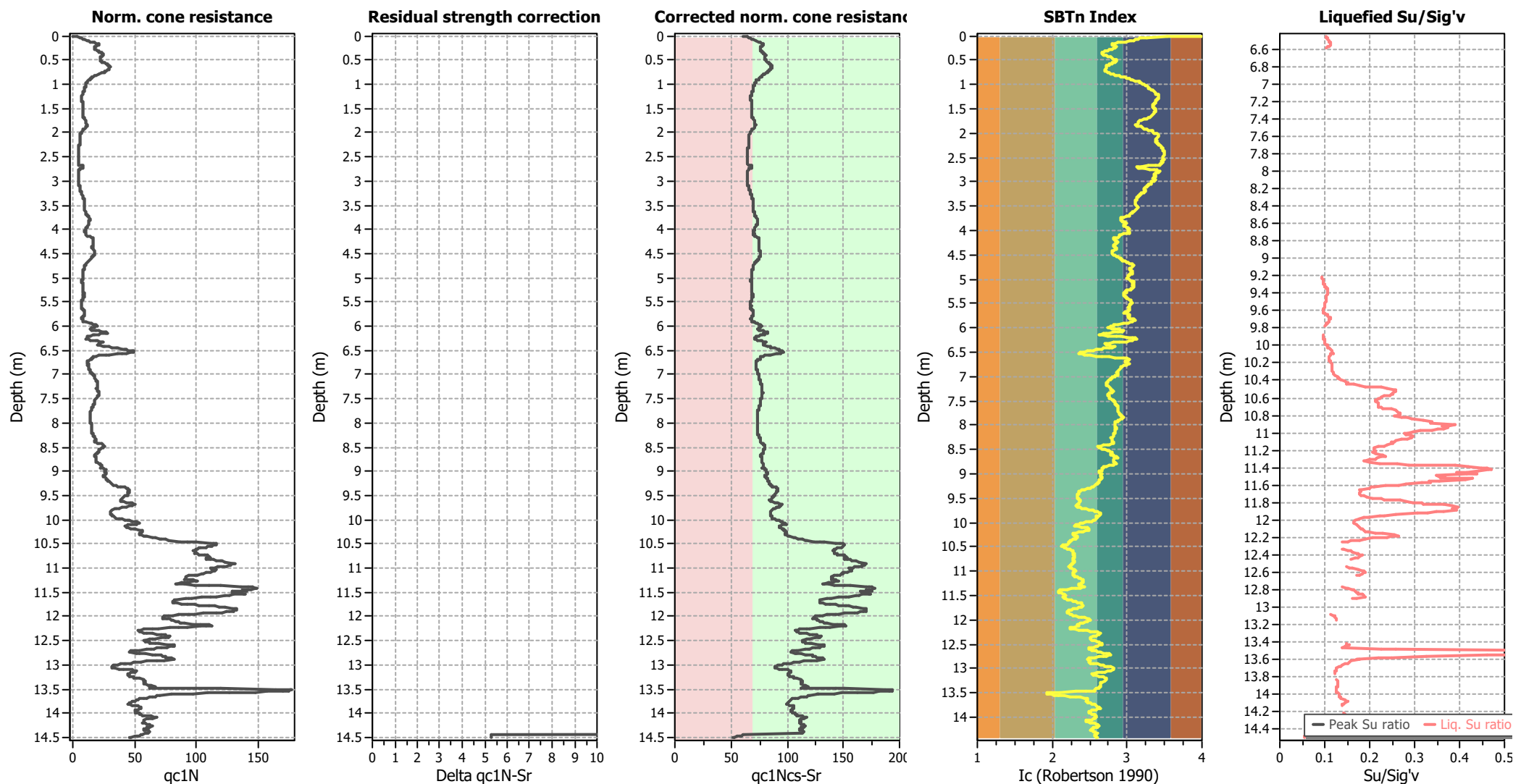
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
■	Unlike to liquefy
■	Almost certain it will not liquefy

LPI color scheme

■	Very high risk
■	High risk
■	Low risk

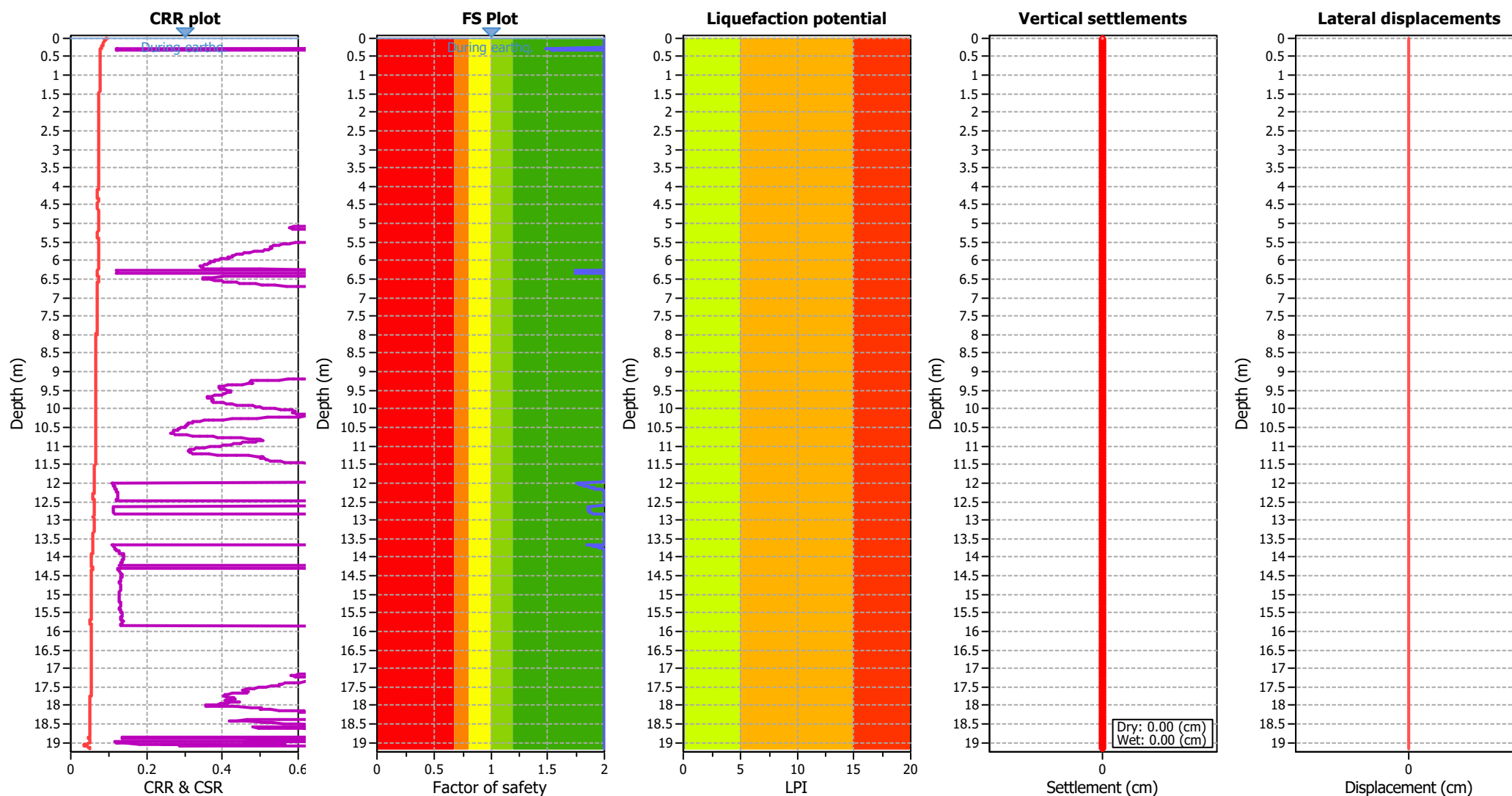
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

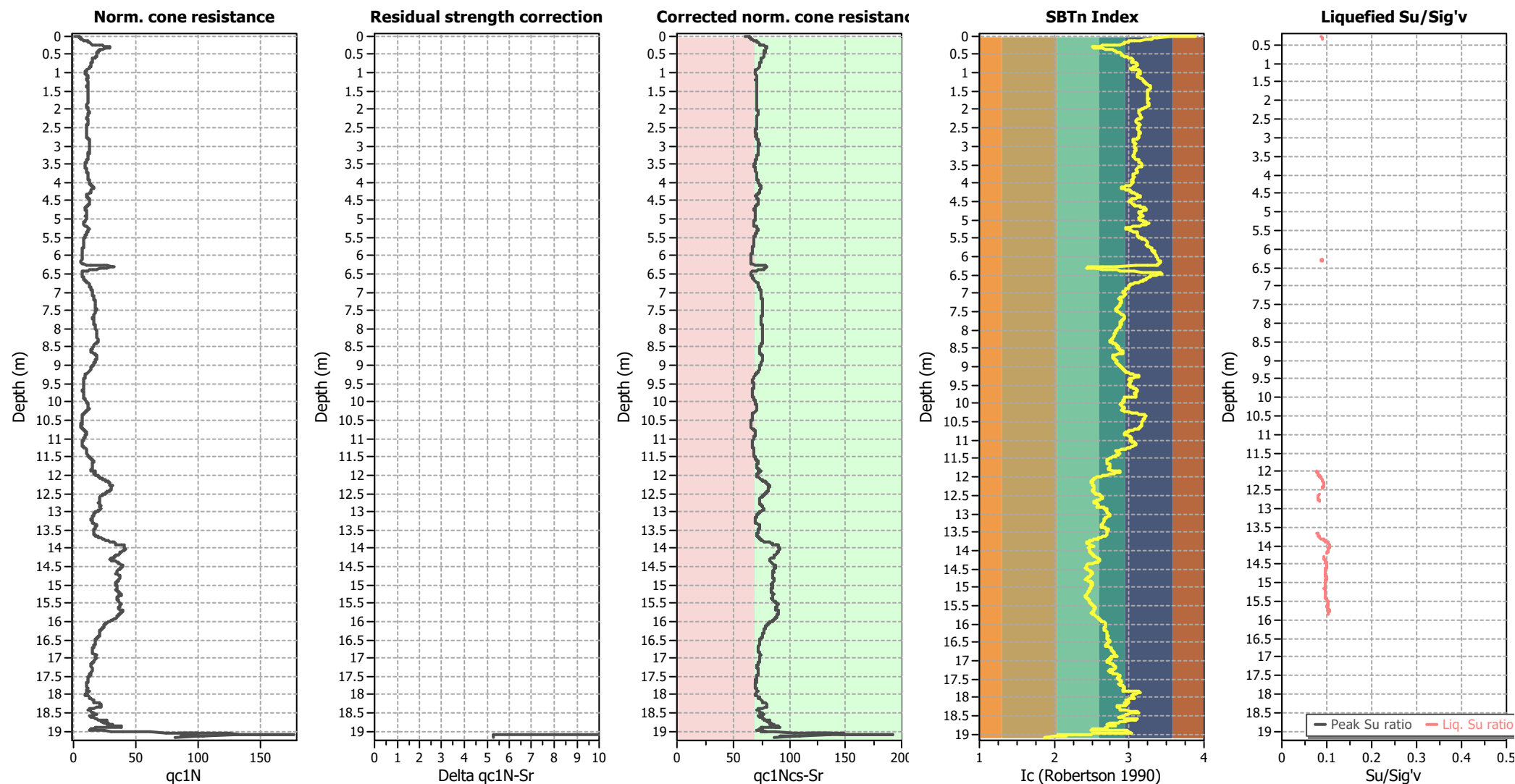
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

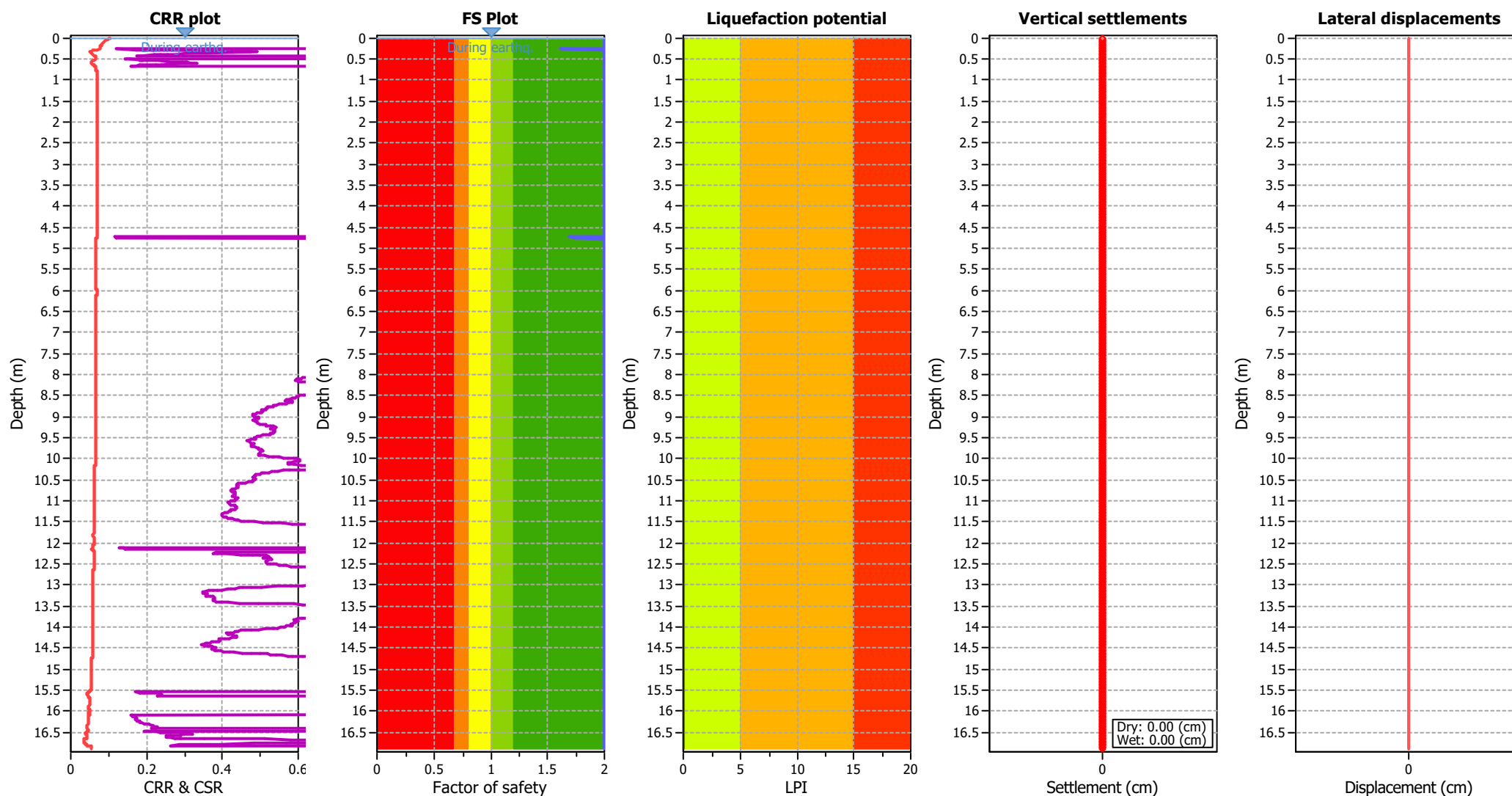
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

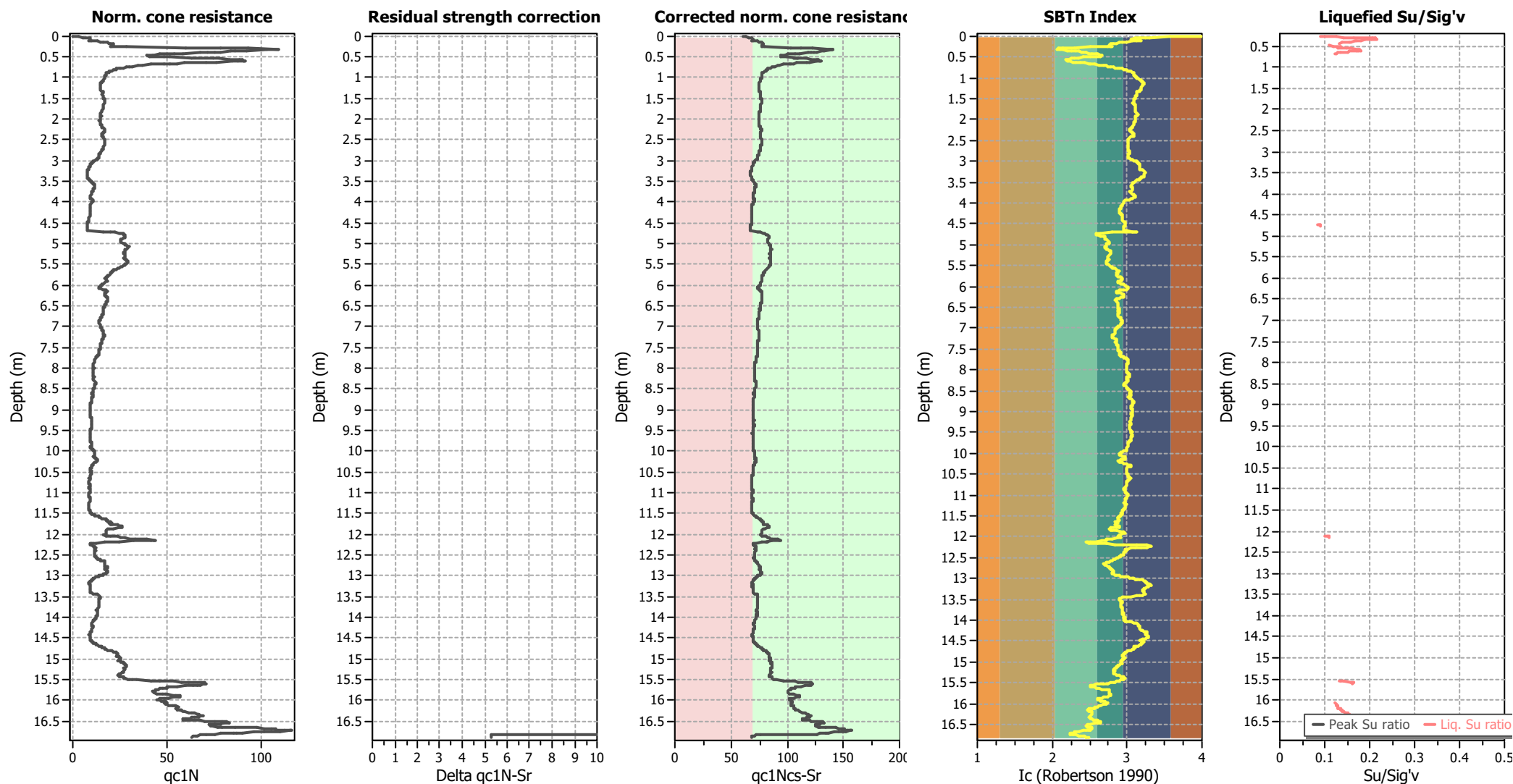
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
■	Unlike to liquefy
■	Almost certain it will not liquefy

LPI color scheme

■	Very high risk
■	High risk
■	Low risk

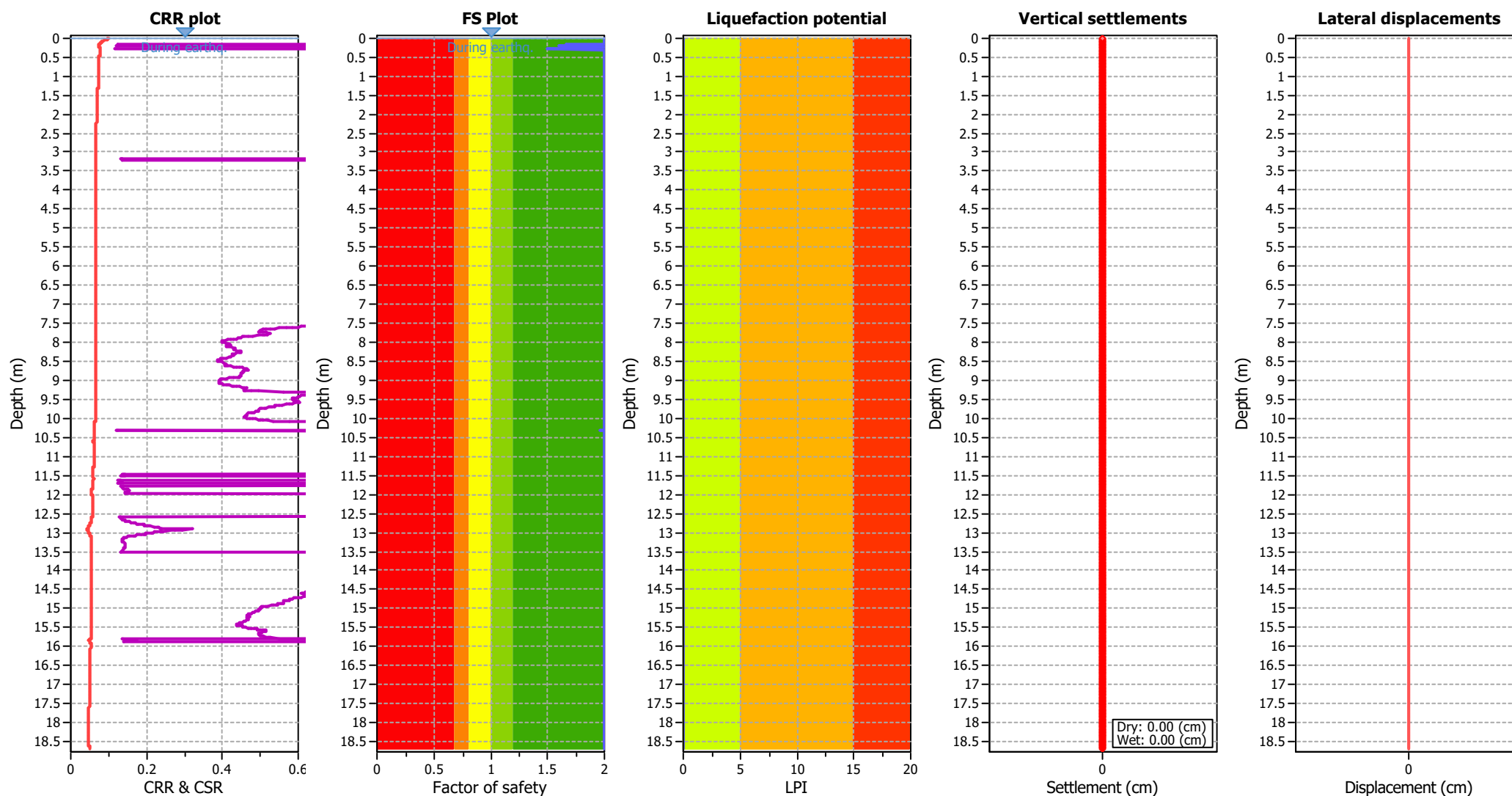
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_G applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

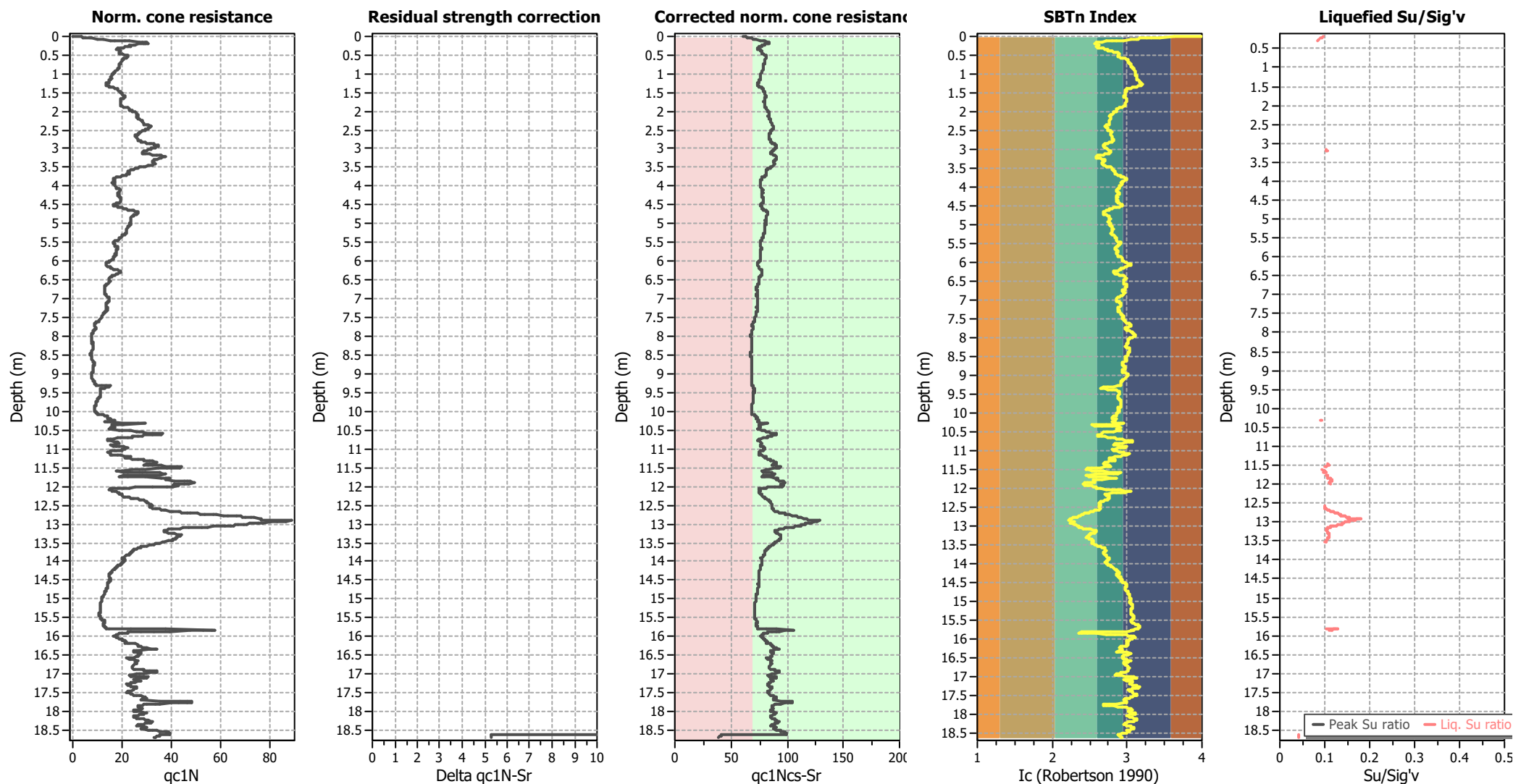
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
■	Unlike to liquefy
■	Almost certain it will not liquefy

LPI color scheme

■	Very high risk
■	High risk
■	Low risk

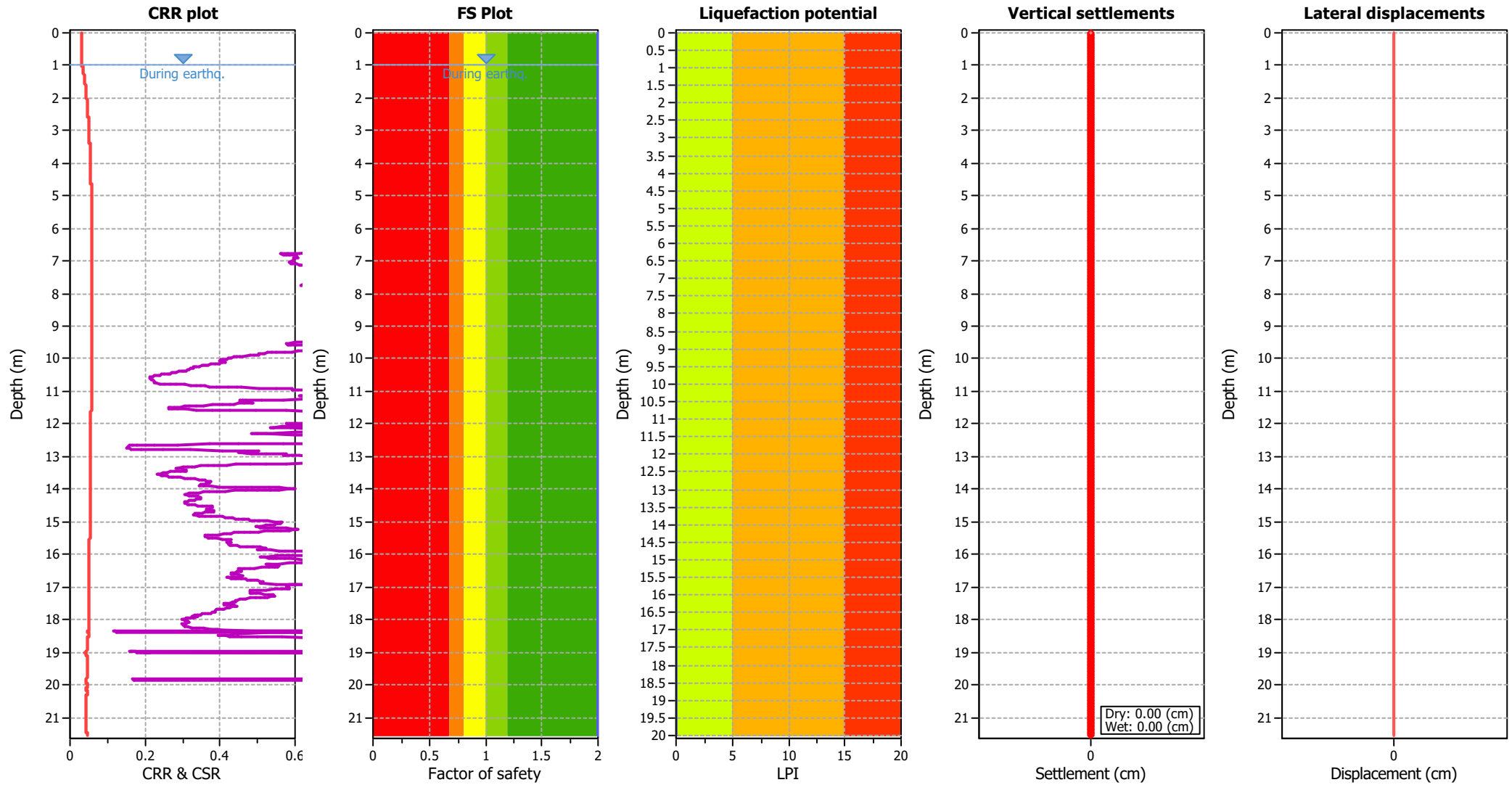
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

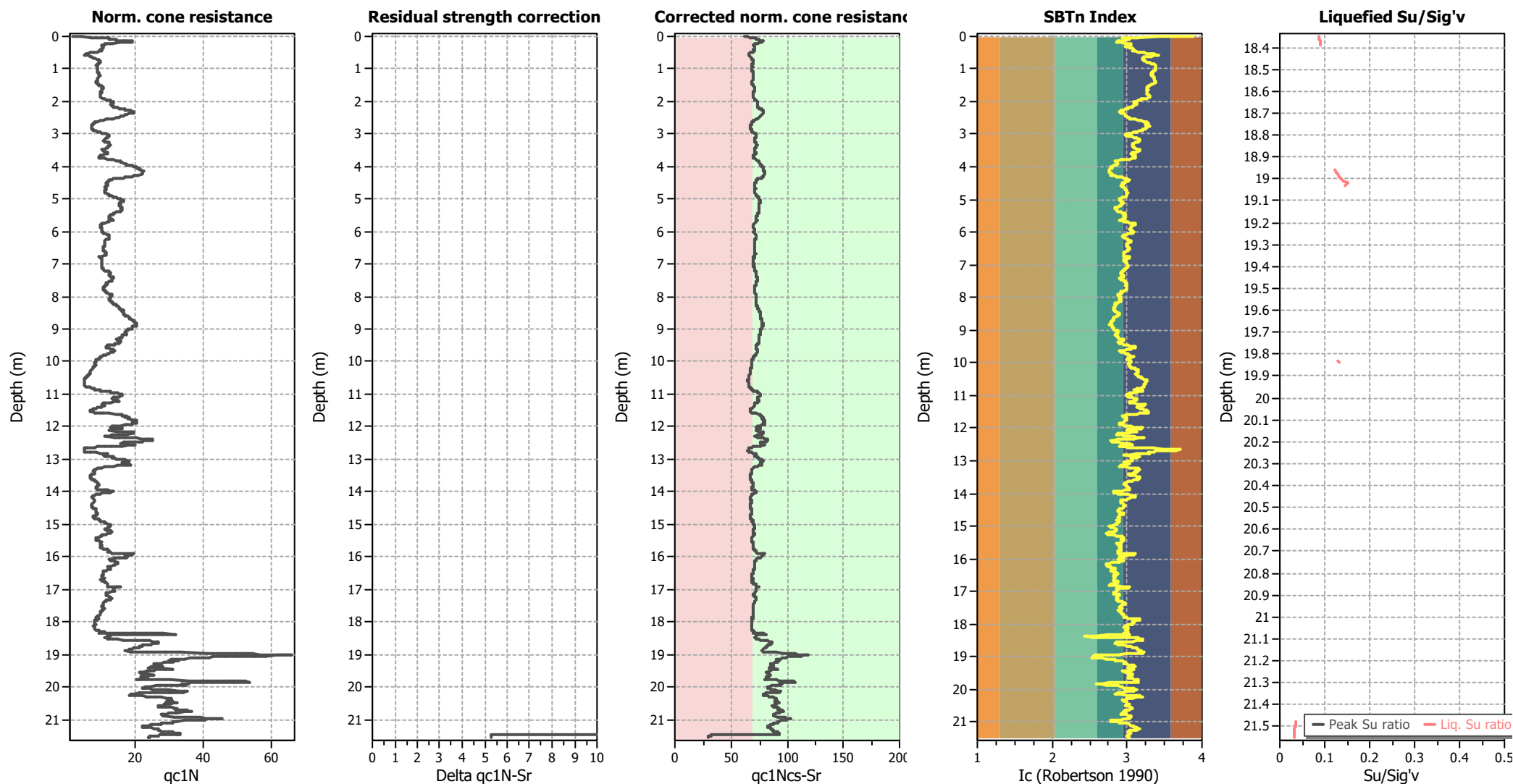
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

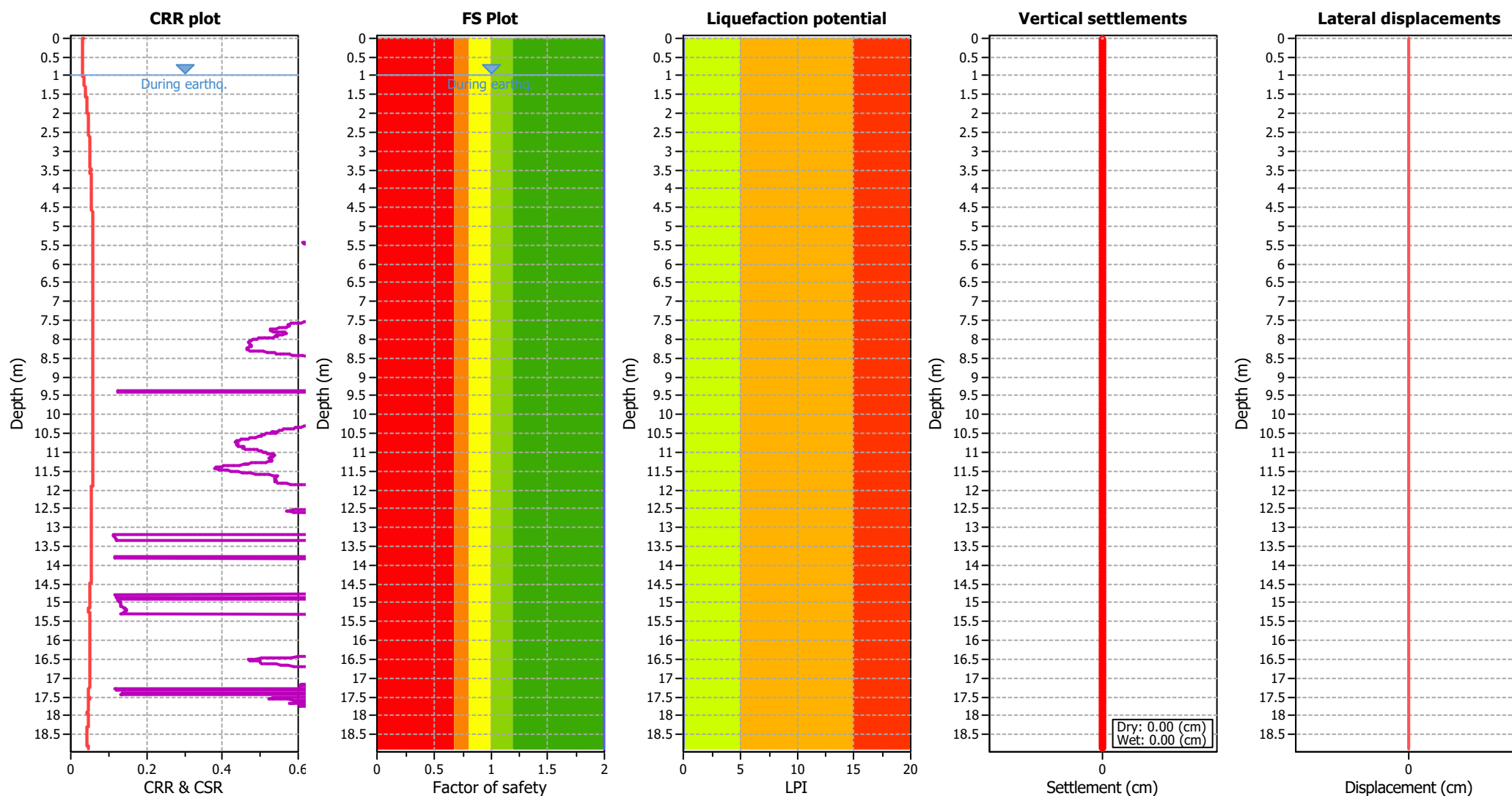
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

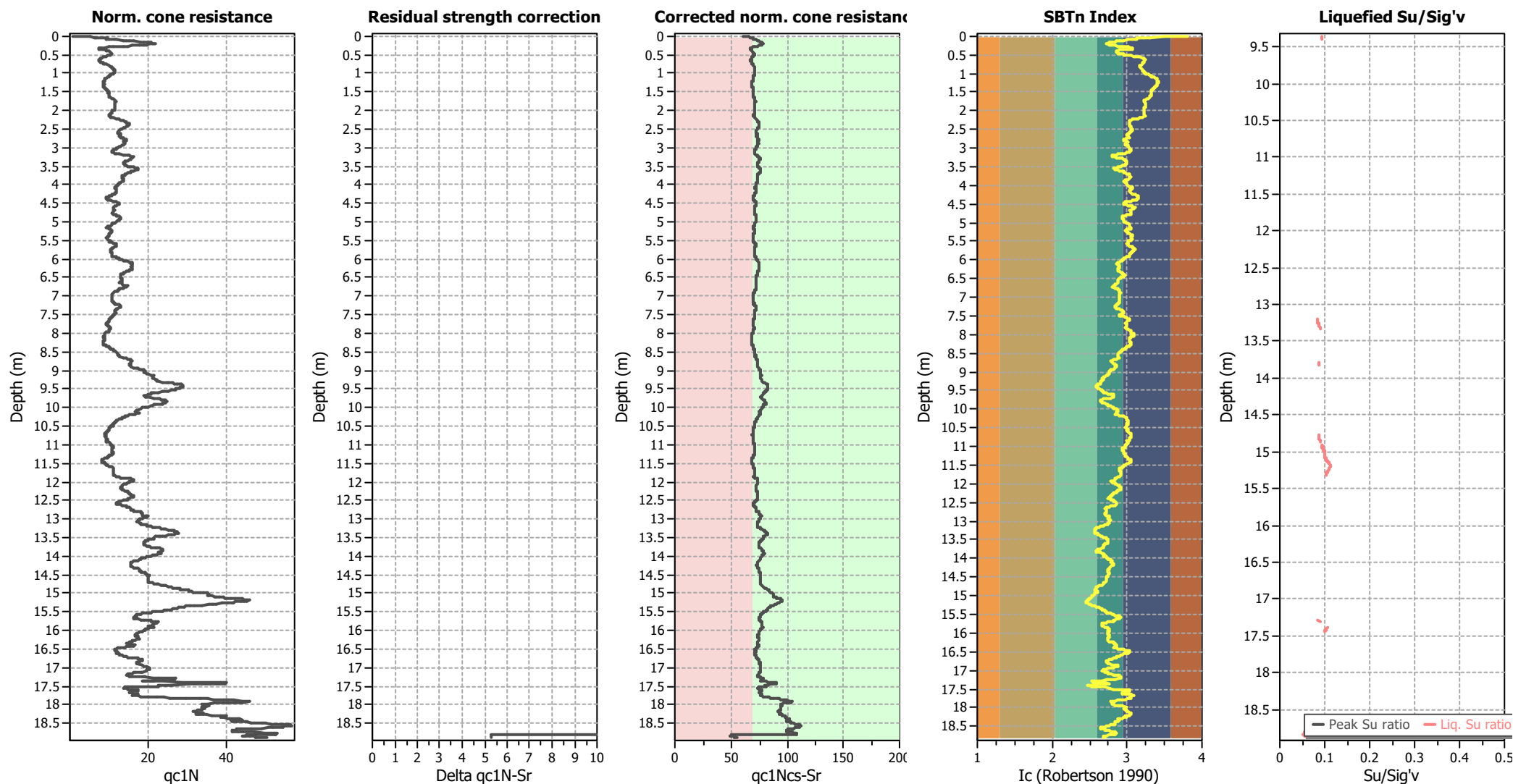
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

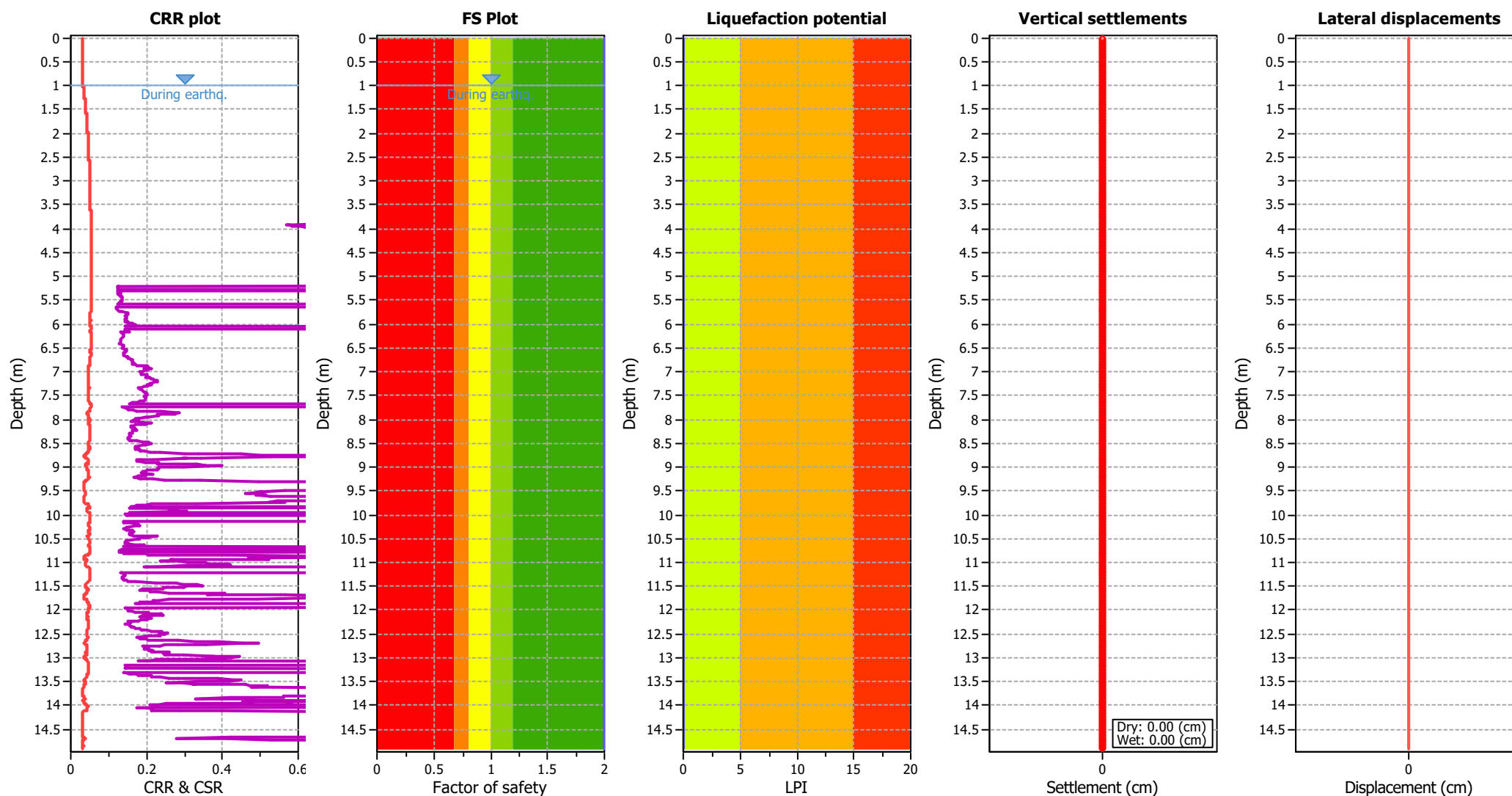
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

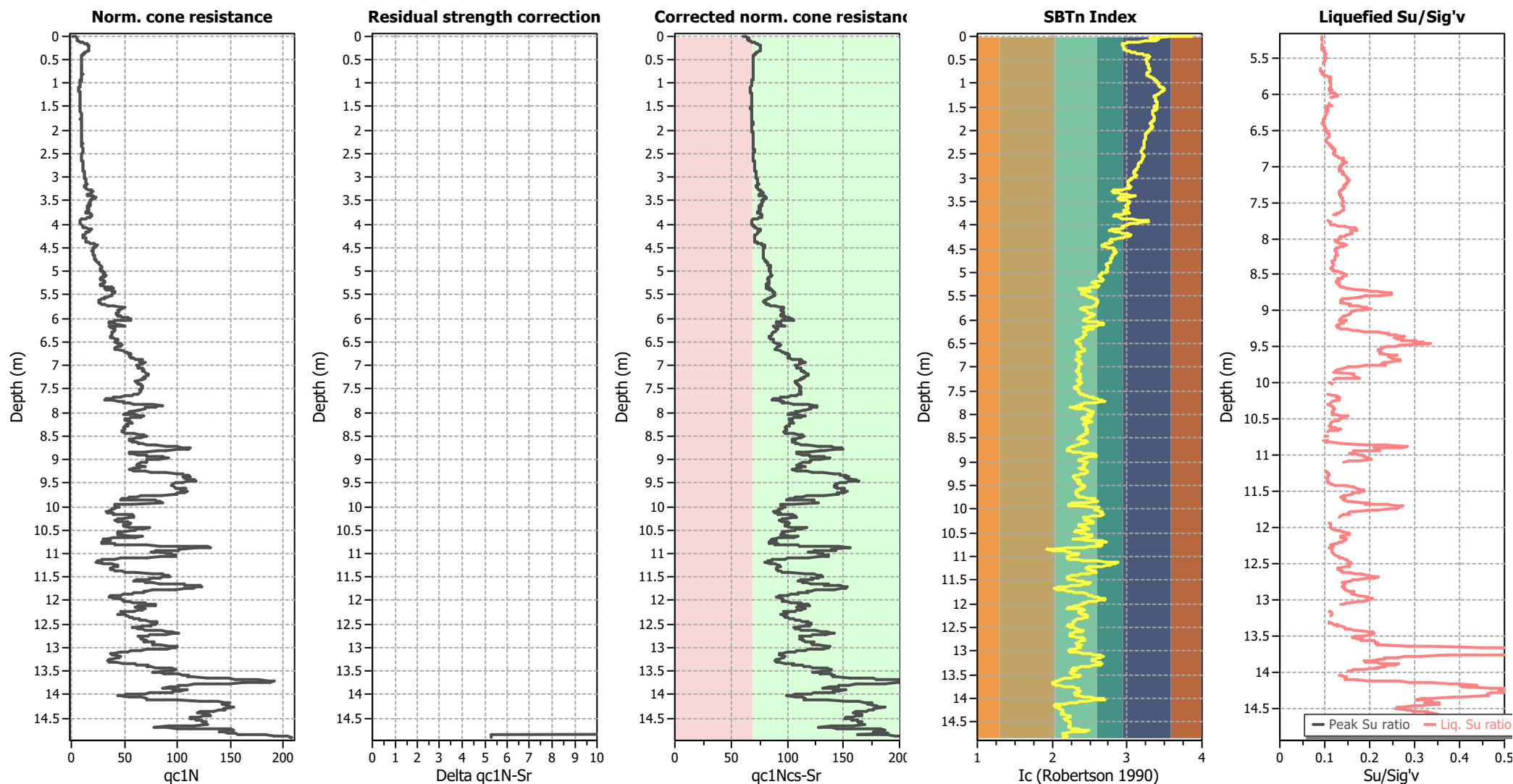
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
■	Unlike to liquefy
■	Almost certain it will not liquefy

LPI color scheme

■	Very high risk
■	High risk
■	Low risk

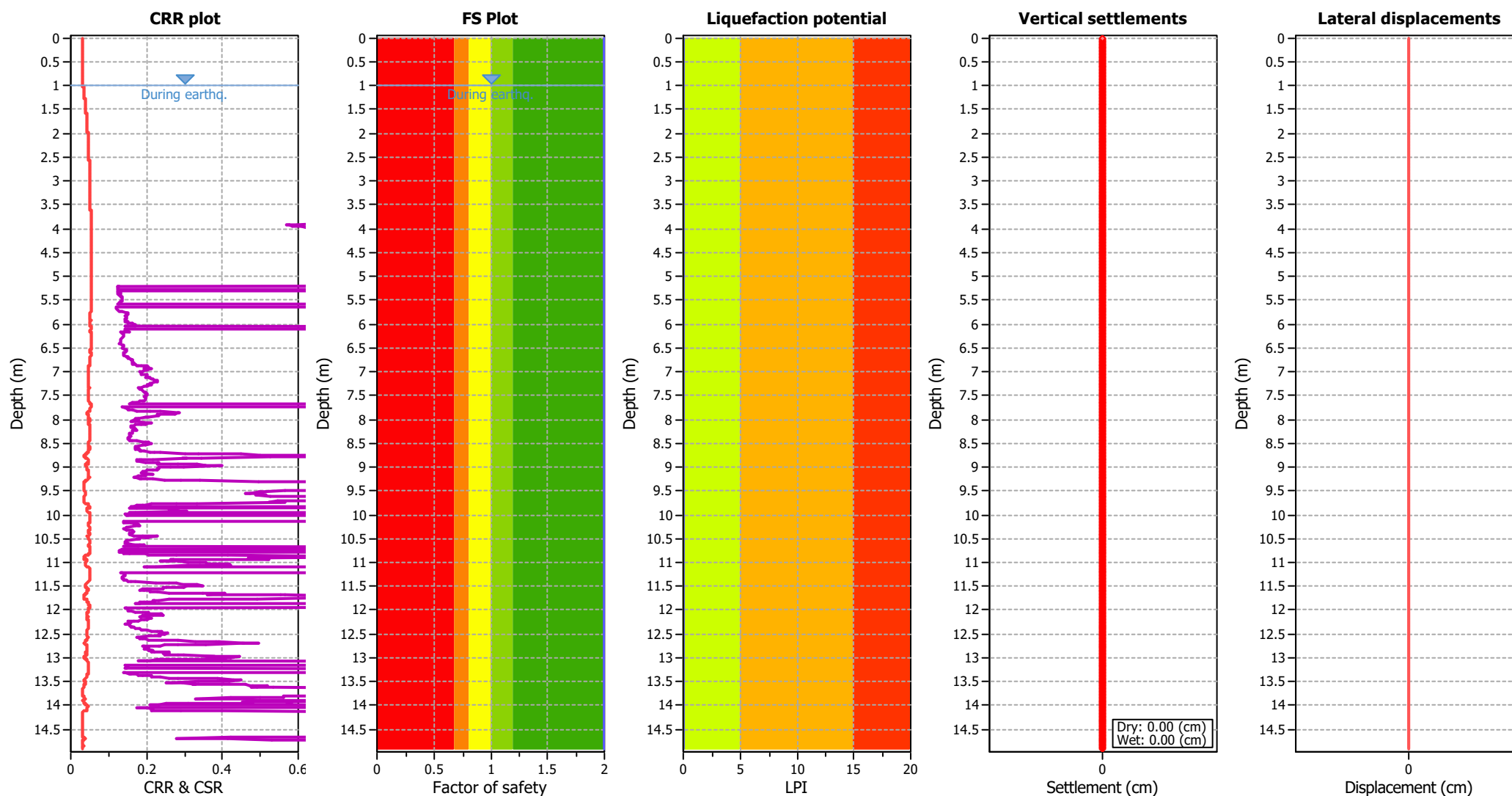
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

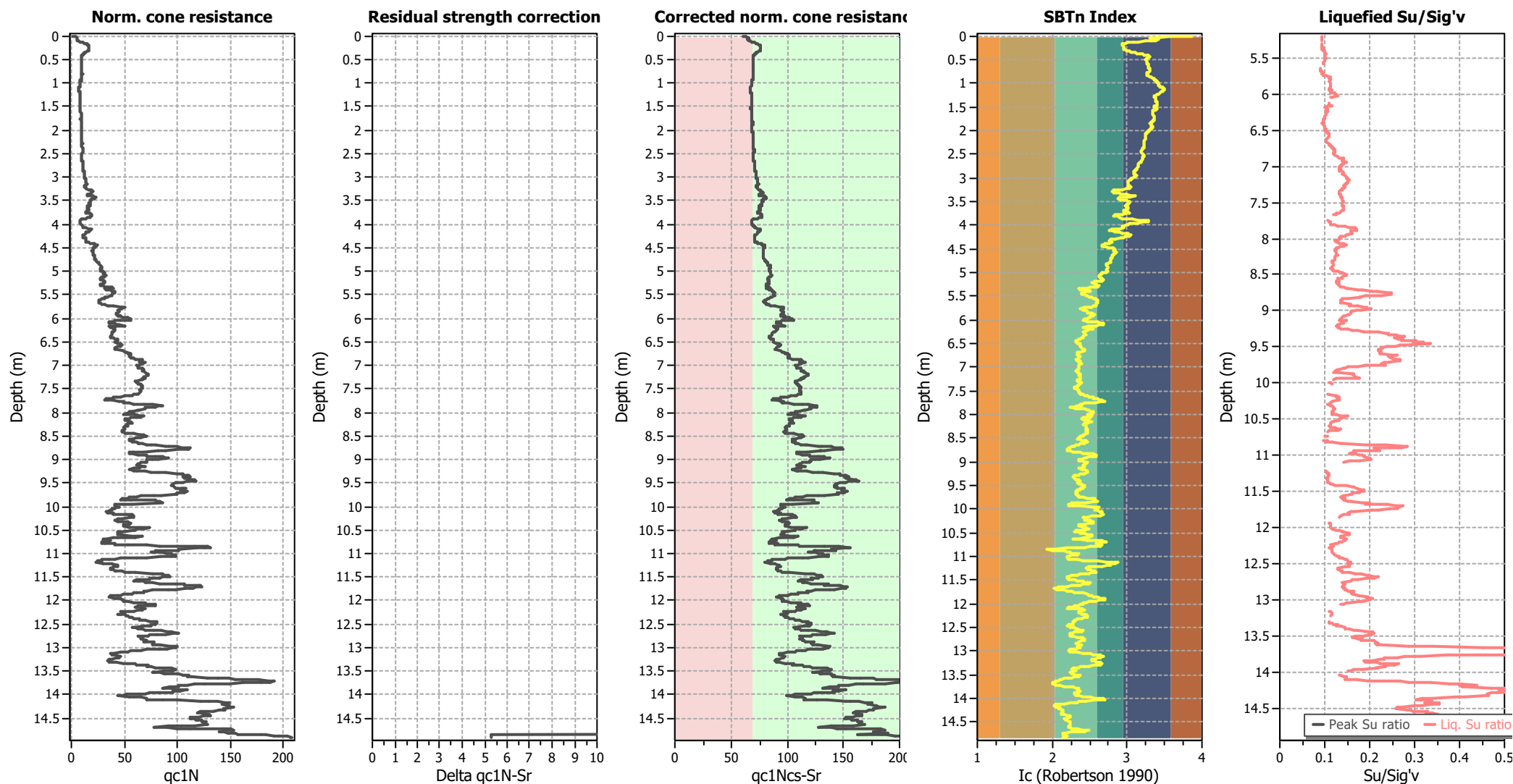
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
■	Unlike to liquefy
■	Almost certain it will not liquefy

LPI color scheme

■	Very high risk
■	High risk
■	Low risk

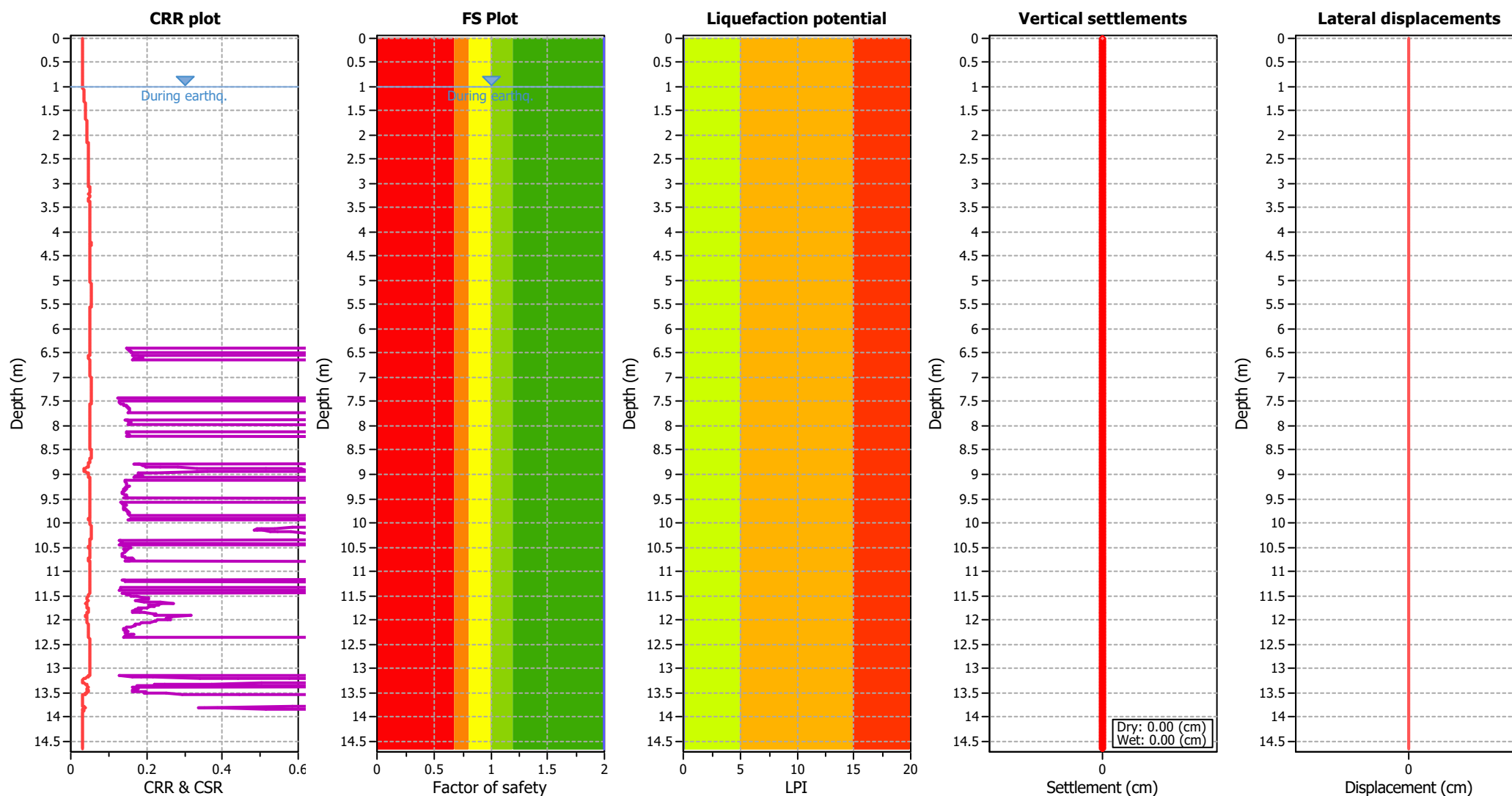
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

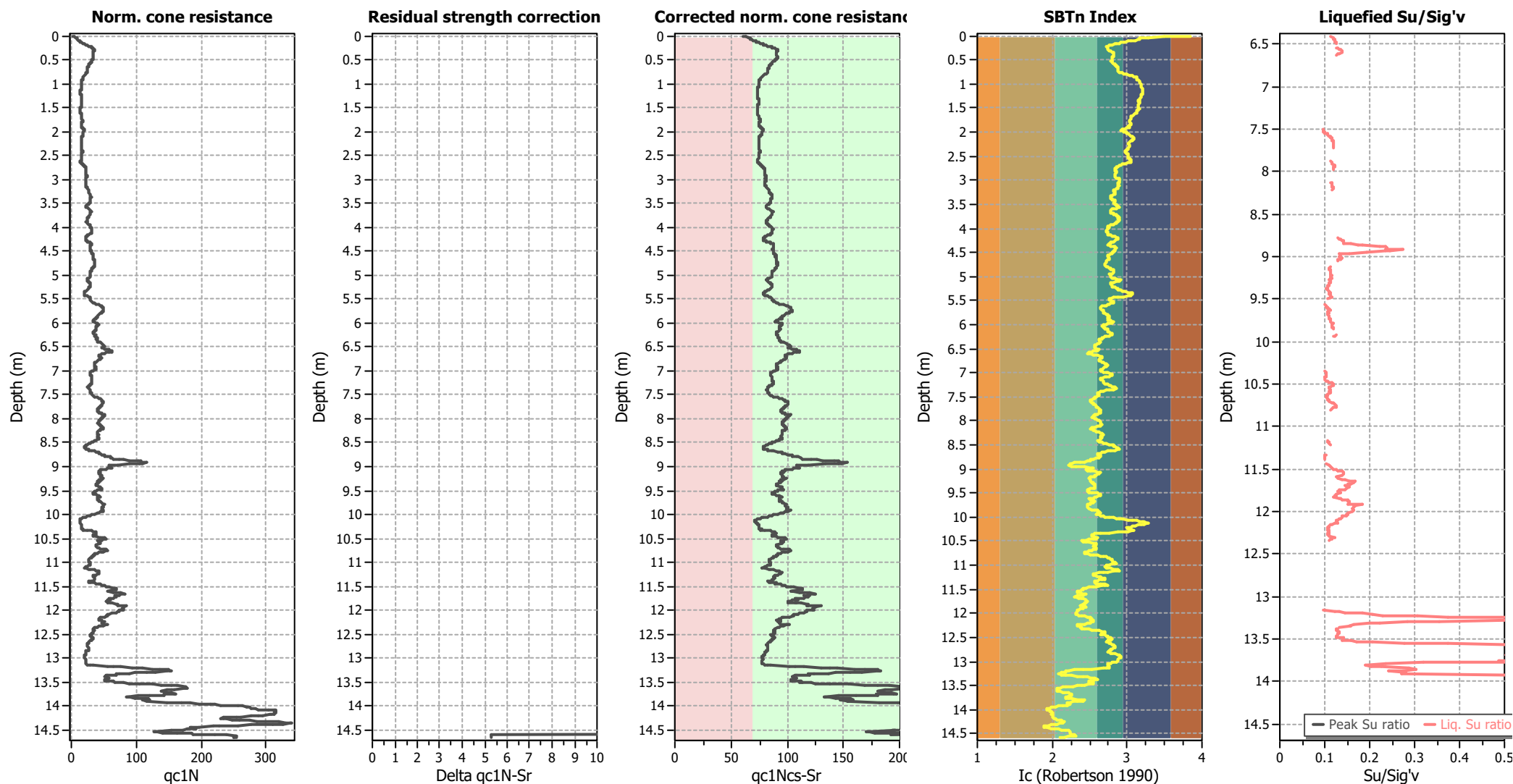
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
■	Unlike to liquefy
■	Almost certain it will not liquefy

LPI color scheme

■	Very high risk
■	High risk
■	Low risk

Check for strength loss plots (Idriss & Boulanger (2008))

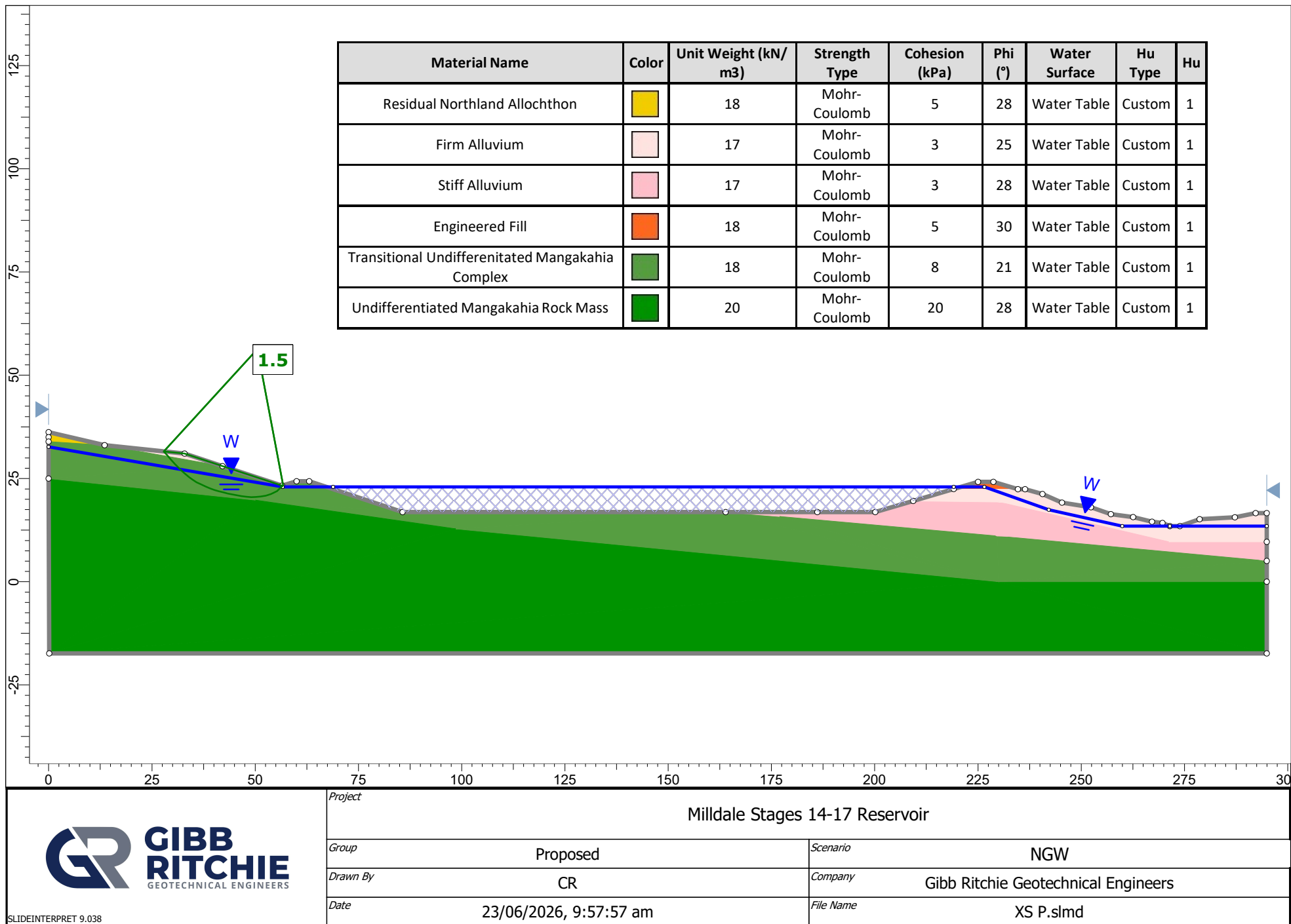


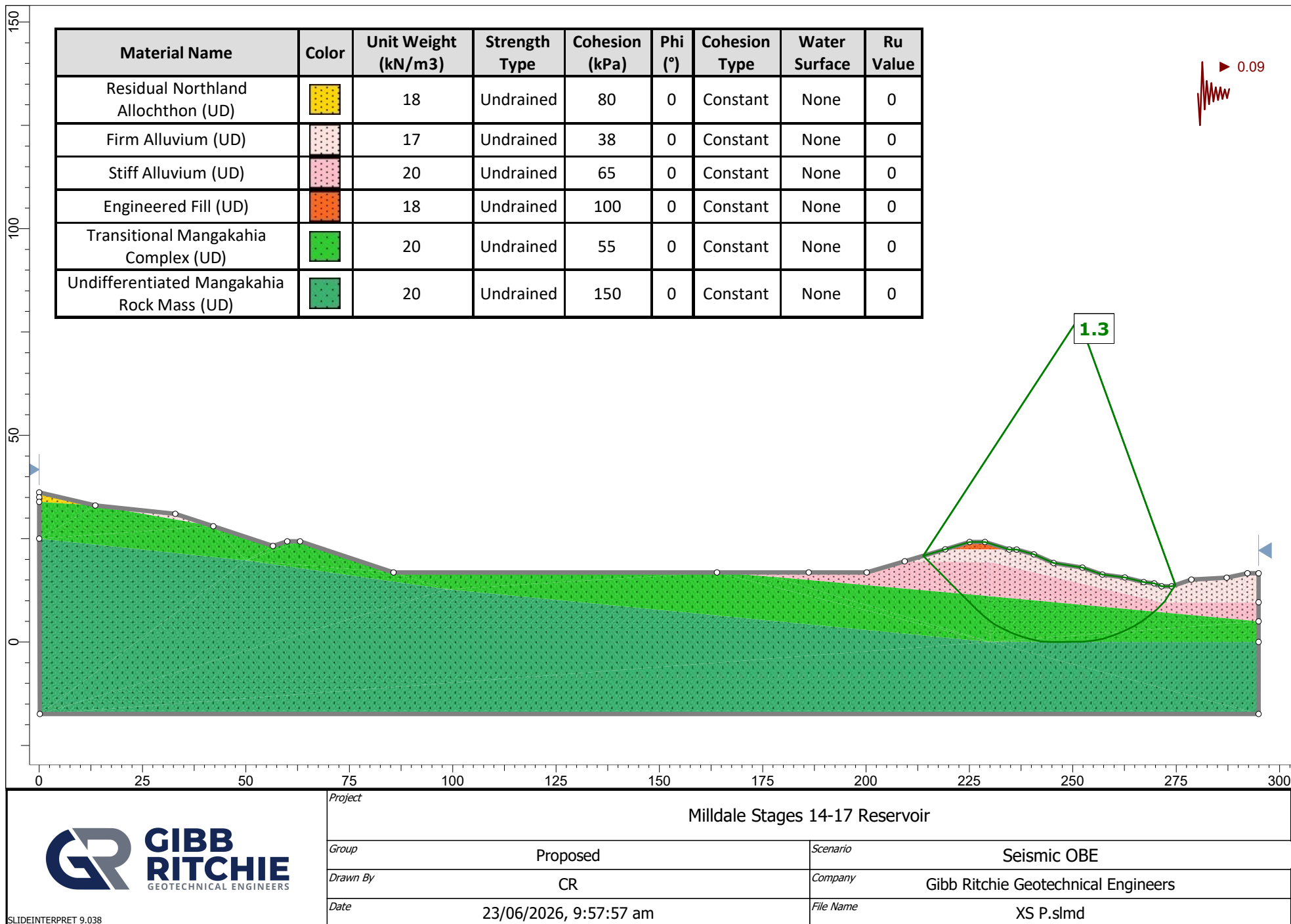
Input parameters and analysis data

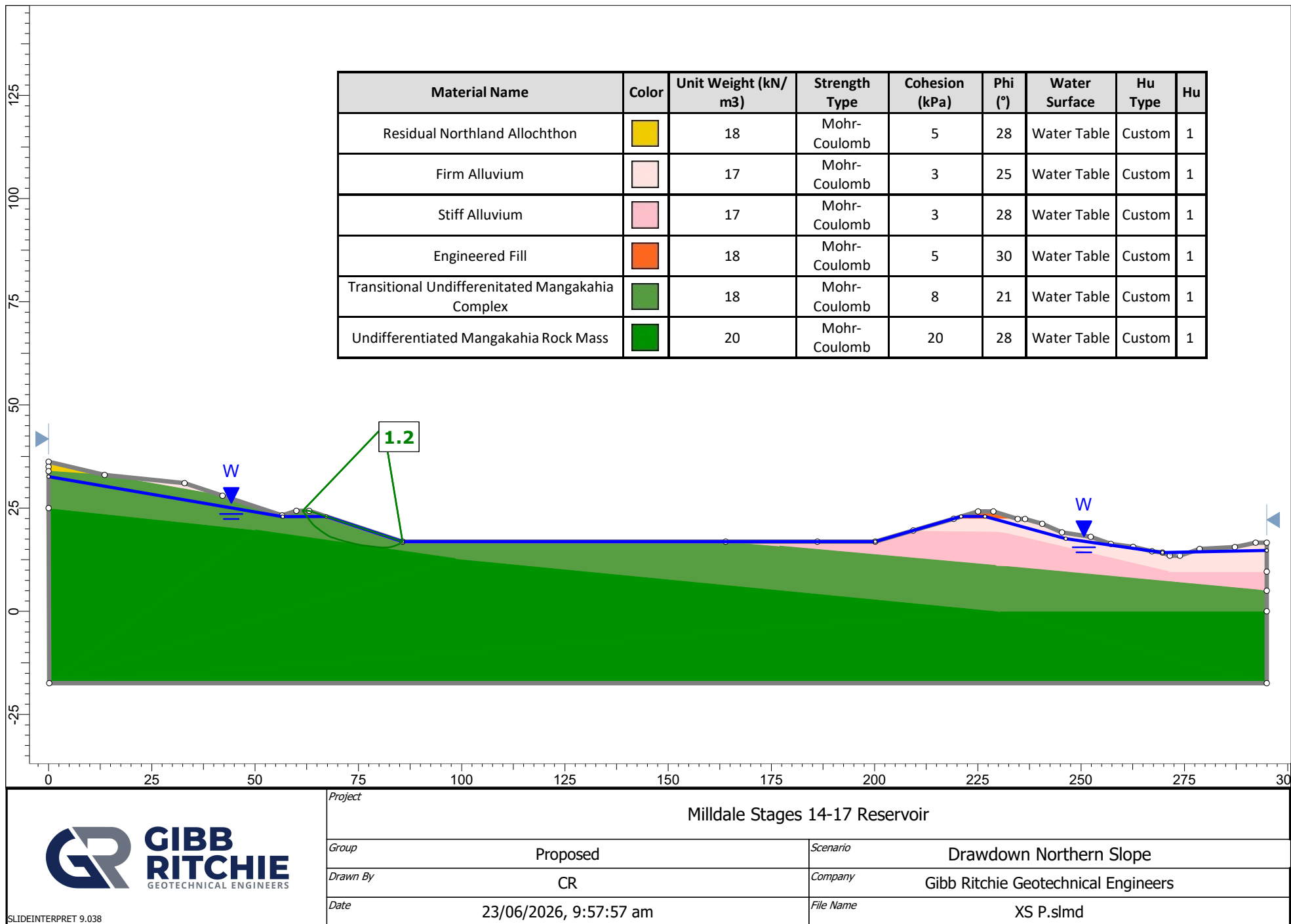
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

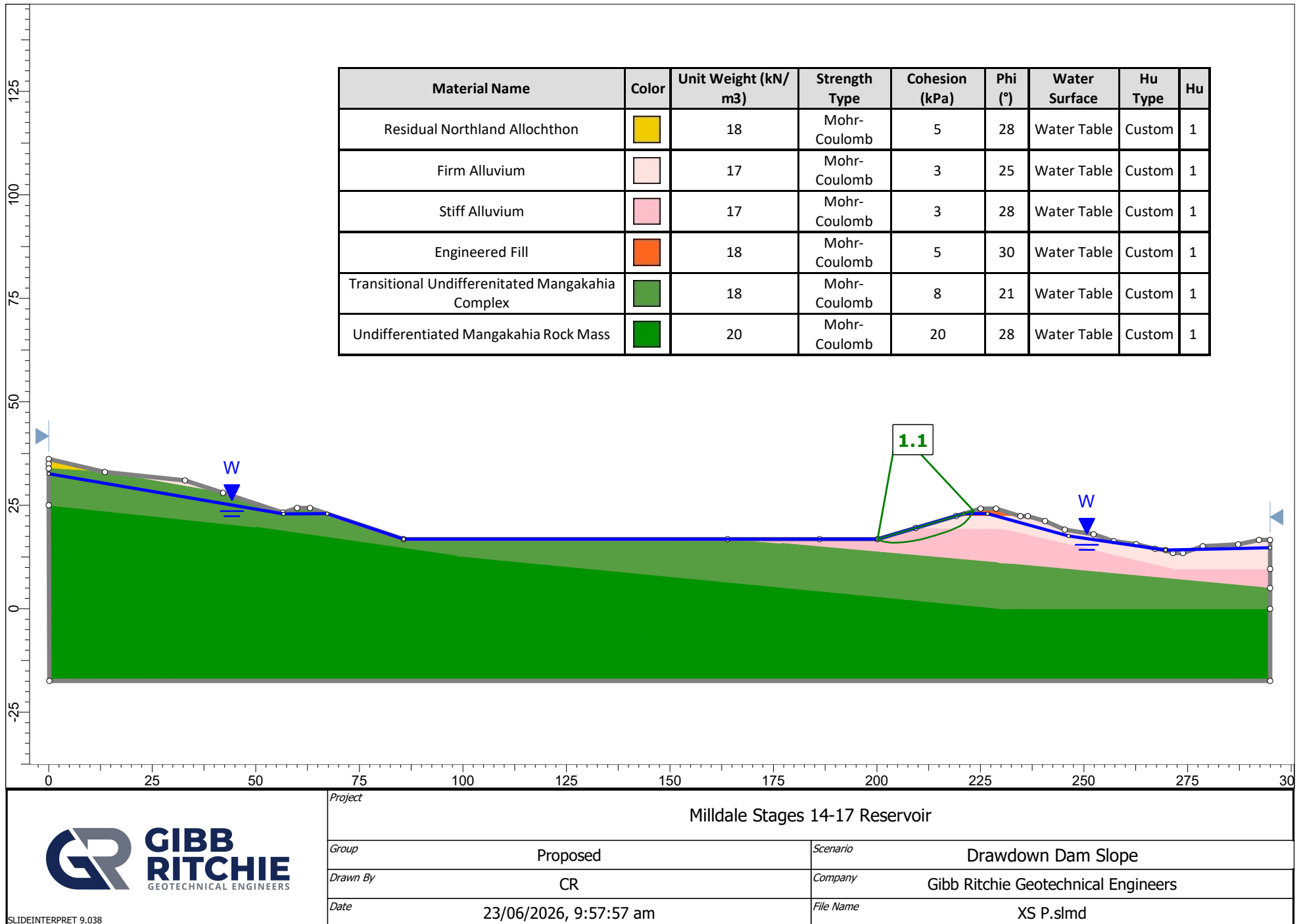
APPENDIX F

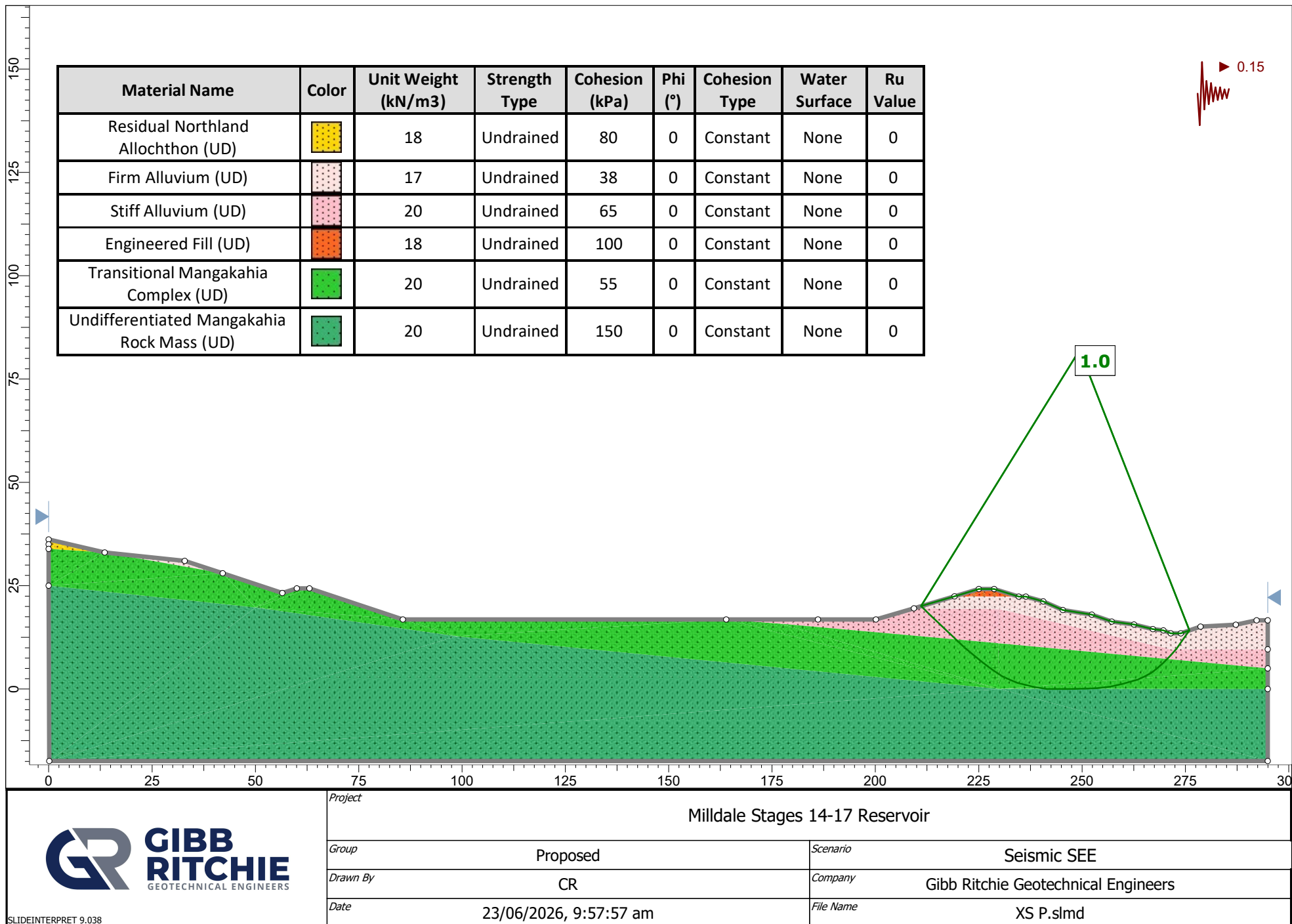
Slope Stability Outputs

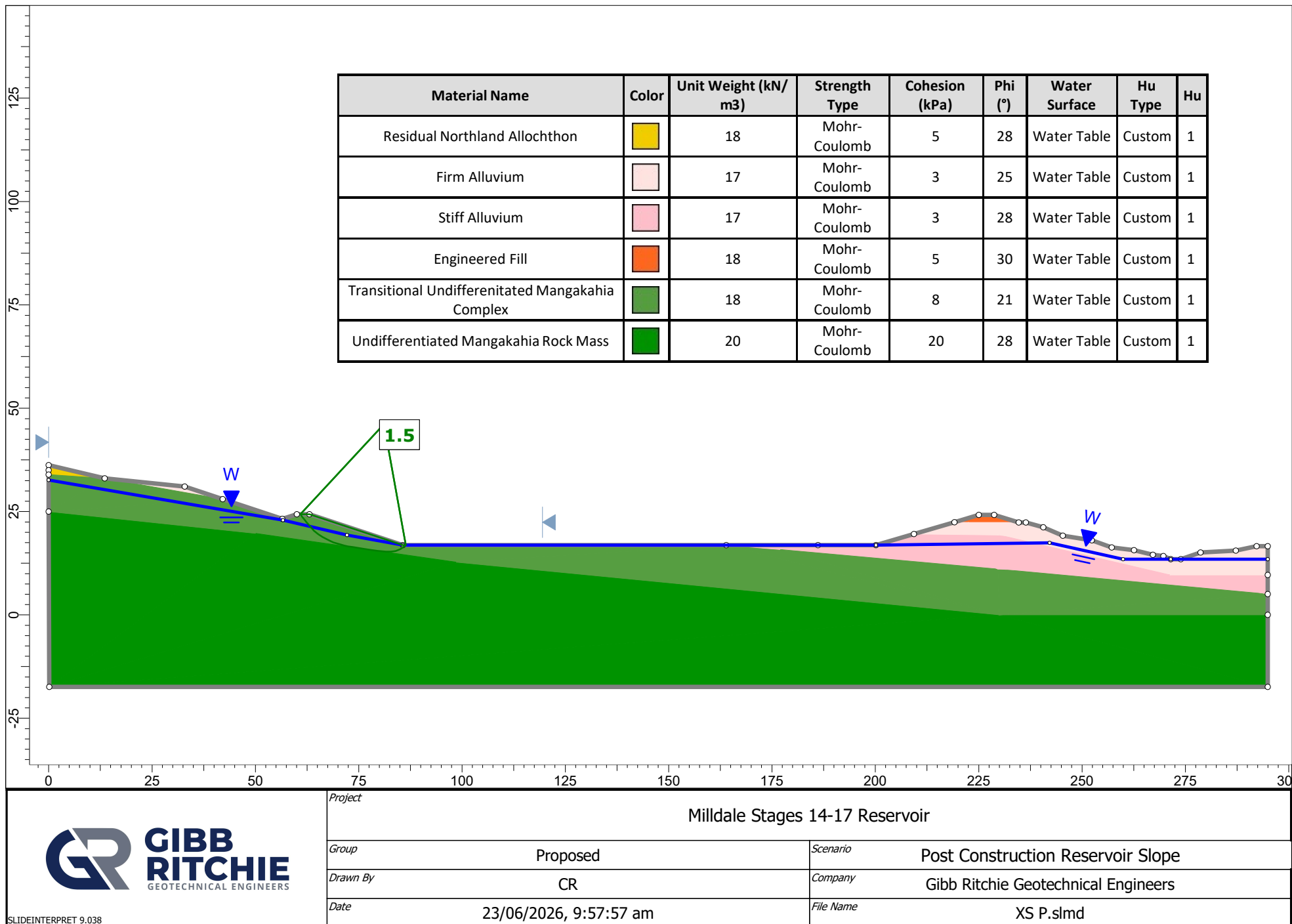


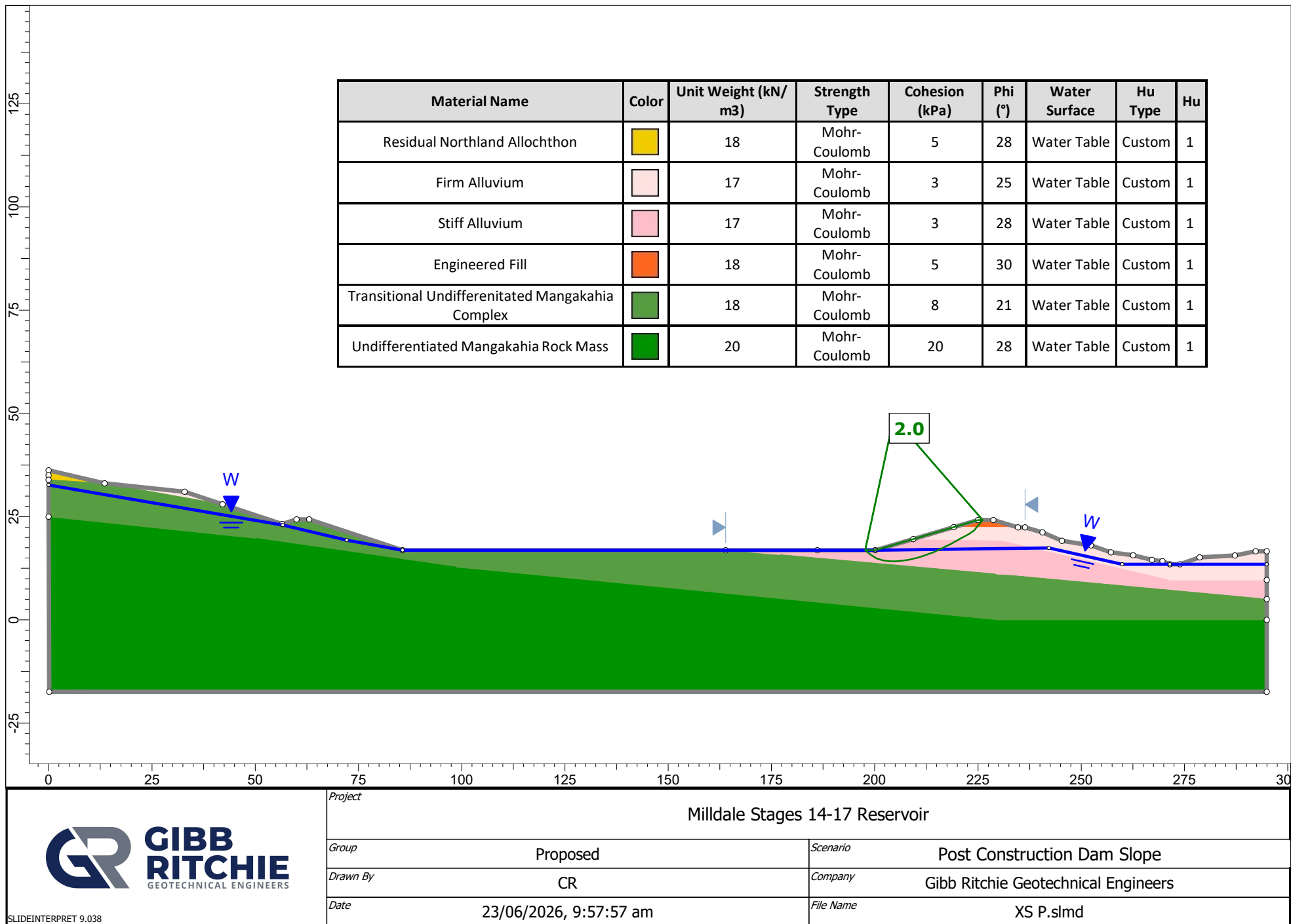


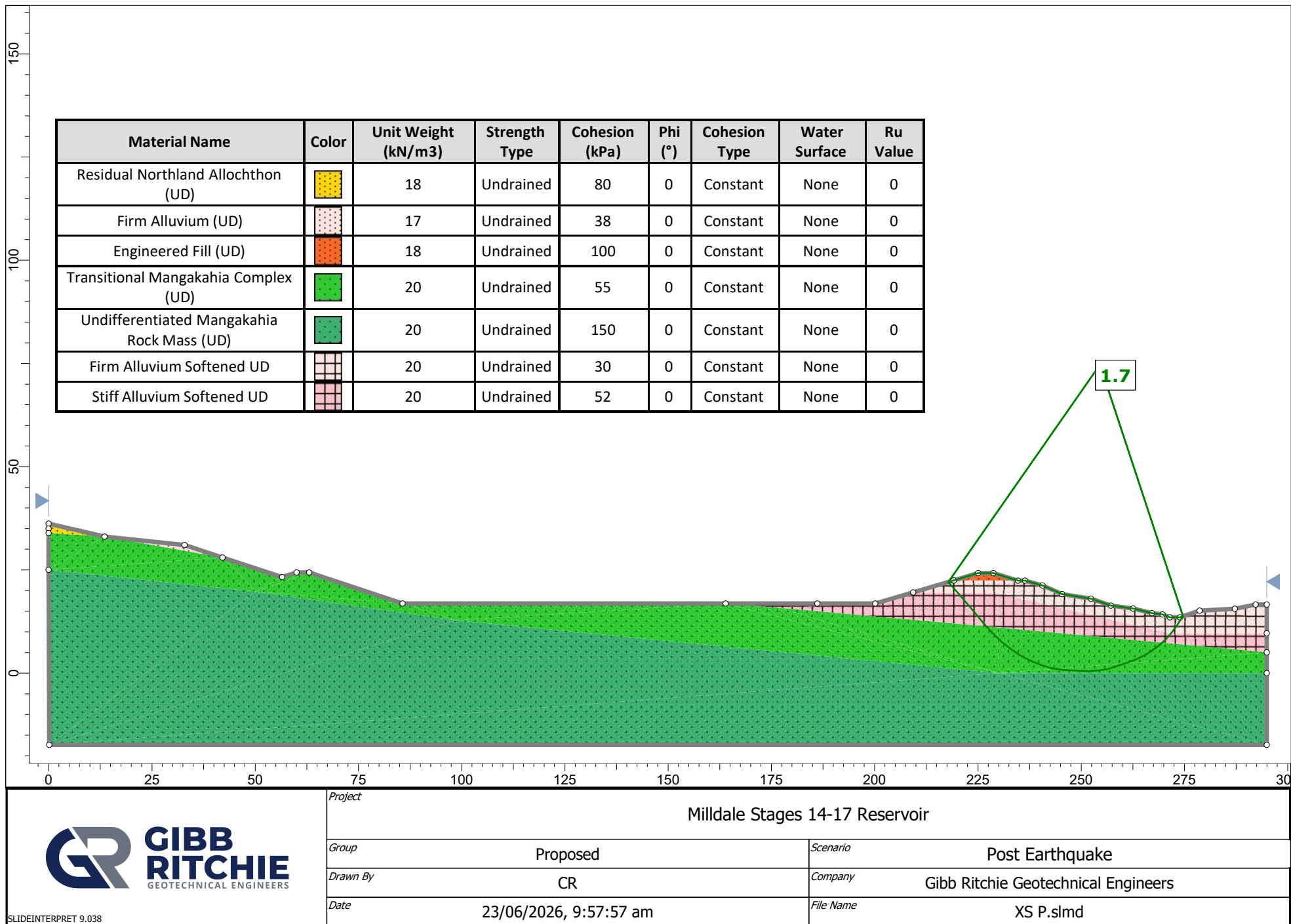


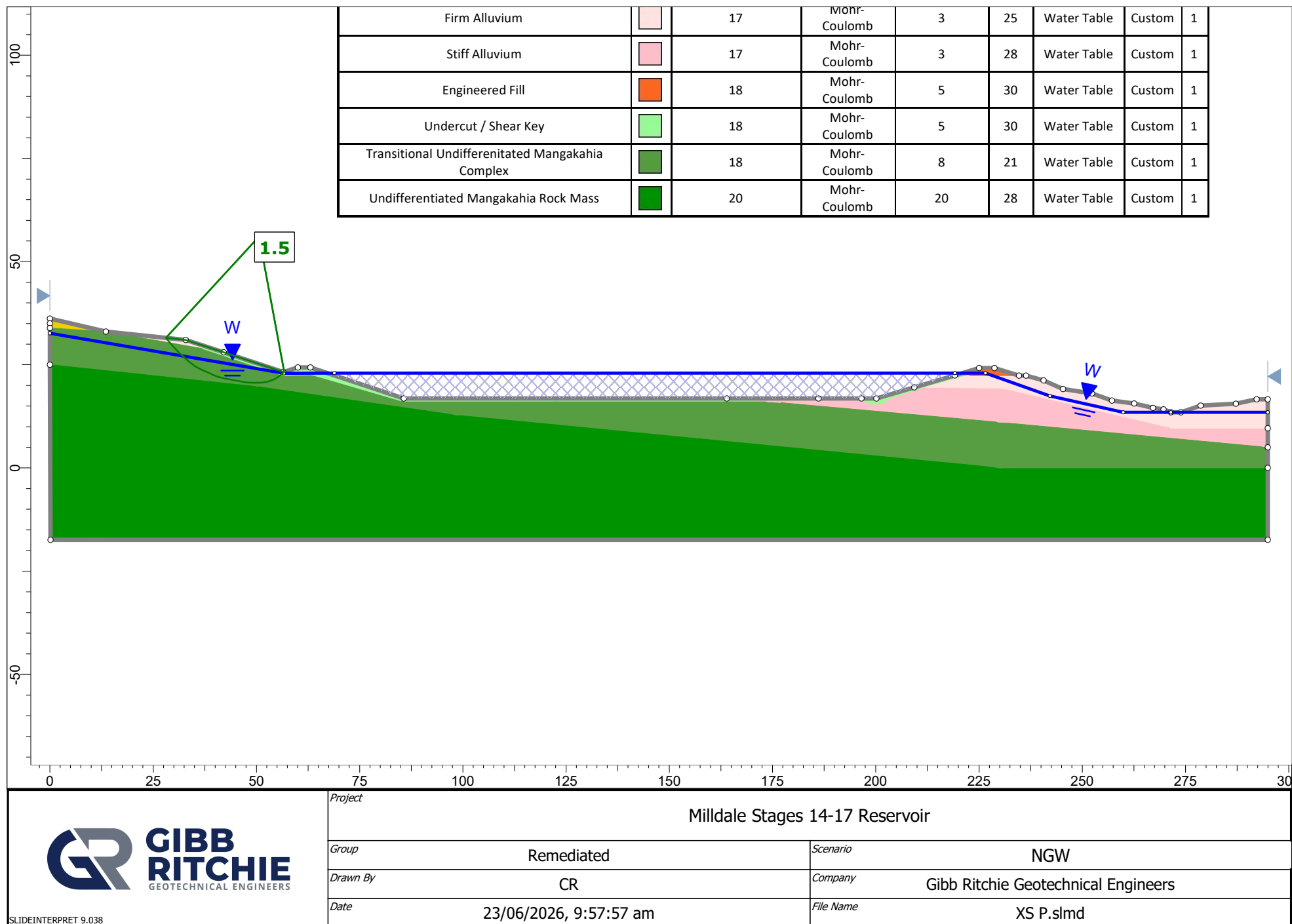






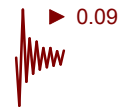




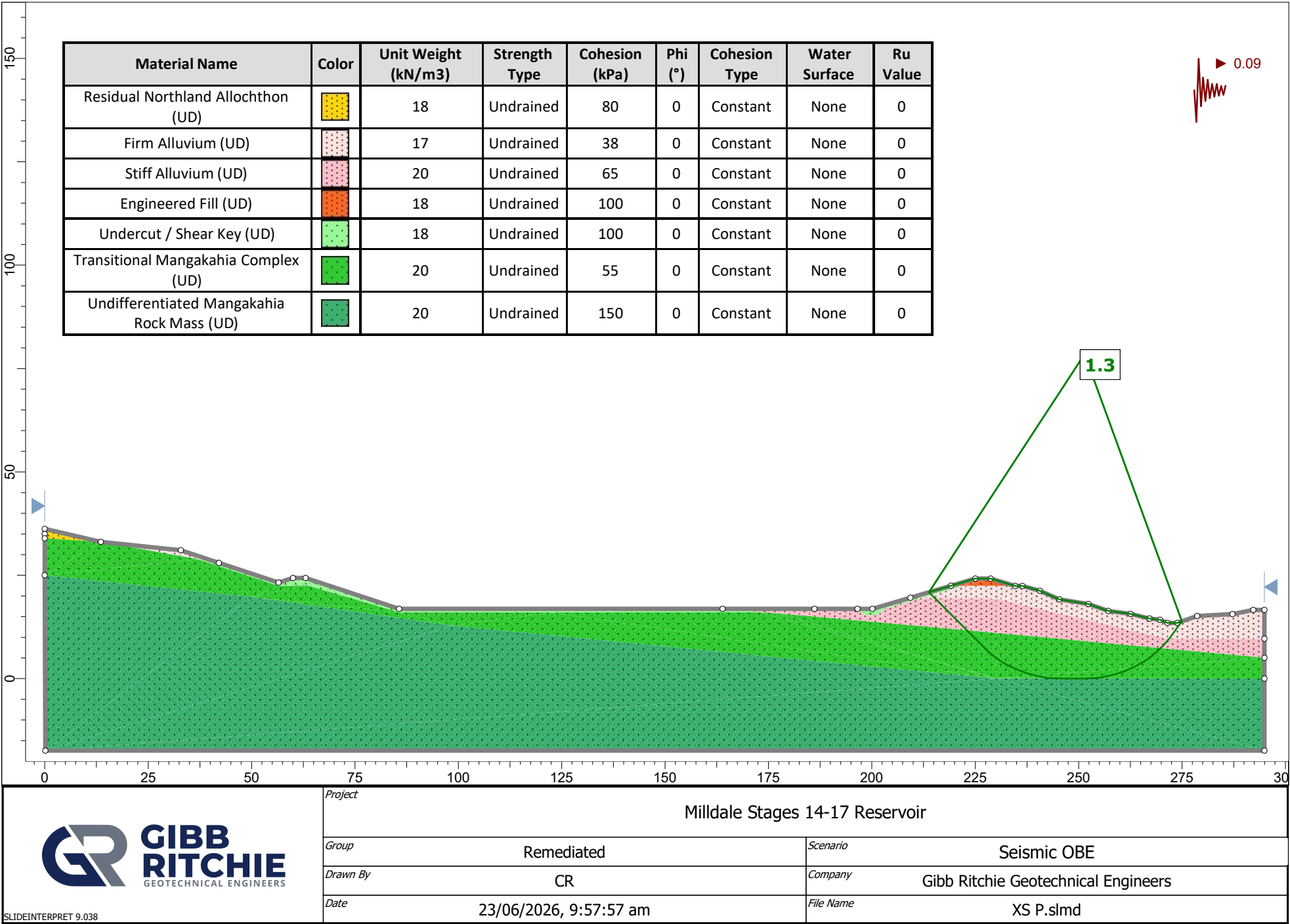


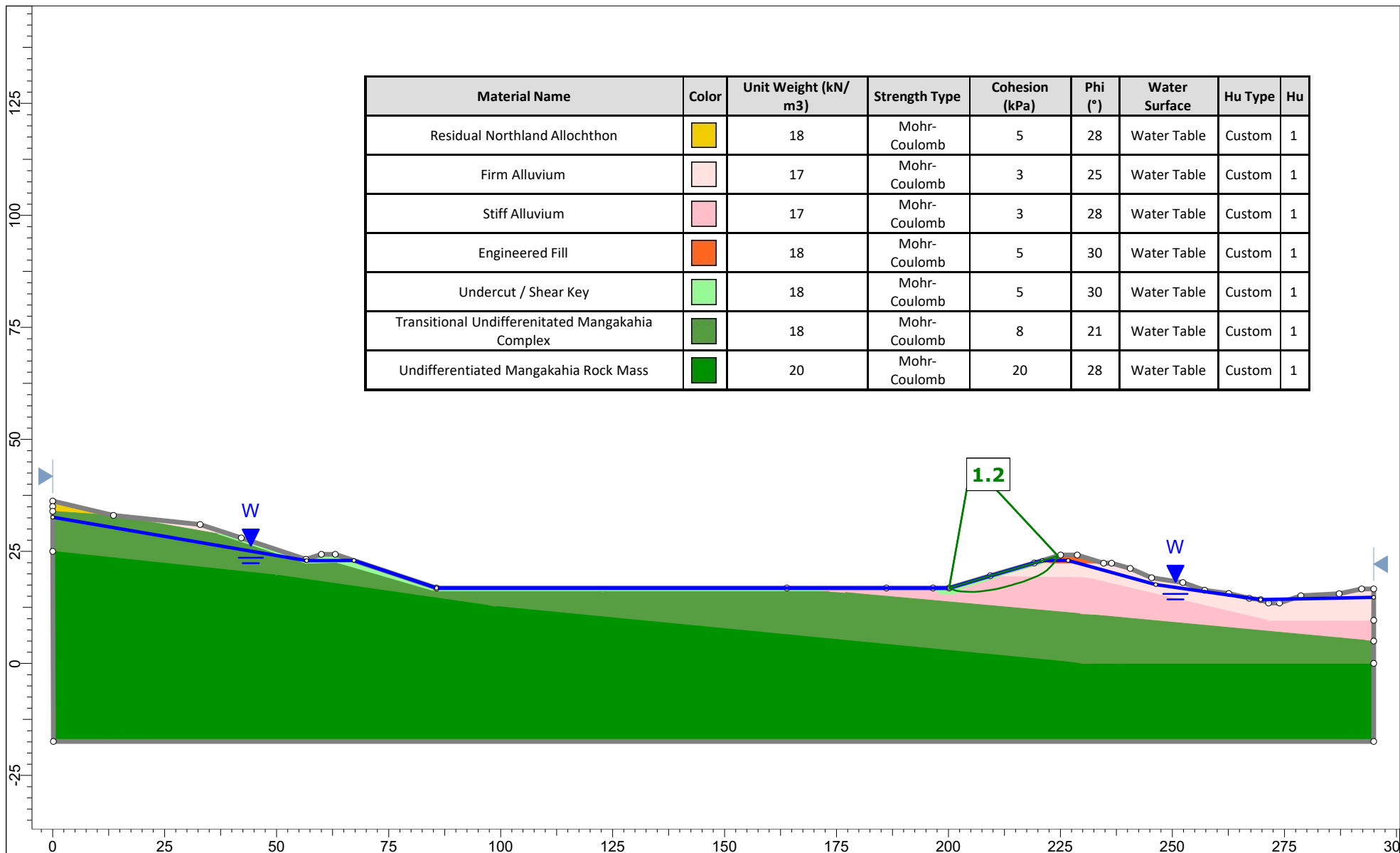
Project		Milldale Stages 14-17 Reservoir	
Group	Remediated	Scenario	NGW
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	23/06/2026, 9:57:57 am	File Name	XS P.sldm

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface	Ru Value
Residual Northland Allochthon (UD)		18	Undrained	80	0	Constant	None	0
Firm Alluvium (UD)		17	Undrained	38	0	Constant	None	0
Stiff Alluvium (UD)		20	Undrained	65	0	Constant	None	0
Engineered Fill (UD)		18	Undrained	100	0	Constant	None	0
Undercut / Shear Key (UD)		18	Undrained	100	0	Constant	None	0
Transitional Mangakahia Complex (UD)		20	Undrained	55	0	Constant	None	0
Undifferentiated Mangakahia Rock Mass (UD)		20	Undrained	150	0	Constant	None	0



1.3



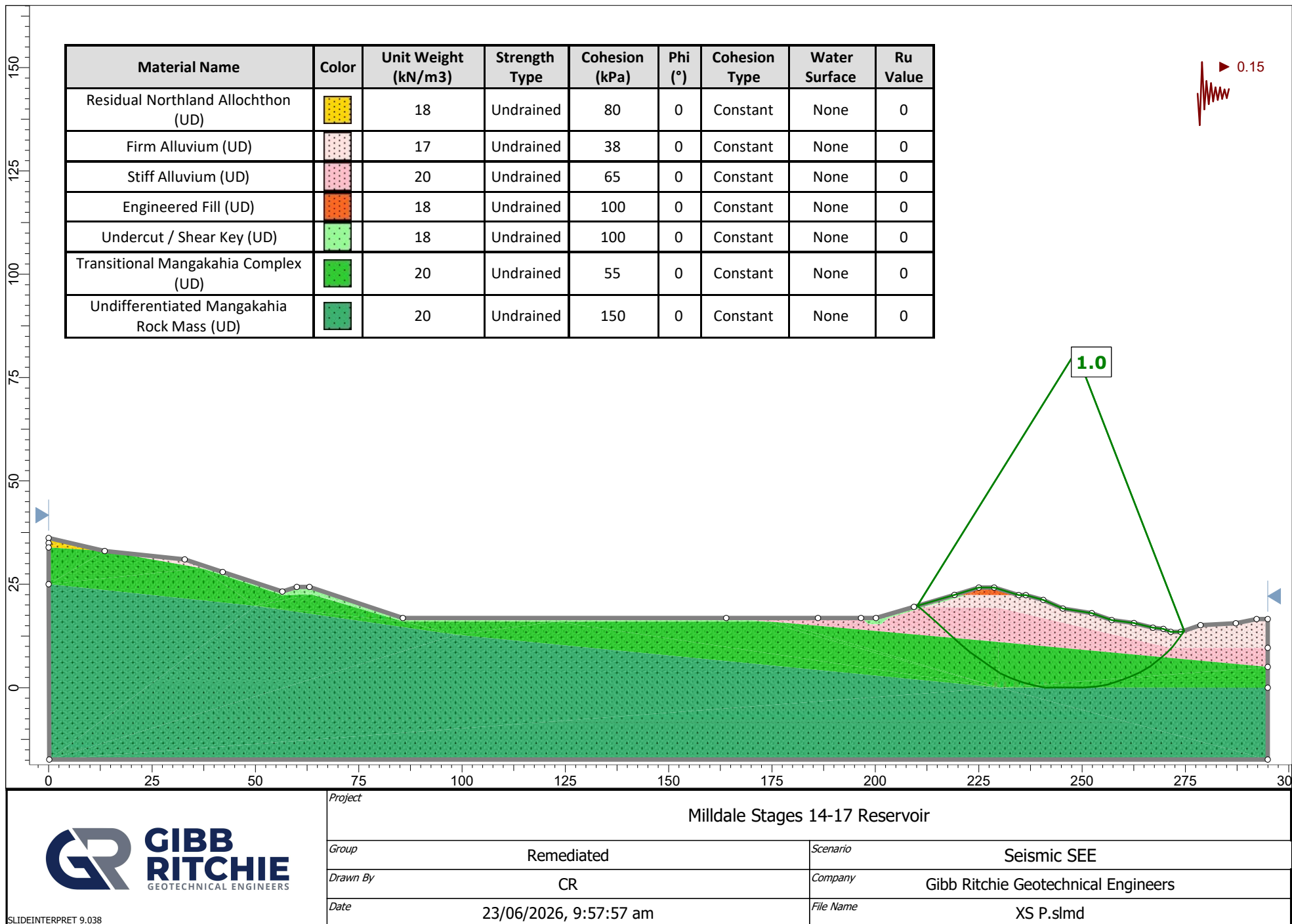


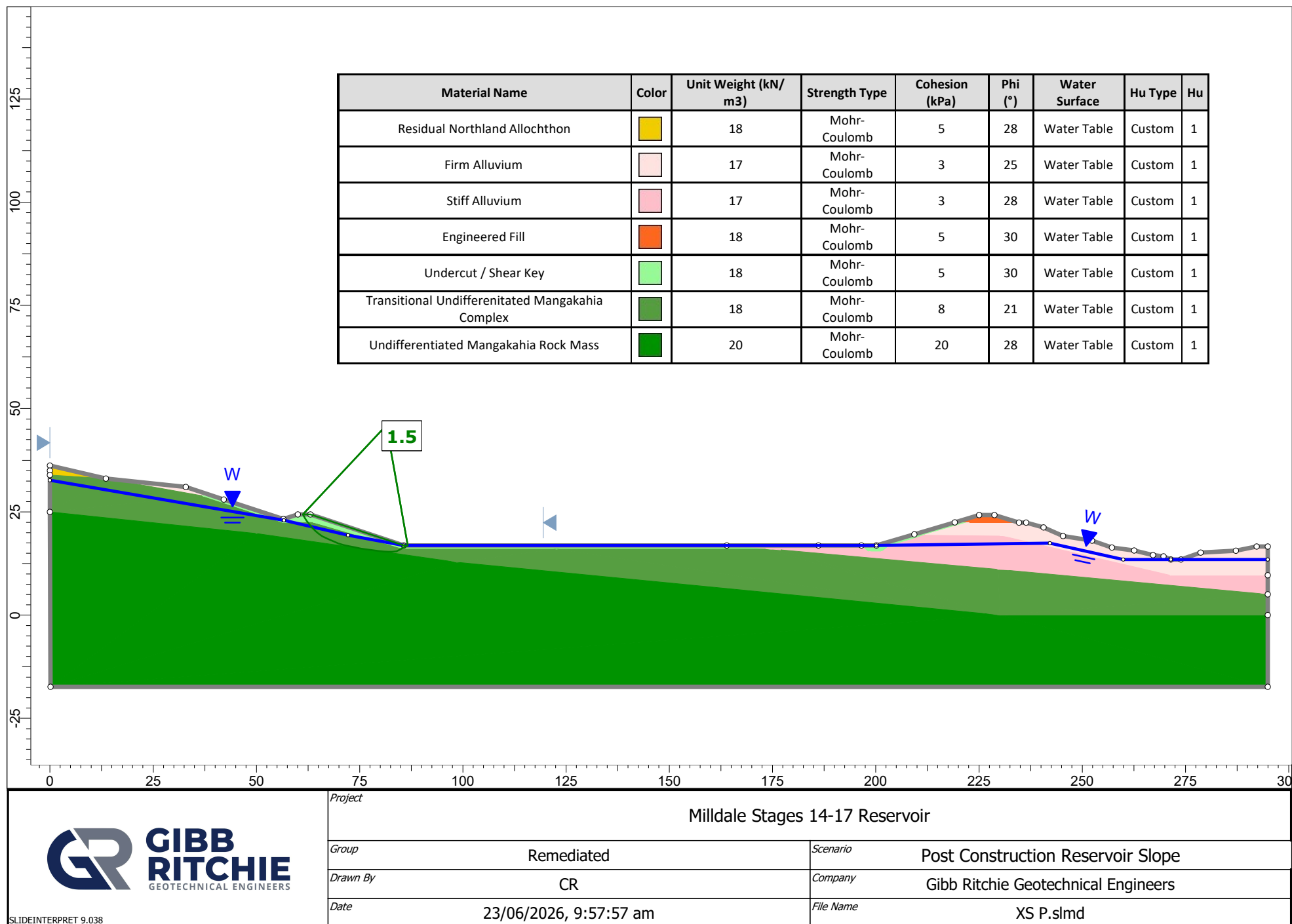
Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon		18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium		17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium		17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Undercut / Shear Key		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex		18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass		20	Mohr-Coulomb	20	28	Water Table	Custom	1

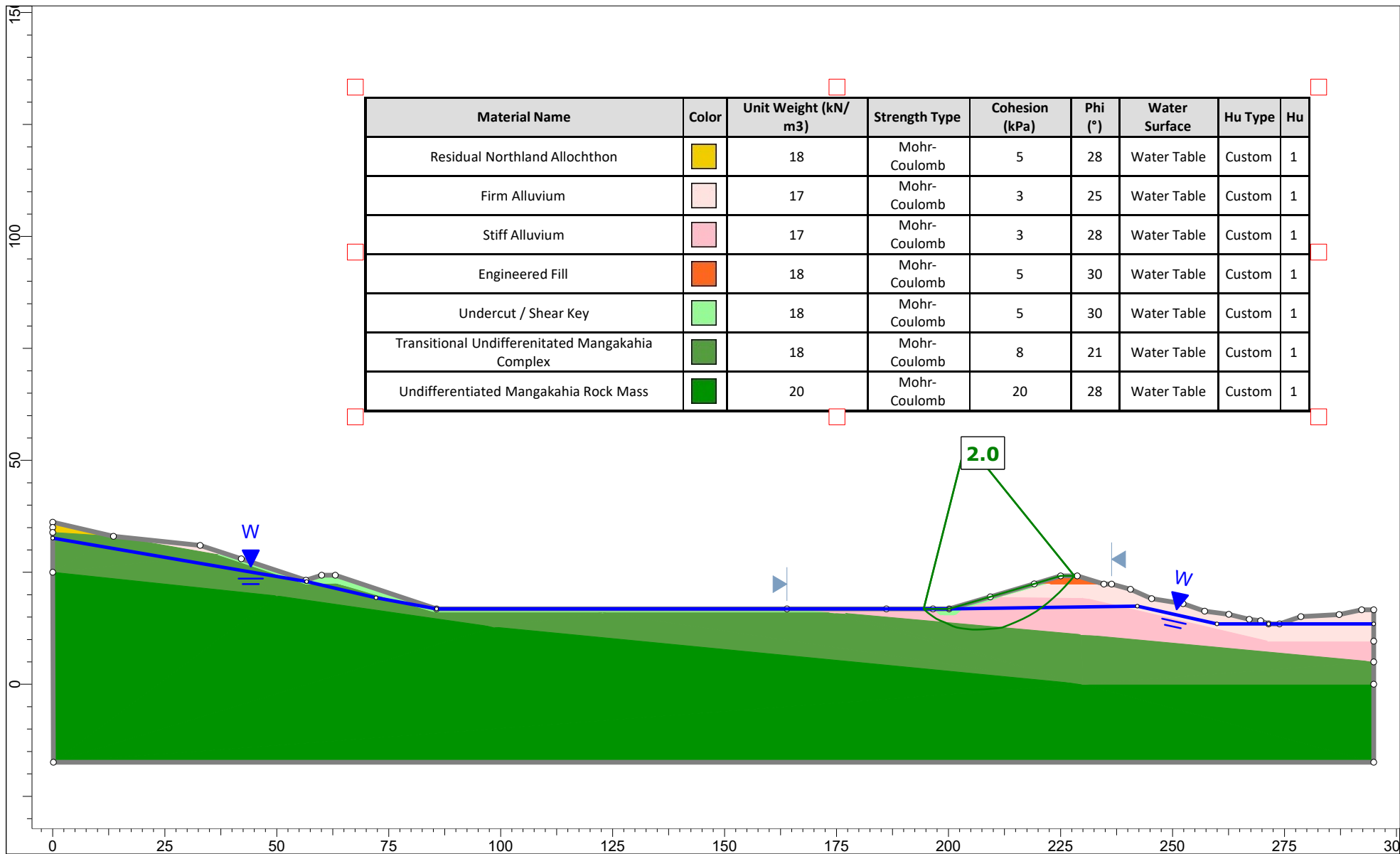


SLIDEINTERPRET 9.038

Project		Milldale Stages 14-17 Reservoir	
Group	Remediated	Scenario	Drawdown Dam Slope
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	23/06/2026, 9:57:57 am	File Name	XS P.sldm





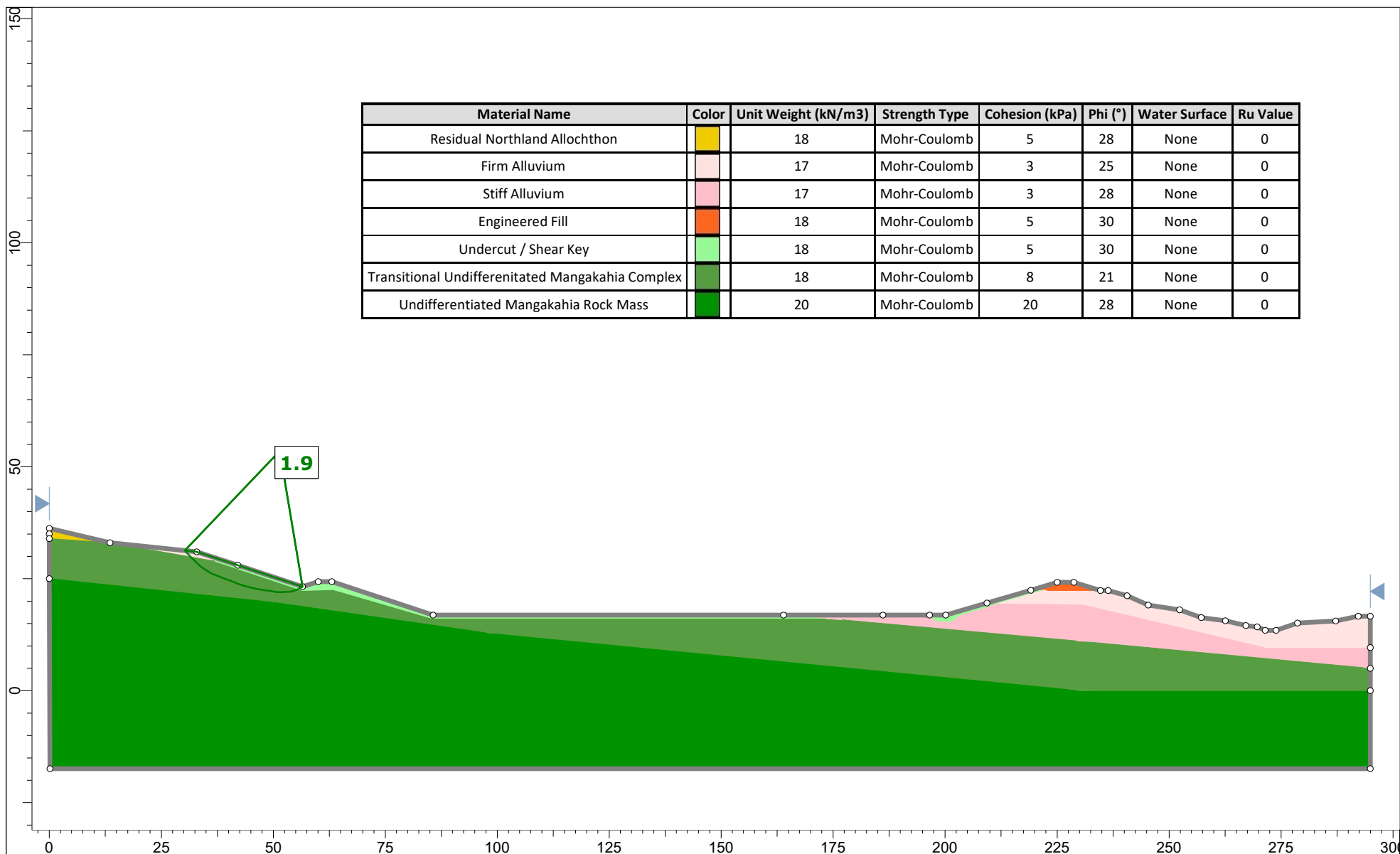


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon		18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium		17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium		17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Undercut / Shear Key		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex		18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass		20	Mohr-Coulomb	20	28	Water Table	Custom	1



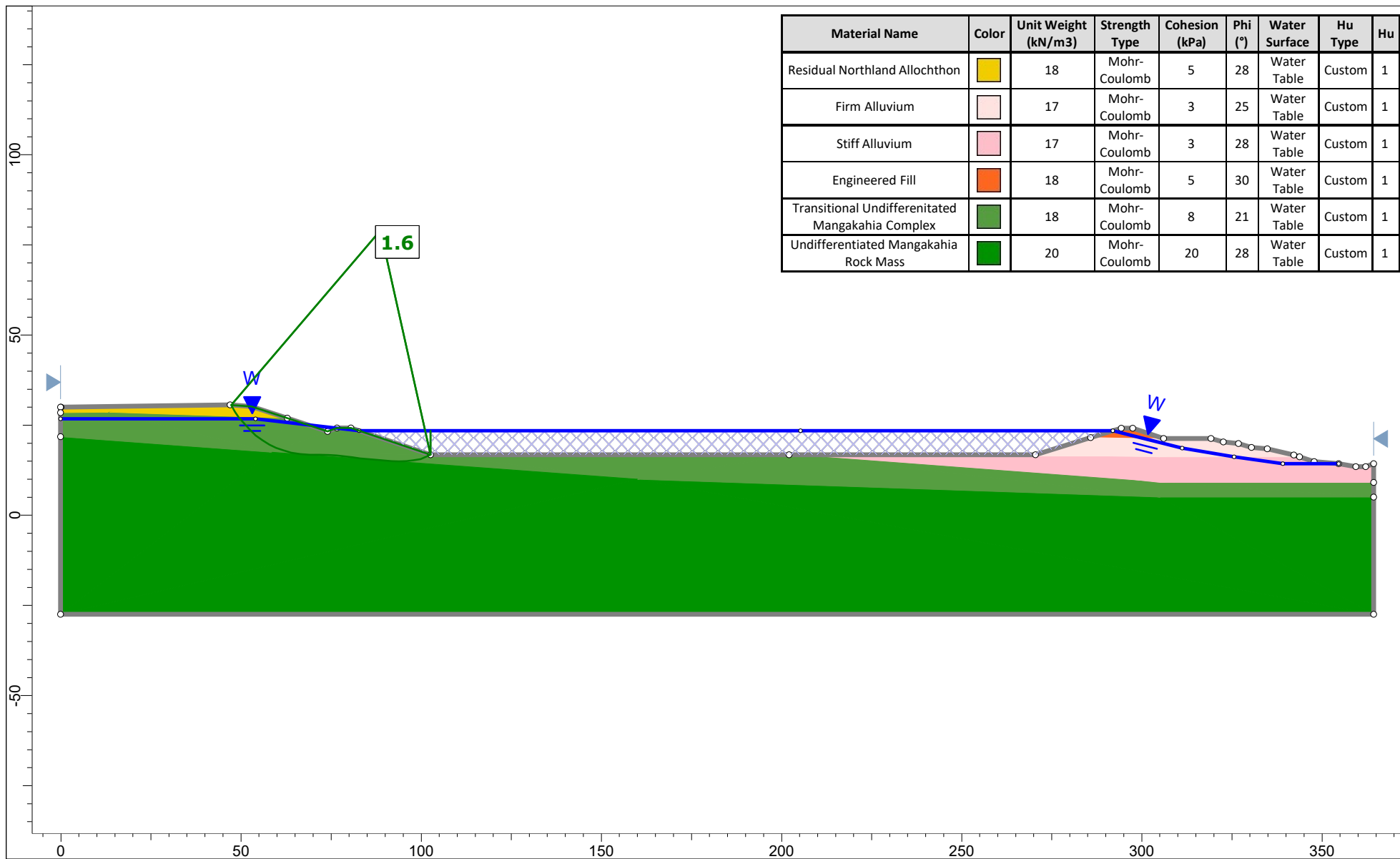
SLIDEINTERPRET 9.038

Project			
Milldale Stages 14-17 Reservoir			
Group	Remediated	Scenario	Post Construction Dam Slope
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	23/06/2026, 9:57:57 am	File Name	XS P.sldm



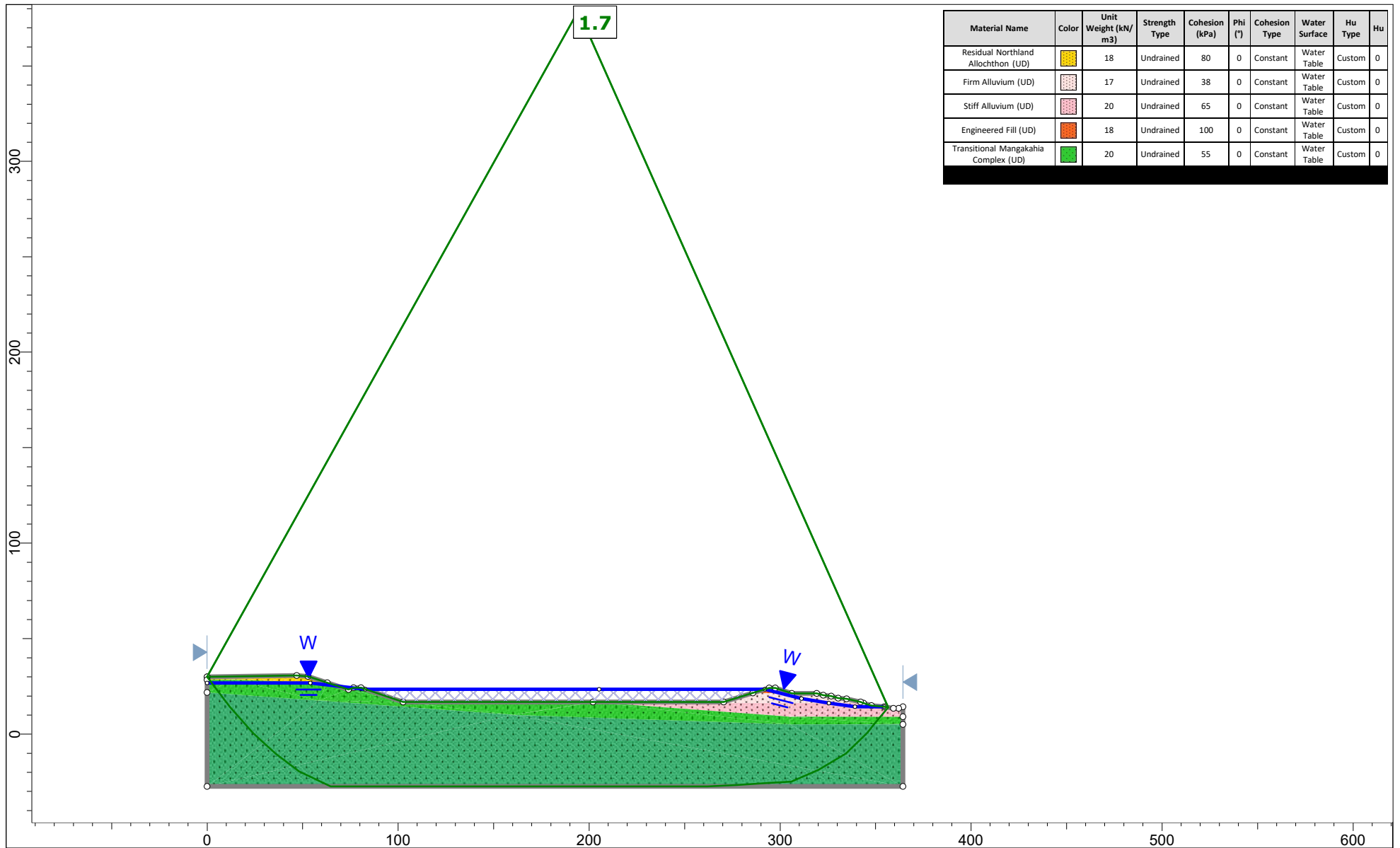
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Project		Milldale Stages 14-17 Reservoir	
Group	Remediated	Scenario	Post Earthquake
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	23/06/2026, 9:57:57 am	File Name	XS P.slm



SLIDEINTERPRET 9.038

Project			XS Q - Milldale Stages 14 to 17 Reservoir		
Group		Proposed	Scenario		NGW
Drawn By		CR	Company		Gibb Ritchie Geotechnical Engineers
Date		24/06/2026, 8:10:33 am	File Name		XS Q.slm

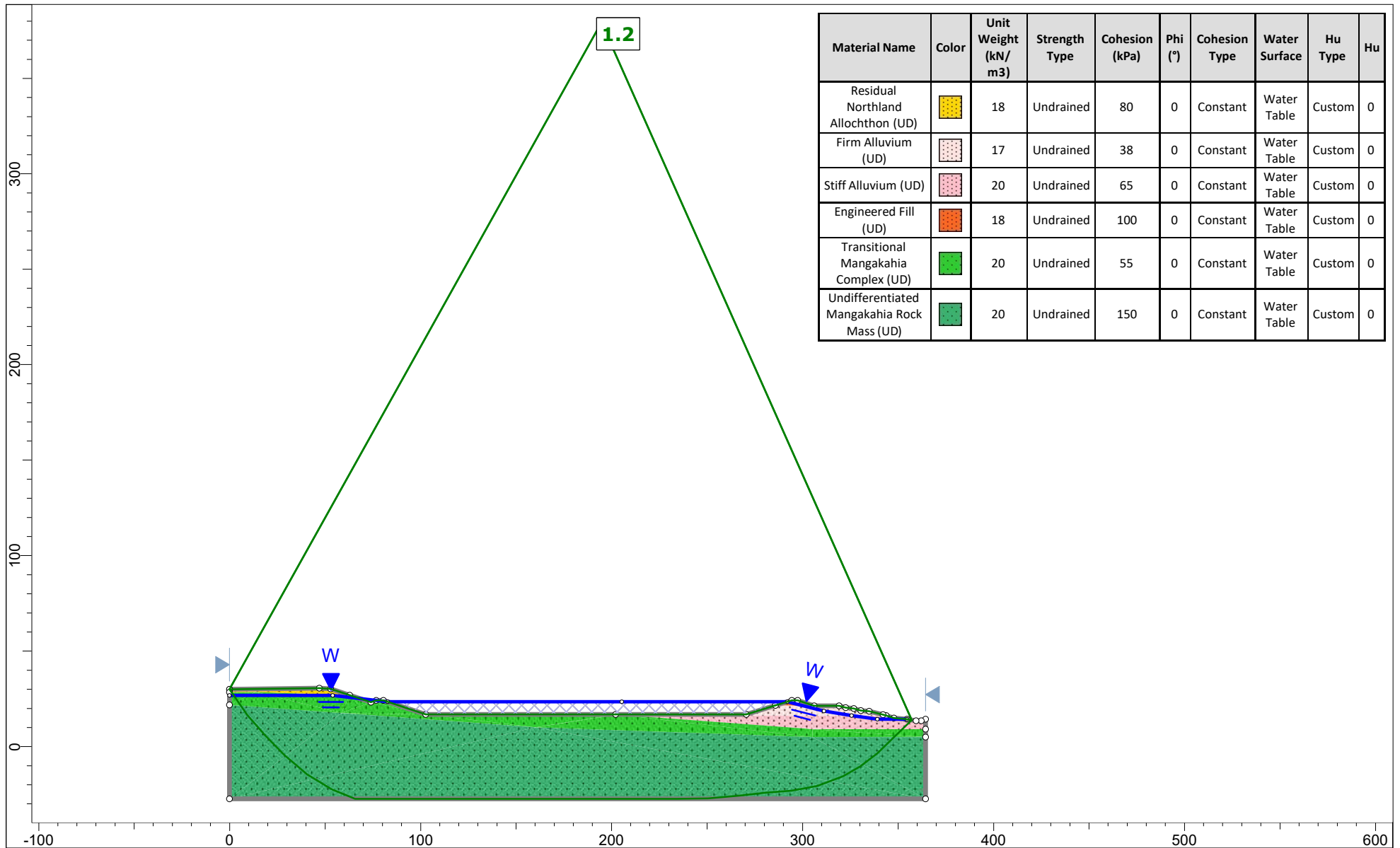


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface	Hu Type	Hu
Residual Northland Allochthon (UD)		18	Undrained	80	0	Constant	Water Table	Custom	0
Firm Alluvium (UD)		17	Undrained	38	0	Constant	Water Table	Custom	0
Stiff Alluvium (UD)		20	Undrained	65	0	Constant	Water Table	Custom	0
Engineered Fill (UD)		18	Undrained	100	0	Constant	Water Table	Custom	0
Transitional Mangakahia Complex (UD)		20	Undrained	55	0	Constant	Water Table	Custom	0



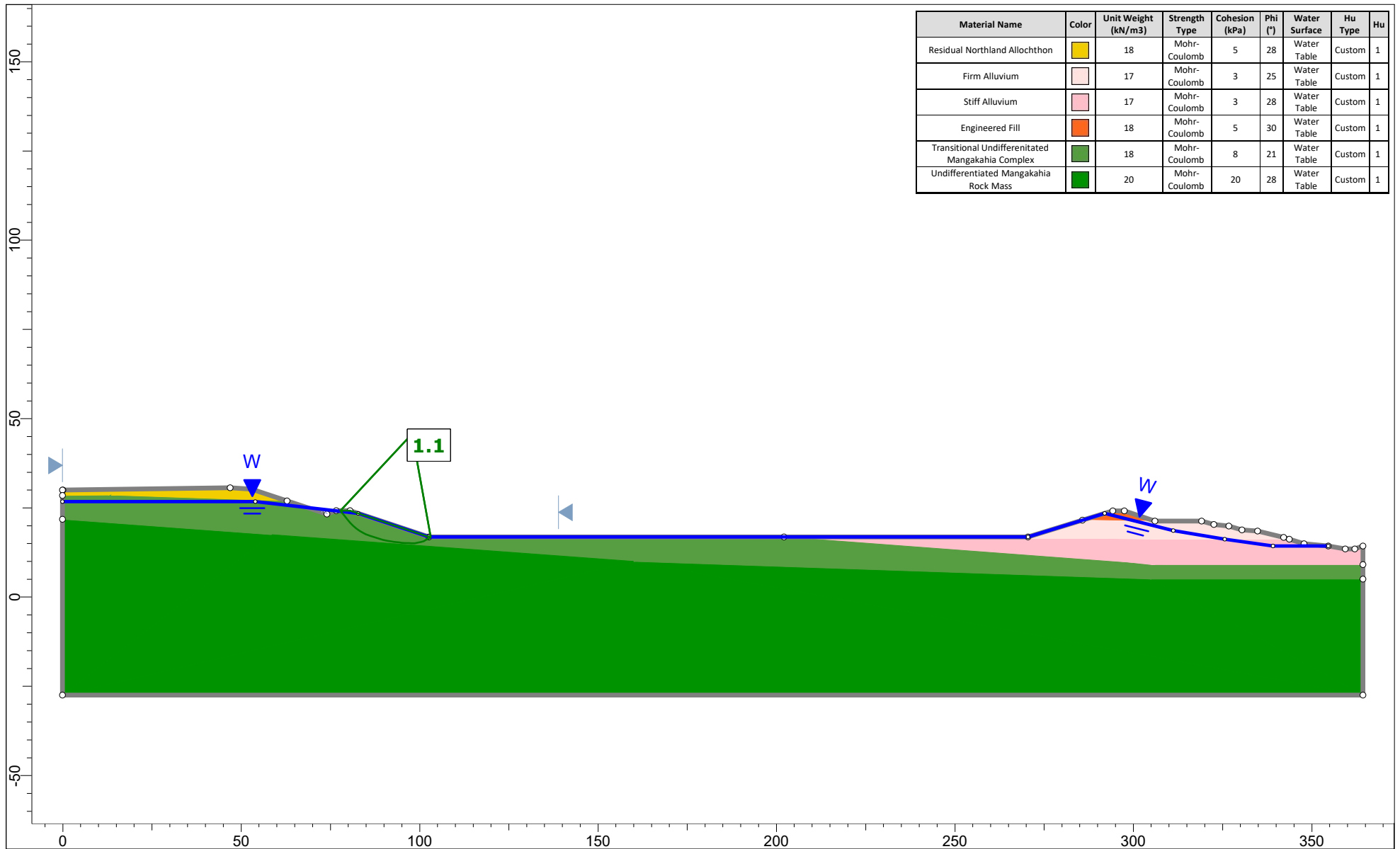
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Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Seismic (OBE)
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.sldm



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Seismic (SEE)
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

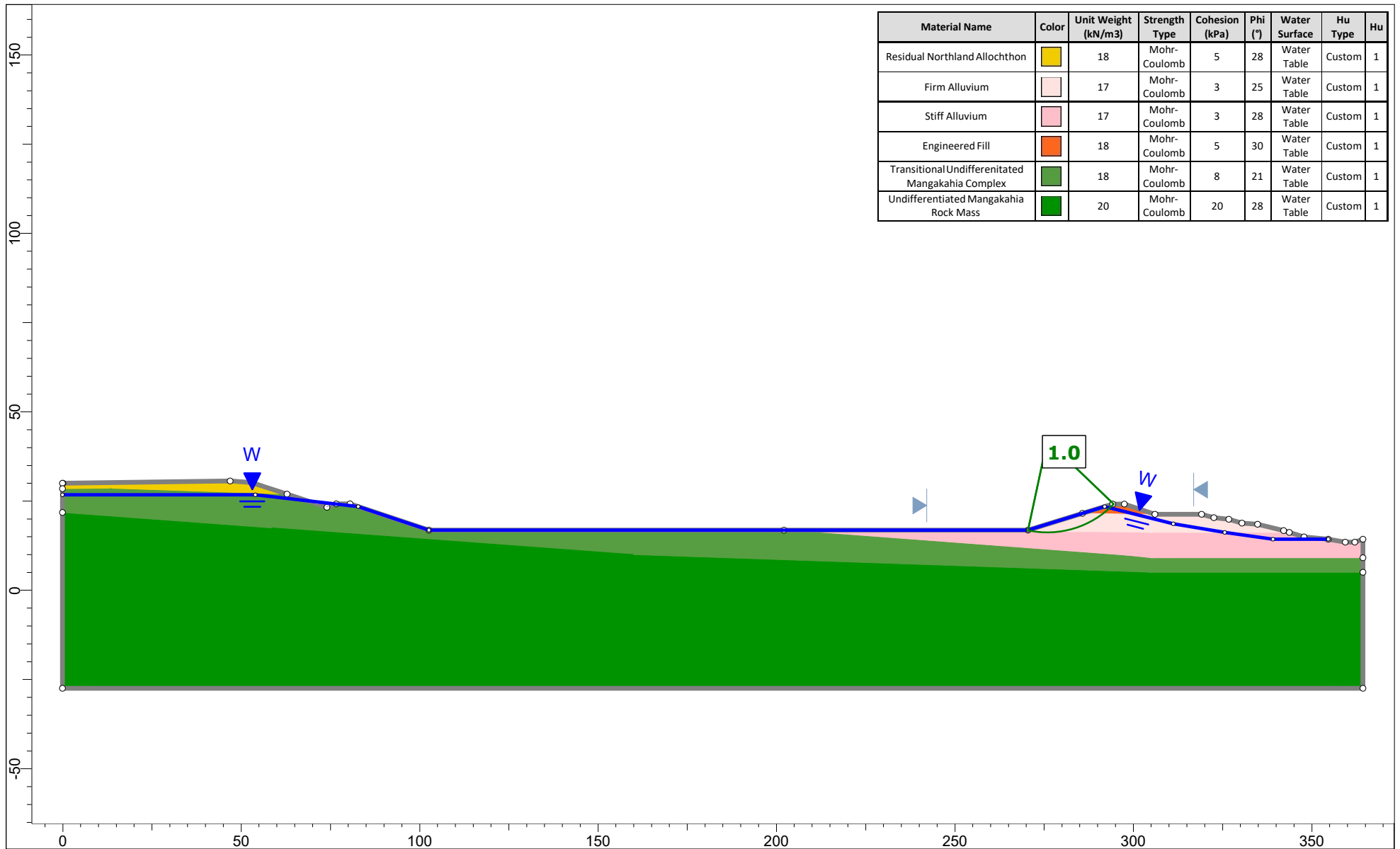


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon	Yellow	18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium	Pink	17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium	Light Pink	17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill	Orange	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex	Green	18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass	Dark Green	20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Drawdown Reservoir Slope
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

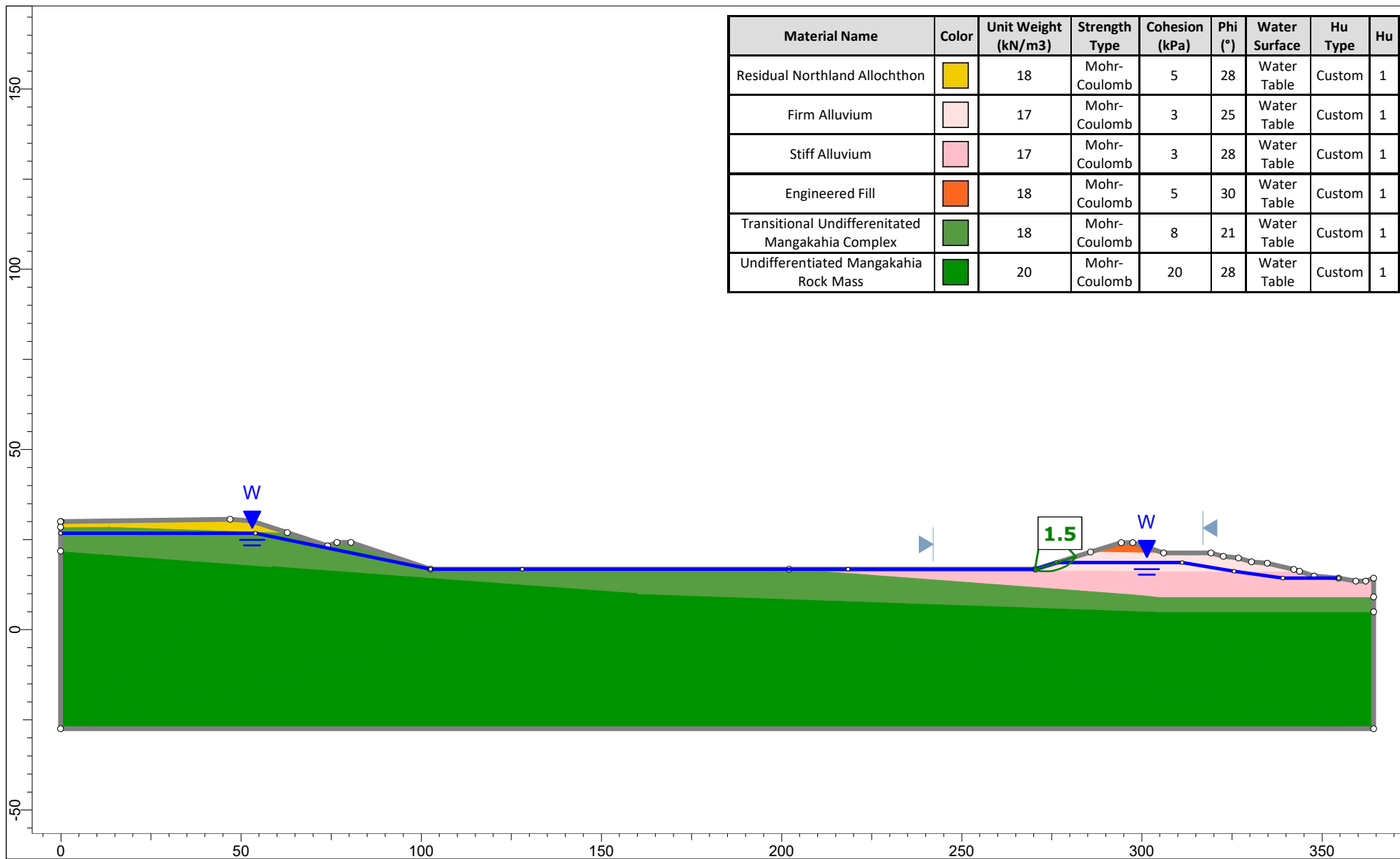


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon	Yellow	18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium	Light Pink	17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium	Pink	17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill	Orange	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex	Light Green	18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass	Dark Green	20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Drawdown Dam Slope
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.sldm

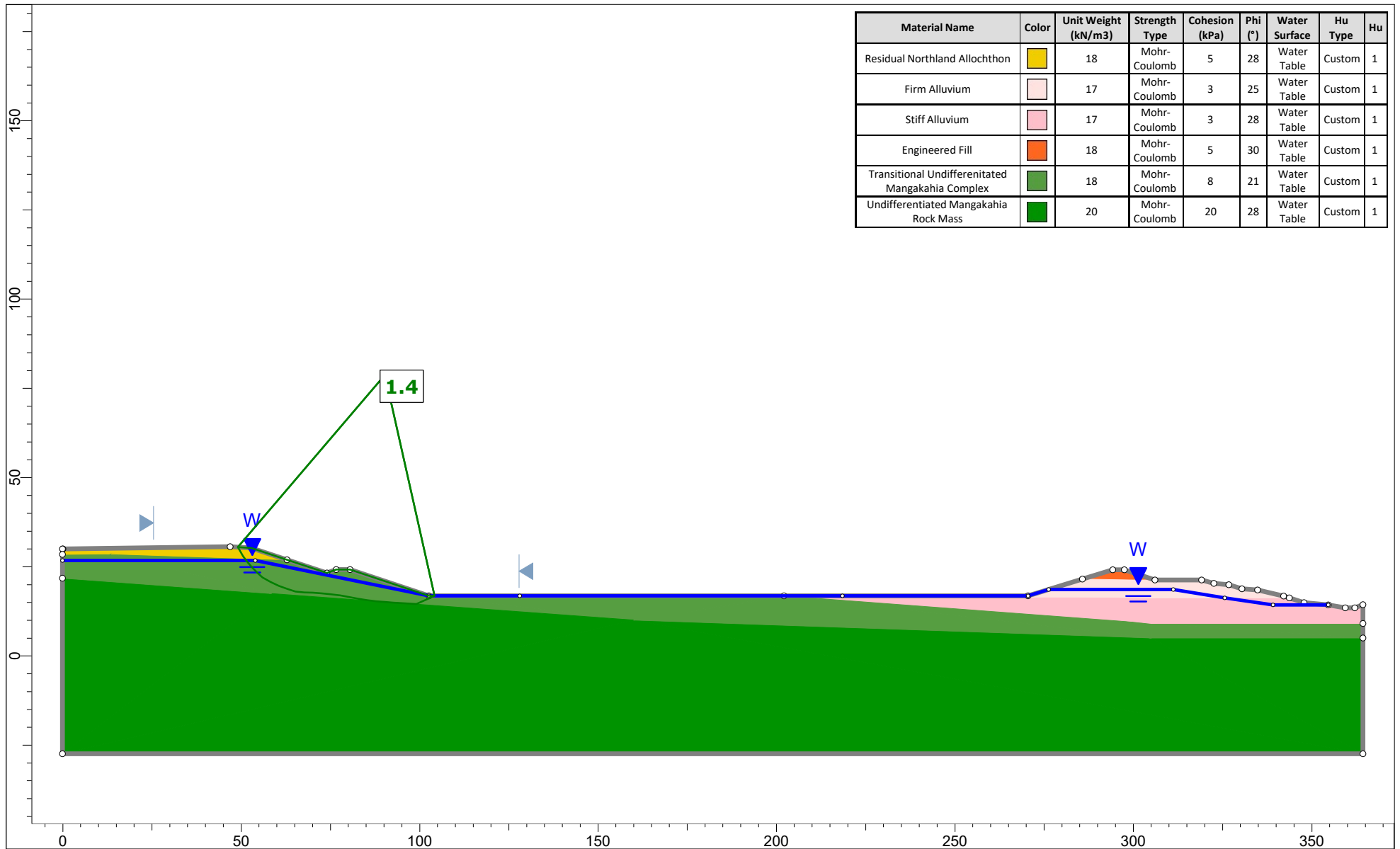


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon		18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium		17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium		17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex		18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass		20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Construction Dam
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

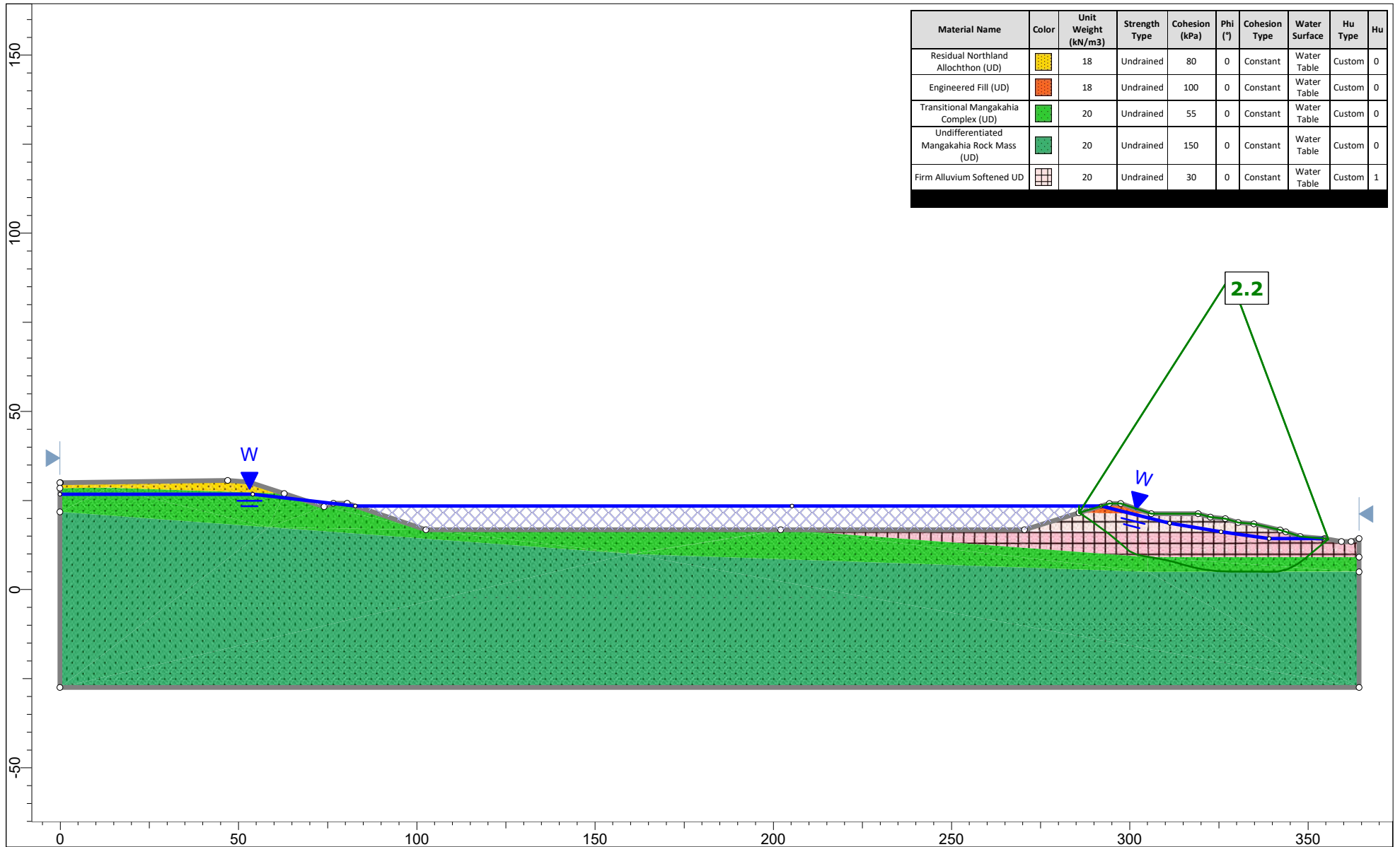


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon		18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium		17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium		17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex		18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass		20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Construction Reservoir
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

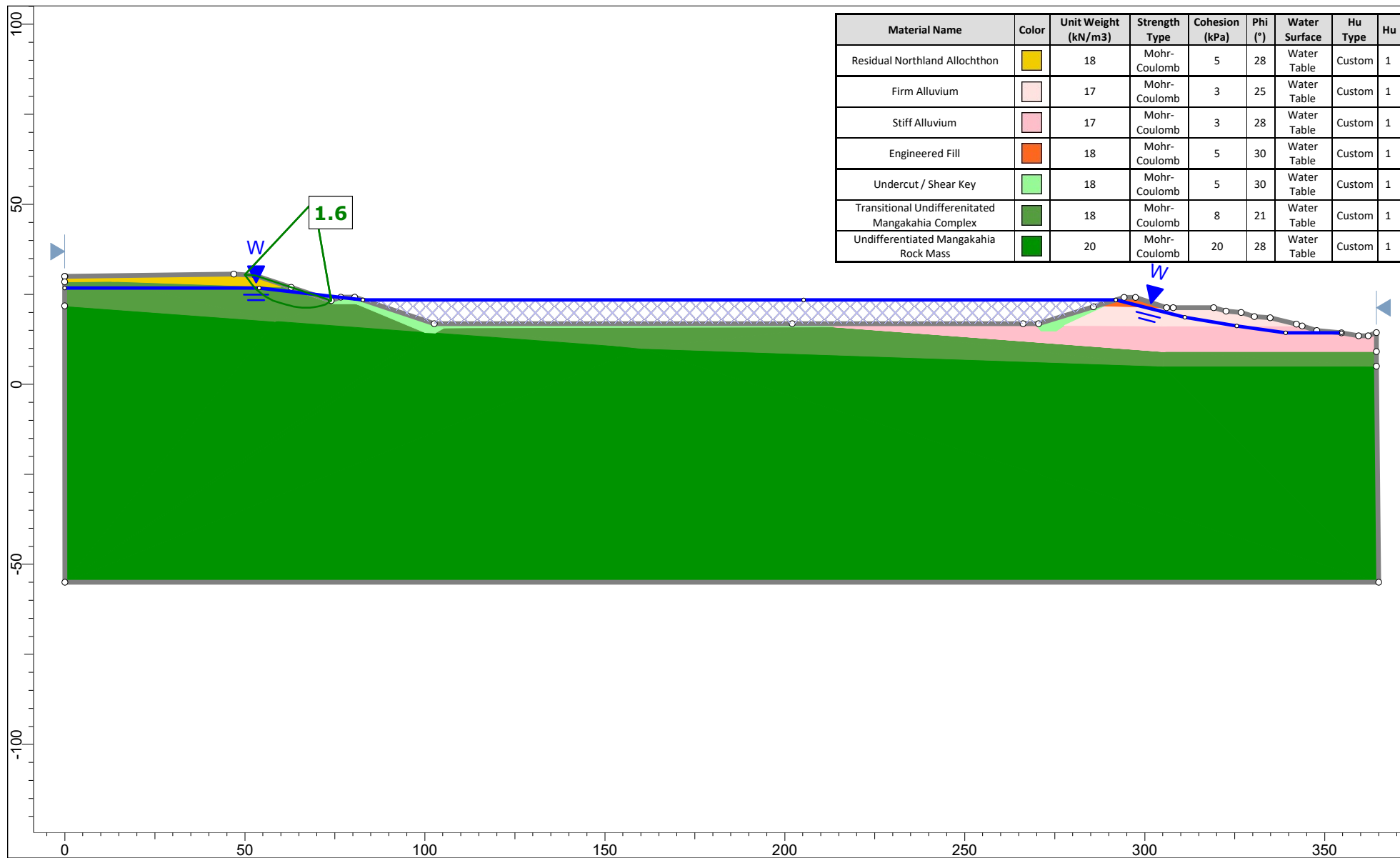


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface	Hu Type	Hu
Residual Northland Allochthon (UD)		18	Undrained	80	0	Constant	Water Table	Custom	0
Engineered Fill (UD)		18	Undrained	100	0	Constant	Water Table	Custom	0
Transitional Mangakahia Complex (UD)		20	Undrained	55	0	Constant	Water Table	Custom	0
Undifferentiated Mangakahia Rock Mass (UD)		20	Undrained	150	0	Constant	Water Table	Custom	0
Firm Alluvium Softened UD		20	Undrained	30	0	Constant	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Proposed	Scenario	Post EQ (cyclic softening)
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

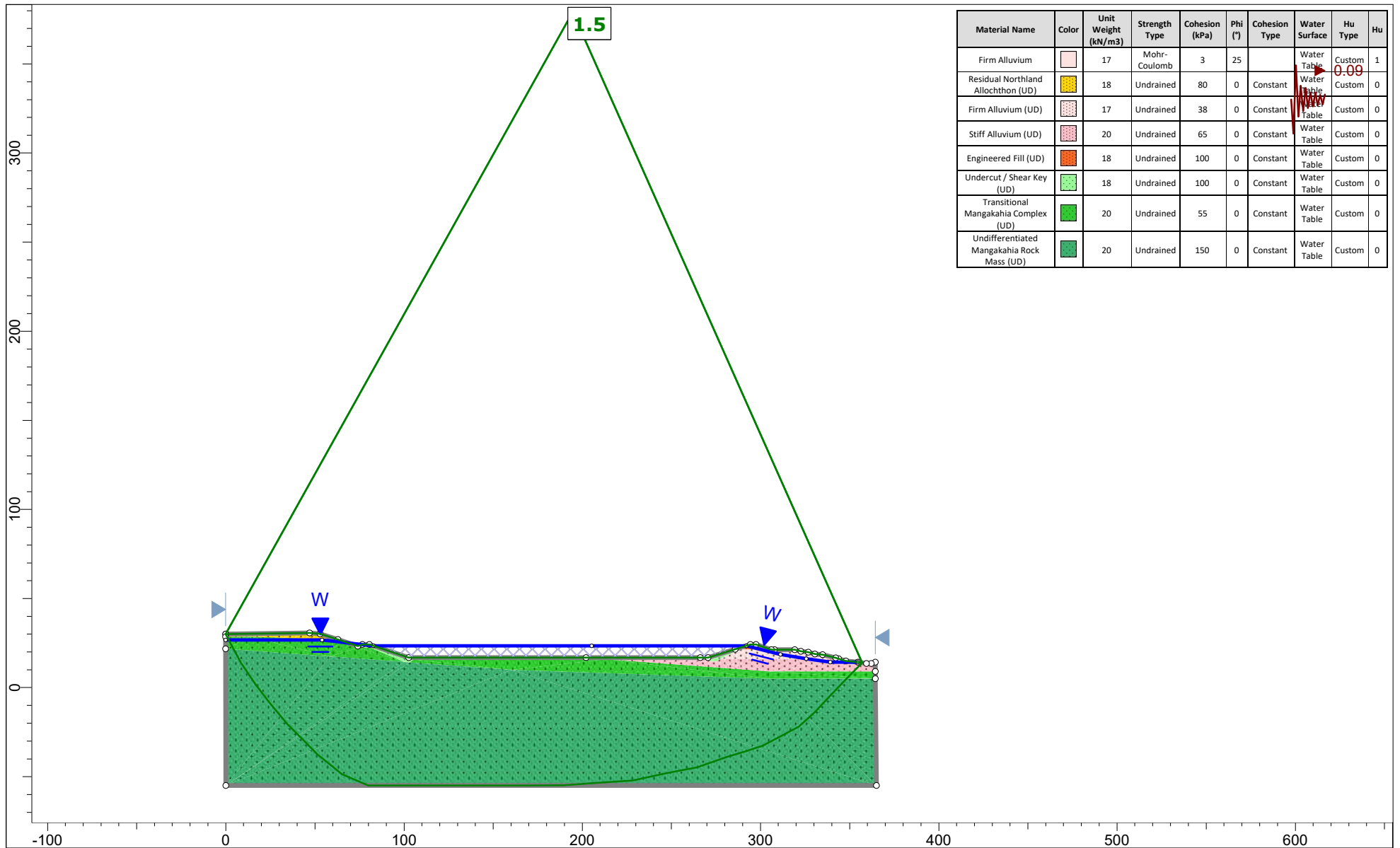


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon		18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium		17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium		17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Undercut / Shear Key		18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex		18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass		20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project			XS Q - Milldale Stages 14 to 17 Reservoir		
Group		Remediated	Scenario		NGW
Drawn By		CR	Company		Gibb Ritchie Geotechnical Engineers
Date		24/06/2026, 8:10:33 am	File Name		XS Q.slm

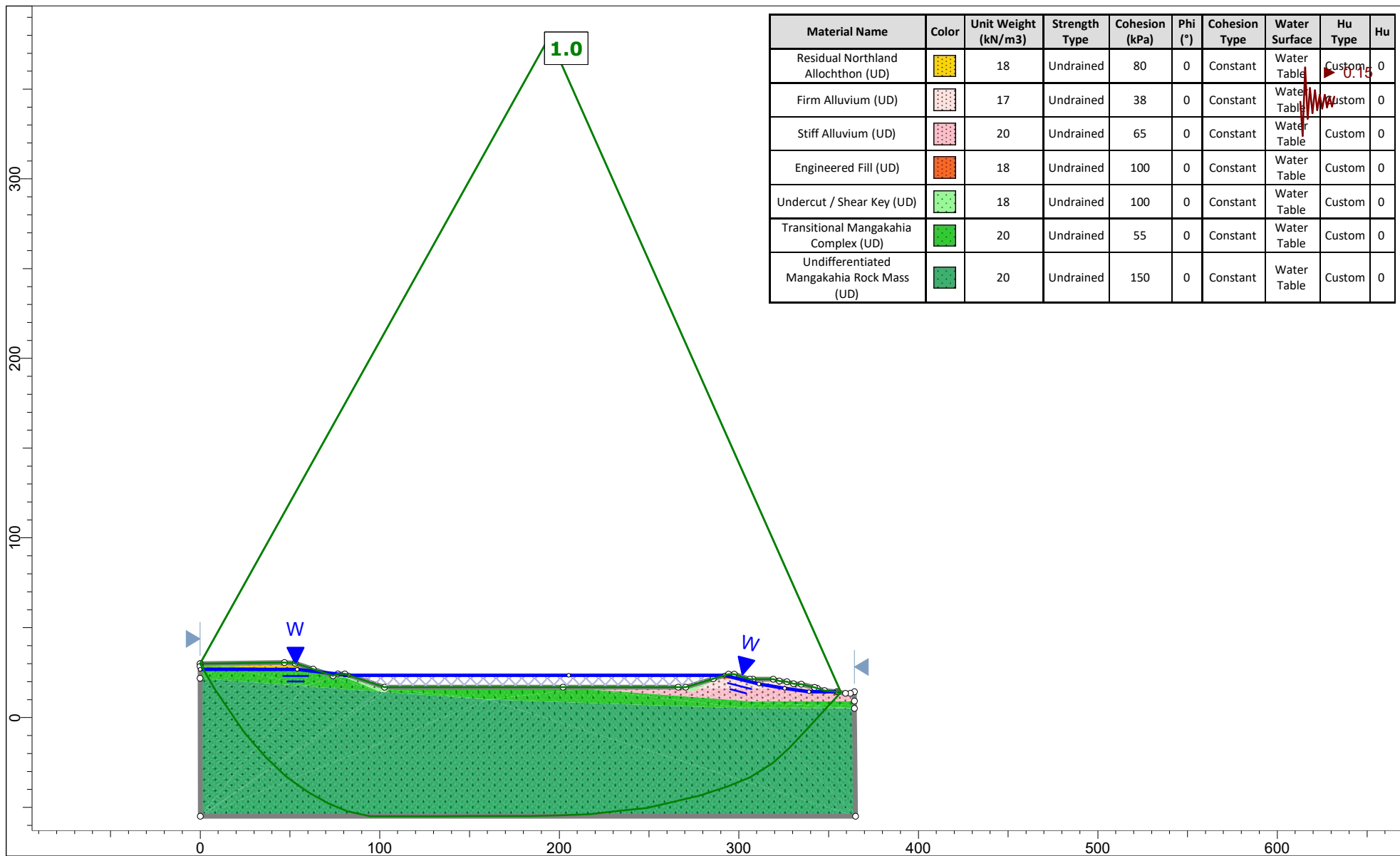


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface	Hu Type	Hu
Firm Alluvium		17	Mohr-Coulomb	3	25		Water Table	Custom	1
Residual Northland Allochthon (UD)		18	Undrained	80	0	Constant	Water Table	Custom	0
Firm Alluvium (UD)		17	Undrained	38	0	Constant	Water Table	Custom	0
Stiff Alluvium (UD)		20	Undrained	65	0	Constant	Water Table	Custom	0
Engineered Fill (UD)		18	Undrained	100	0	Constant	Water Table	Custom	0
Undercut / Shear Key (UD)		18	Undrained	100	0	Constant	Water Table	Custom	0
Transitional Mangakahia Complex (UD)		20	Undrained	55	0	Constant	Water Table	Custom	0
Undifferentiated Mangakahia Rock Mass (UD)		20	Undrained	150	0	Constant	Water Table	Custom	0



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Remediated	Scenario	Seismic (OBE)
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

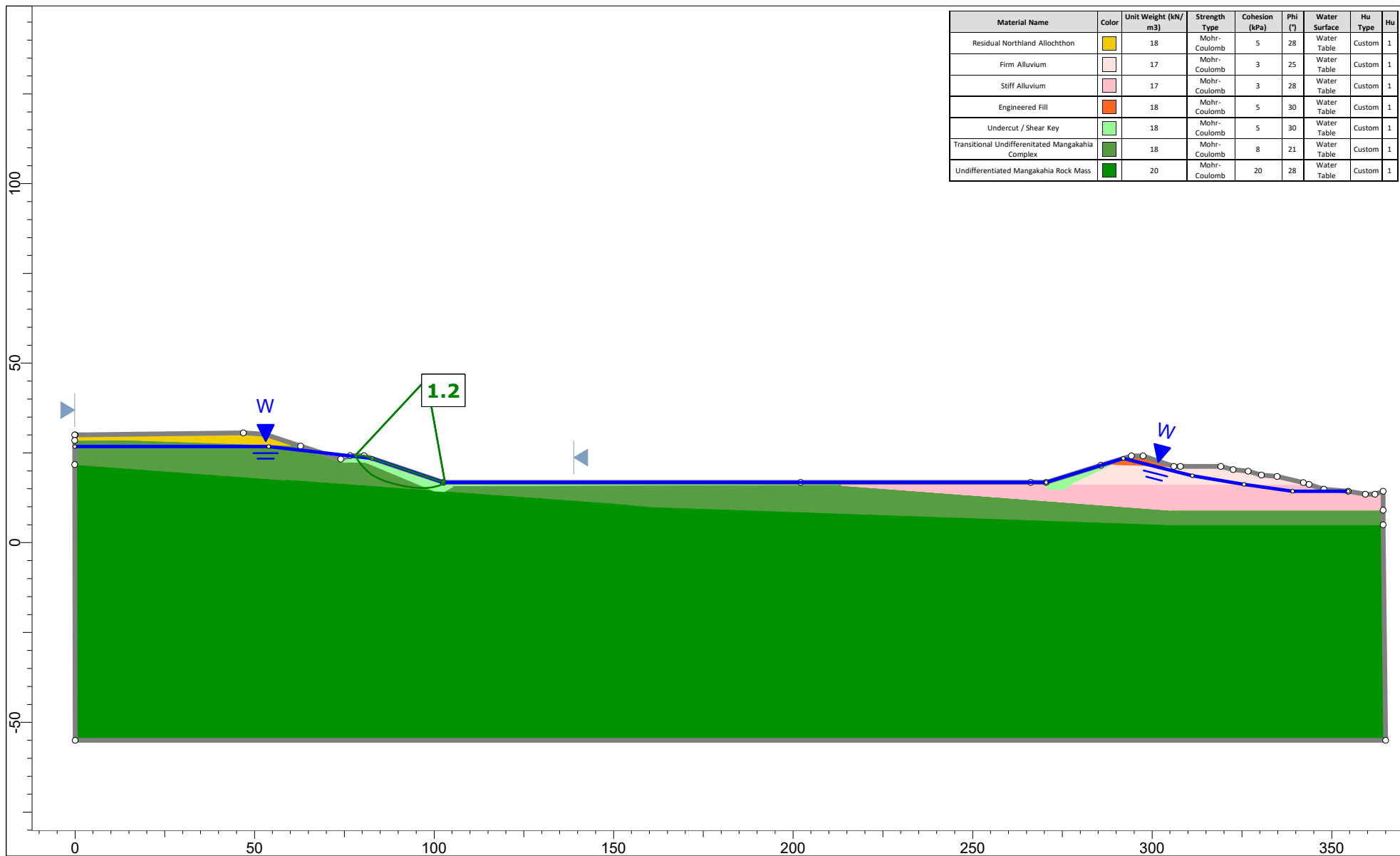


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface	Hu Type	Hu
Residual Northland Allochthon (UD)		18	Undrained	80	0	Constant	Water Table	Custom	0
Firm Alluvium (UD)		17	Undrained	38	0	Constant	Water Table	Custom	0
Stiff Alluvium (UD)		20	Undrained	65	0	Constant	Water Table	Custom	0
Engineered Fill (UD)		18	Undrained	100	0	Constant	Water Table	Custom	0
Undercut / Shear Key (UD)		18	Undrained	100	0	Constant	Water Table	Custom	0
Transitional Mangakahia Complex (UD)		20	Undrained	55	0	Constant	Water Table	Custom	0
Undifferentiated Mangakahia Rock Mass (UD)		20	Undrained	150	0	Constant	Water Table	Custom	0



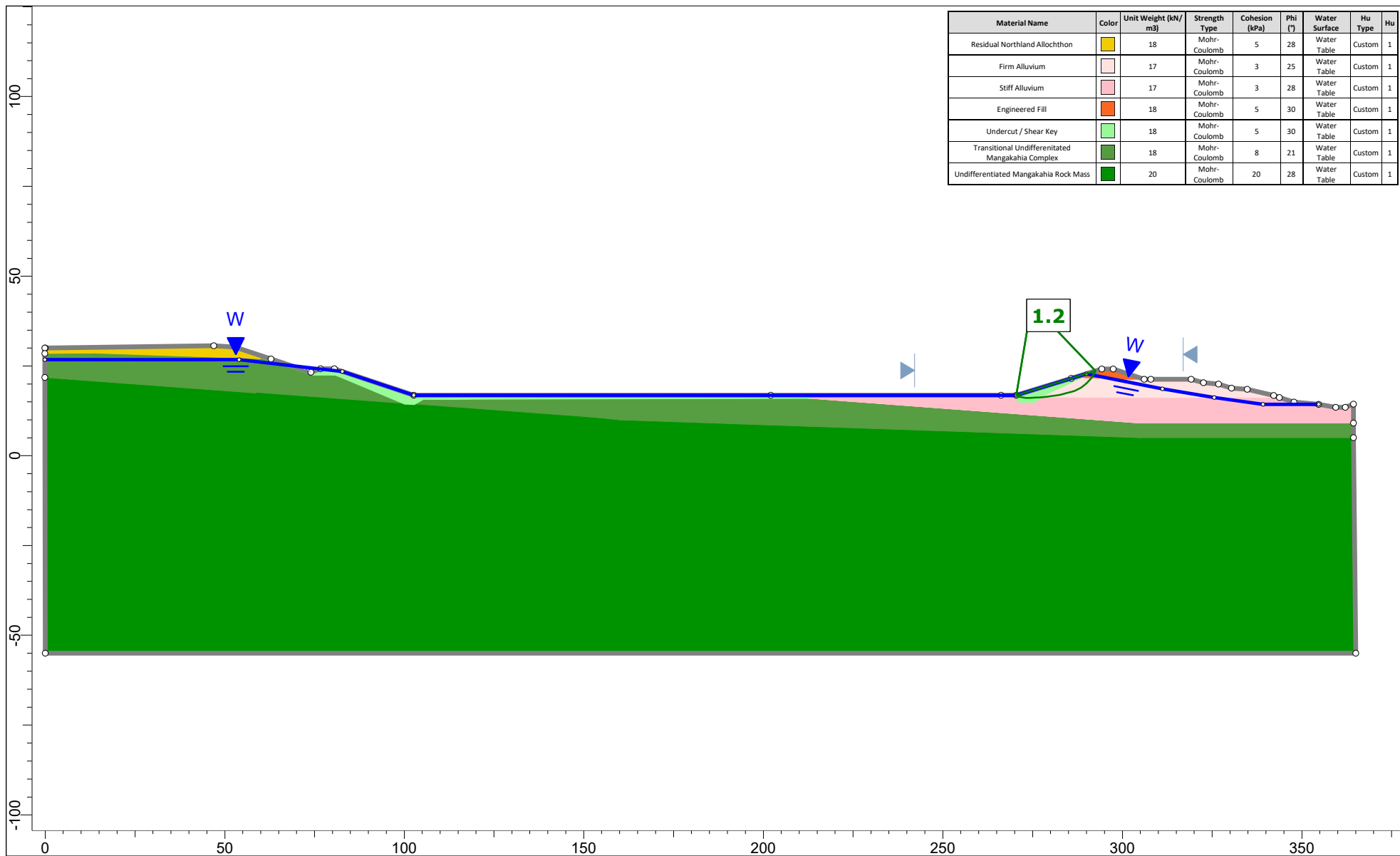
SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Remediated	Scenario	Seismic (SEE)
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Remediated	Scenario	Drawdown Reservoir Slope
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

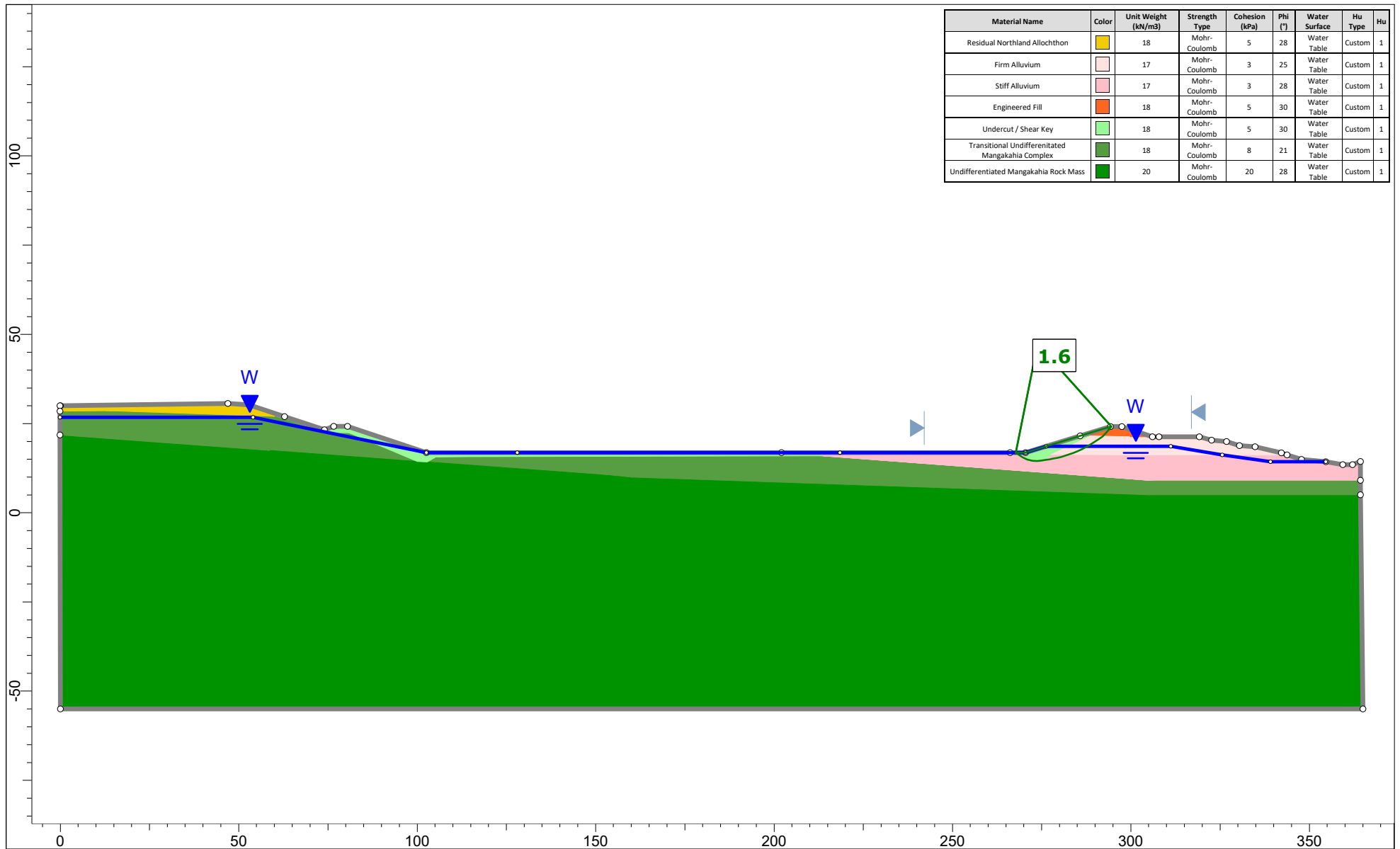


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon	Yellow	18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium	Light Pink	17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium	Pink	17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill	Orange	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Undercut / Shear Key	Light Green	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex	Dark Green	18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass	Green	20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project	XS Q - Milldale Stages 14 to 17 Reservoir		
Group	Remediated	Scenario	Drawdown Dam Slope
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

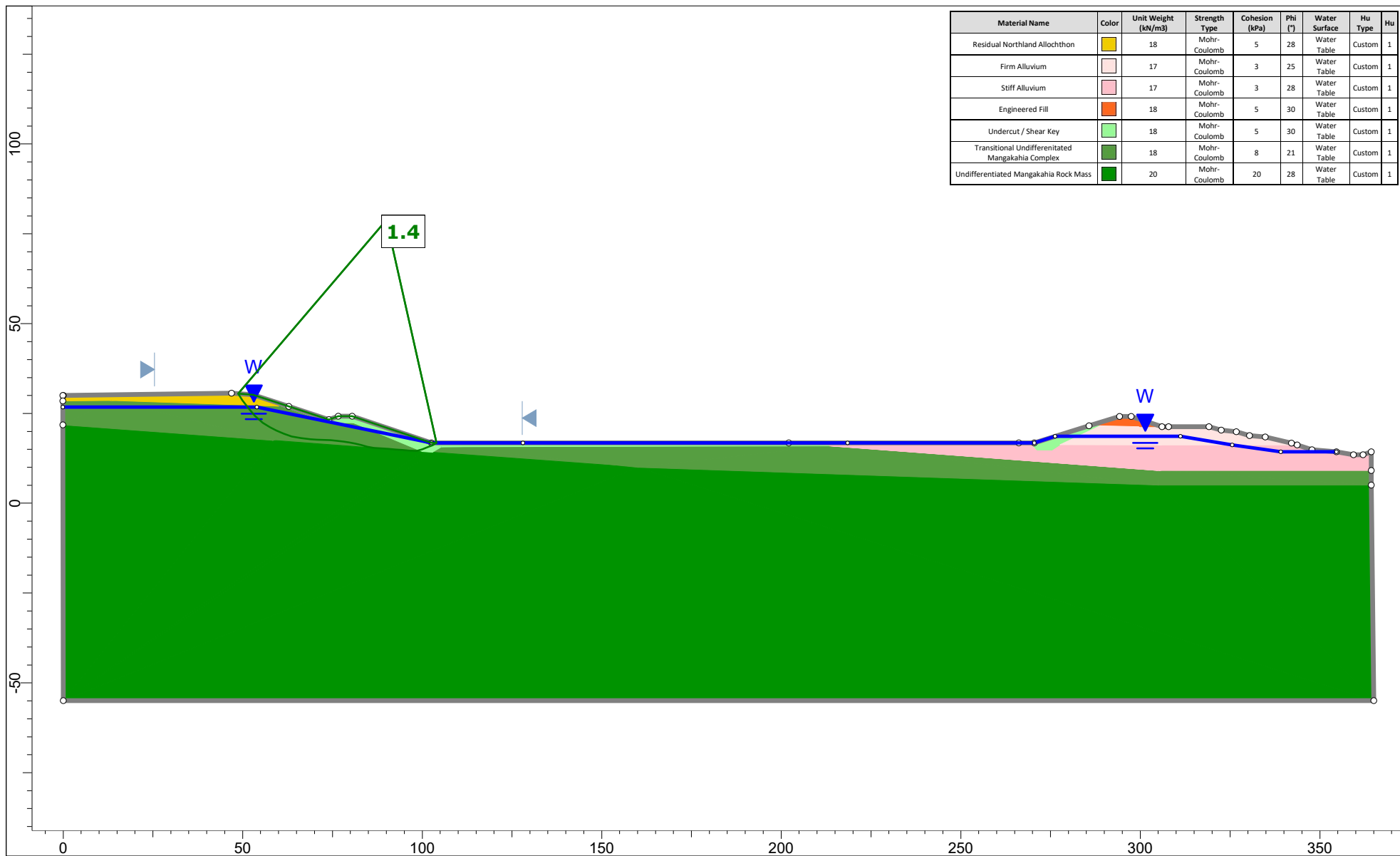


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allochthon	Yellow	18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium	Light Yellow	17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium	Light Pink	17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill	Orange	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Undercut / Shear Key	Light Green	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex	Pink	18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass	Green	20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Remediated	Scenario	Construction Dam
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.slm

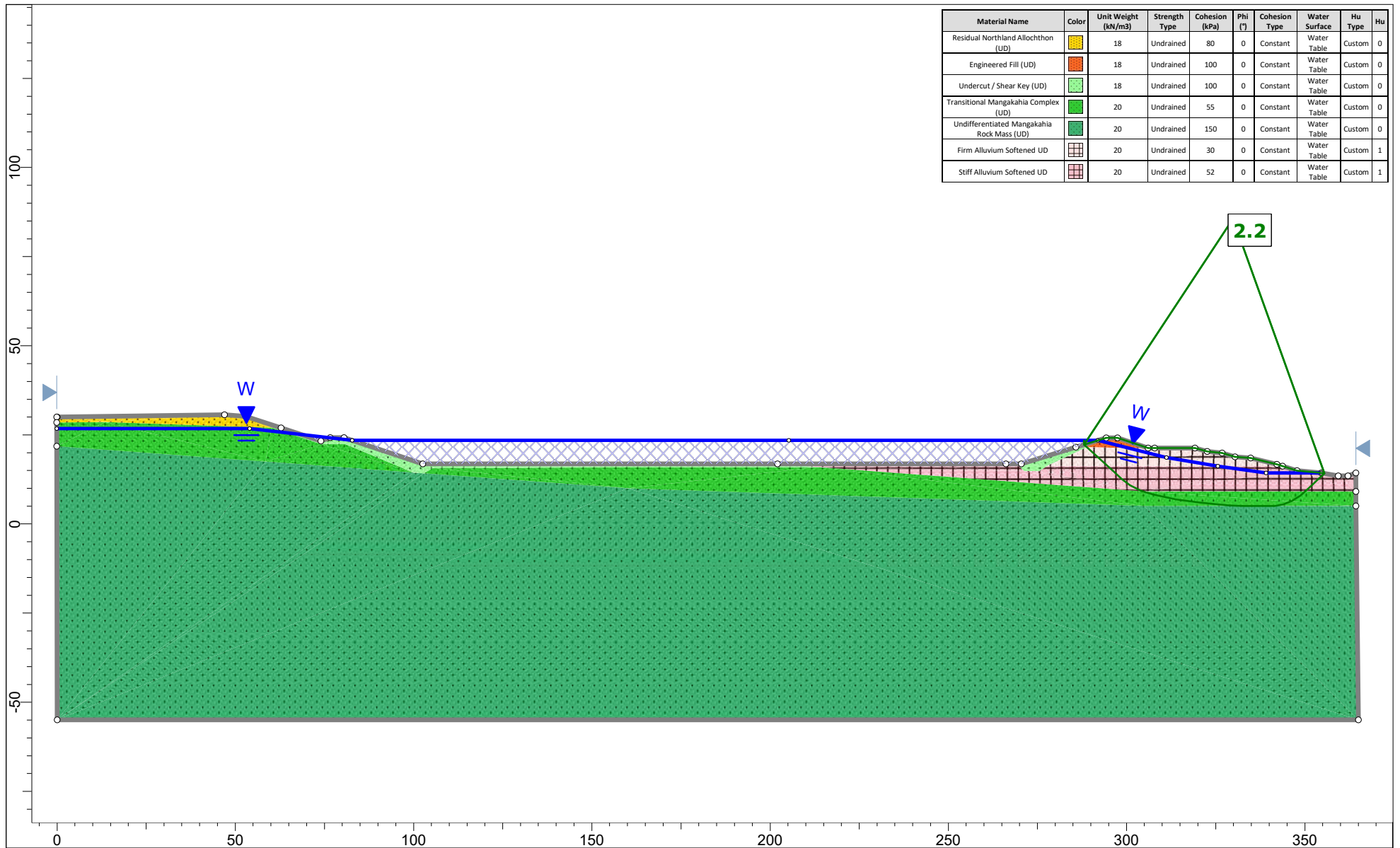


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Residual Northland Allocthon	Yellow	18	Mohr-Coulomb	5	28	Water Table	Custom	1
Firm Alluvium	Pink	17	Mohr-Coulomb	3	25	Water Table	Custom	1
Stiff Alluvium	Light Pink	17	Mohr-Coulomb	3	28	Water Table	Custom	1
Engineered Fill	Orange	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Undercut / Shear Key	Light Green	18	Mohr-Coulomb	5	30	Water Table	Custom	1
Transitional Undifferentiated Mangakahia Complex	Dark Green	18	Mohr-Coulomb	8	21	Water Table	Custom	1
Undifferentiated Mangakahia Rock Mass	Dark Green	20	Mohr-Coulomb	20	28	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Remediated	Scenario	Construction Reservoir
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.sldm



Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface	Hu Type	Hu
Residual Northland Allochthon (UD)	Yellow	18	Undrained	80	0	Constant	Water Table	Custom	0
Engineered Fill (UD)	Orange	18	Undrained	100	0	Constant	Water Table	Custom	0
Undercut / Shear Key (UD)	Green	18	Undrained	100	0	Constant	Water Table	Custom	0
Transitional Mangakahia Complex (UD)	Dark Green	20	Undrained	55	0	Constant	Water Table	Custom	0
Undifferentiated Mangakahia Rock Mass (UD)	Light Green	20	Undrained	150	0	Constant	Water Table	Custom	0
Firm Alluvium Softened UD	Blue	20	Undrained	30	0	Constant	Water Table	Custom	1
Stiff Alluvium Softened UD	Red	20	Undrained	52	0	Constant	Water Table	Custom	1



SLIDEINTERPRET 9.038

Project		XS Q - Milldale Stages 14 to 17 Reservoir	
Group	Remediated	Scenario	Post EQ (cyclic softening)
Drawn By	CR	Company	Gibb Ritchie Geotechnical Engineers
Date	24/06/2026, 8:10:33 am	File Name	XS Q.sldm

APPENDIX G

PC 120 Landslide Assessment



LANDSLIDE RISK ASSESSMENT

Milldale Stages 14-17 Water Reservoir

Fulton Hogan Land Development Ltd
AK26-027AD Rev.1

16 July 2026

LIMITATIONS AND USE OF THIS REPORT

This report has been prepared by Gibb Ritchie Geotechnical Engineers for the exclusive use of Fulton Hogan Land Development Ltd in relation to the Milldale Stages 14-17 Water Reservoir project. It has been prepared in accordance with the scope of work and the specific purpose agreed with the client.

The report should not be used for any other project, site, or purpose without the prior written consent of Gibb Ritchie Geotechnical Engineers. Where a party other than the named client seeks to rely on or use this report, they must first obtain such consent. Gibb Ritchie Geotechnical Engineers accepts no responsibility or liability to any other party who may use or rely on the contents of this report without authorisation.

This report is based on information available at the time of preparation, including site conditions observed and data obtained during the investigation. Subsurface conditions can vary significantly between investigation locations, and no warranty is given that the conditions described are representative of those across the entire site.

If you have any questions about the content or use of this report, please contact Gibb Ritchie Geotechnical Engineers for clarification.

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2	LANDSLIDE RISK ASSESSMENT METHODOLOGY	3
3	STAGE 1 DESKTOP STUDY AND HAZARD ASSESSMENT.....	4
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Date	Revision	Comments
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3 July 2026	A	Internal Draft
16 July 2026	0	Draft for review
7 August 2026	1	Final

Name	Position	Signature
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Prepared by

Chris Ritchie	Principal Geotechnical Engineer, CPEng
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Reviewed by

Sam Gibb	Principal Geotechnical Engineer, CPEng
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1 INTRODUCTION

Gibb Ritchie Geotechnical Engineers Limited (GRGE) was engaged by Fulton Hogan Land Development Ltd to carry out a site-specific landslide assessment of the water reservoir as part of the wider Milldale Stages 14-17 subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal referenced AK26-027AA Rev 0.

2 LANDSLIDE RISK ASSESSMENT METHODOLOGY

Appendix 24 of Plan Change 120 presents a structured process for assessing landslide risk in land-use planning contexts. It consists of **four stages**:

1. **Desk Study** – Review landslide inventories, susceptibility maps, and run-out zones to identify potential hazards and their activity status (recent vs. ancient).
2. **Method Selection** – Choose an appropriate risk assessment approach based on susceptibility class and proposed land use or zoning change, using predefined tables.
3. **Risk Assessment** – Applying either:
 - **Method 1** (semi-quantitative) for lower-risk scenarios, combining likelihood and consequence categories; or
 - **Method 2** (semi-quantitative + quantitative) for higher-risk scenarios, including calculation of Annual Individual Fatality Risk (AIFR) using probability-based models or event trees. Climate change impacts (SSP5-8.5) must be considered.
4. **Activity Status Determination** – Use the highest risk classification from the assessment to determine planning activity status under AUP Plan Change 120 Table E36.4.1B.

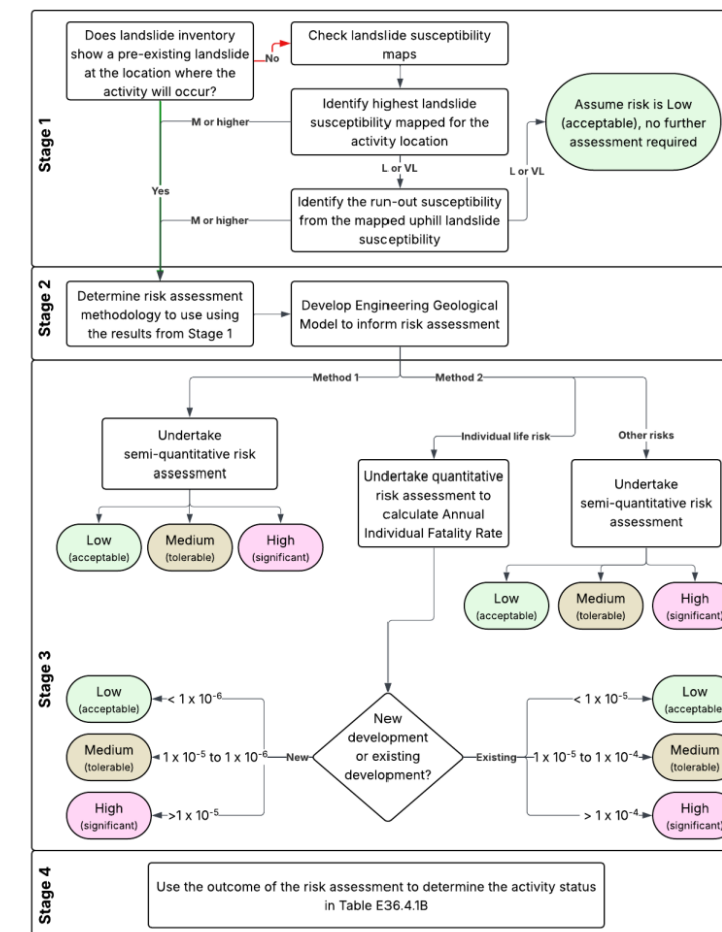
The process requires the development of an **Engineering Geological Model**, considering credible hazard scenarios, and applying robust legal and technical standards to ensure risk-informed land-use decisions.

These stages are summarised in Figure 2.

Figure 1 Site Location Plan



Figure 2 Appendix 24 Landslide Methodology



3 STAGE 1 DESKTOP STUDY AND HAZARD ASSESSMENT

3.1 Related Documents

A comprehensive desk-study assessment was undertaken reviewing the following sources:

- Auckland Council GeoMaps natural hazard layers
- Published landslide inventories
- Shallow and deep-seated landslide susceptibility maps
- Landslide runout susceptibility for areas within 150 m uphill of the site
- Aerial photography, LIDAR contours, and geomorphological interpretation

3.2 Landslide Susceptibility Maps

A comprehensive desk-study assessment was undertaken reviewing the following sources:

- Auckland Council GeoMaps natural hazard layers.
- Published landslide inventories.
- Shallow and deep-seated landslide susceptibility maps.
- Landslide runout susceptibility for areas within 150 m uphill of each stage.

Outputs of both shallow and deep-seated landslide susceptibility maps for each stage are shown in Figure 3. In summary:

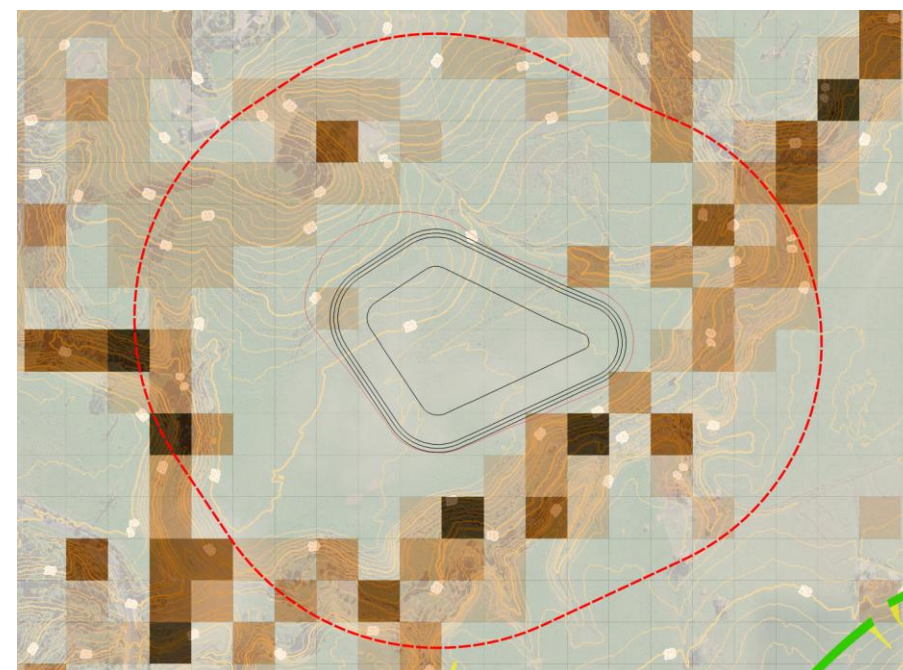
- Large scale landslide susceptibility is mapped as very low within the footprint of the reservoir,
- Shallow landslide susceptibility is mapped as generally very low to medium
- To determine run-out susceptibility, the highest landslide susceptibility class mapped within 150m upslope of the site was reviewed. This shows very high shallow landslide susceptibility on the neighbouring slopes above the reservoir.

In summary the maps typically show very low to low shallow and large-scale landslide susceptibility. However, high large-scale landslide susceptibility is present within 150m of the facility.

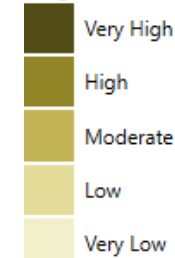
3.3 Mapped Existing Landslides

No mapped or observed landslides were identified on the subject site.

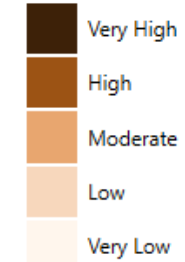
Figure3 Landslide Susceptibility Maps from Auckland Council GIS



Large Scale Landslide Susceptibility



Shallow Landslide Susceptibility



4 STAGE 2 RISK ASSESSMENT METHOD SELECTION

Based on these findings, **Method 2** is required due to the proposed activity of “On-site septic tanks, wastewater treatment and disposal systems, effluent disposal fields, underground storage tanks, water tanks (including rainwater tanks) or stormwater pipes or soakage fields, accessways and private roads” and the mapped high shallow landslide susceptibility.

However, no personnel are expected to be present at the reservoir site, and therefore Method 2 is not appropriate ($P_{(T.S)} = 0$). Therefore only a Method 1 is appropriate.

4.1 Geological Model

The full geotechnical investigation and report have been completed for this project. This includes details on the engineering geological ground model, natural hazards assessments including numerical slope stability analysis and preliminary remediation design. The report reference is AK26-027AD Milldale Stages 14 -17 Water Reservoir Geotechnical Investigation Report, Gibb Ritchie Geotechnical Engineers Ltd, dated 16 July 2026.

5 STAGE 3 – METHOD 1

6 SEMI-QUANTITATIVE RISK ASSESSMENT

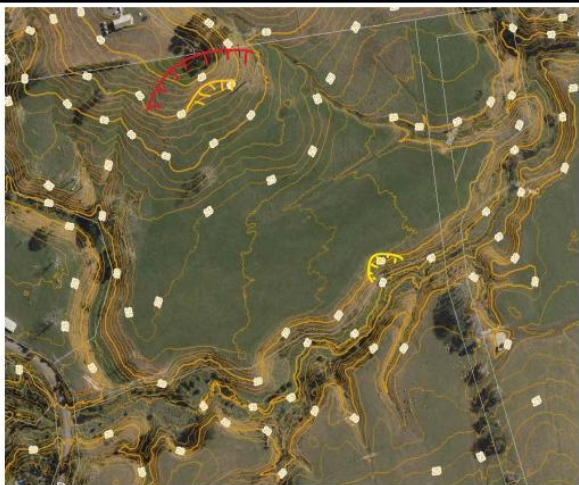
Three credible landslide hazard scenarios were assessed in accordance with Appendix 24:

Project:	Milldale Water Reservoir	Designed:	CR
Client:	Fulton Hogan Land Development Ltd	Checked:	SG
Project No:	AK26-027	Page:	1
Subject:	Appendix 24 - Landslide Risk Assessment	Date:	3/07/2026
Design Case:	Definition of Landslide Hazards		



Landslide Hazard Scenarios	
Scenario	Description
High	Shallow landslide occurring on allochthon slope to the north of the reservoir footprint
Median	Underlip below dam into the Orewa River
Maximum Credible	Global failure of the allochthon slope to the north of the reservoir footprint

Plan



Landslip Type	
A) Rock Fall	B) Rock Topple
C) Rotational Slide	D) Translational Slide
E) Lateral Spread	
F) Debris Avalanche	G) Soil Creep

Figure 9: Schematic cross-sections of different landslide types. (from Highland & Robinson, 2008)

Project:	Milldale Water Reservoir	Designed:	CR
Client:	Fulton Hogan Land Development Ltd	Checked:	SG
Project No:	AK26-027	Page:	1
Subject:	Appendix 24 - Landslide Risk Assessment	Date:	3/07/2026
Design Case:	Method - Qualitative Assessment		



Landslide Hazard Scenarios	
Scenario	Description
High	Shallow landslide occurring on allochthon slope to the north of the reservoir footprint
Median	Underlip below dam into the Orewa River
Maximum Credible	Global failure of the allochthon slope to the north of the reservoir footprint

Likelihood (Table 3, Appendix 24)			
Likelihood Category	Likelihood Descriptor	Annual Probability	Equivalent AEP
Almost certain	The event is expected to occur over the likely duration of the activity	10 ⁻¹	1 in 10 (10%)
Likely	The event will probably occur under adverse conditions over the likely duration of the activity	10 ⁻²	1 in 100 (1%)
Possible	The event could occur under adverse conditions over the likely duration of the activity	10 ⁻³	1 in 1,000 (0.1%)
Unlikely	The event might occur under very adverse circumstances over the likely duration of the activity	10 ⁻⁴	1 in 10,000 (0.01%)
Rare	The event is conceivable but only under exceptional circumstances over the likely duration of the activity	10 ⁻⁵	1 in 100,000 (0.001%)
Barely credible	The event is inconceivable or fanciful over the likely duration of the activity	10 ⁻⁶	1 in 1,000,000 (0.0001%)

Scenario	Justification	Value Adopted
High	No landslides have occurred on this slope following cyclone Gabrielle, slope stability modelling demonstrates factors of safety in excess of 1.5 in prevailing conditions	Rare
Median	Evidence of slope instability on stream banks, however slope stability modelling through this feature does not suggest global failure will affect the dam	Rare
Maximum Credible	Slope stability modelling demonstrates factors of safety in excess of 1.5 in prevailing conditions.	Rare

Consequence (Table 4, Appendix 24)				
Consequence Category	Human safety	Critical Buildings	Community buildings	Buildings Sensitive to Natural Hazards
Catastrophic	>10 dead and/or >1000 injured	Building unusable for >1 week	Building unusable for >1 week	Structure(s) completely destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
Major	1-10 dead and/or 101-1000 injured	Evacuation of building required and/or building unusable for 1 week or less	Building unusable for 1 week to 1 month	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
Medium	0 dead, 11-100 injured	Building in landslide hazard risk assessment area but useability not affected	Evacuation of building required and/or building unusable for 1 week or less	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.
Minor	0 dead, 1-10 injured	N/A	Building in landslide hazard risk assessment area but useability not affected	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.
Insignificant	0 dead, 0 injured	Building outside landslide hazard risk assessment area and useability not affected	Building outside landslide hazard risk assessment area and useability not affected	Little damage.

Scenario	Justification	Value Adopted
High	Very low volumes of debris would enter the reservoir, minor impact on the function	Minor
Median	Slips on the river bank are unlikely to effect dam slope and therefore only minor effect	Minor
Maximum Credible	Global failure of the reservoir slope would cause significant damage and loss of functionality	Major

Risk Classification, Table 6 Appendix 24						
Likelihood Category		Consequence Category				
		Insignificant	Minor	Medium	Major	Catastrophic
	Almost certain	Medium (tolerable)	High (significant)	High (significant)	High (significant)	High (significant)
	Likely	Low (acceptable)	Medium (tolerable)	High (significant)	High (significant)	High (significant)
	Possible	Low (acceptable)	Low (acceptable)	Medium (tolerable)	High (significant)	High (significant)
	Unlikely	Low (acceptable)	Low (acceptable)	Low (acceptable)	Medium (tolerable)	High (significant)
	Rare	Low (acceptable)	Low (acceptable)	Low (acceptable)	Low (acceptable)	Medium (tolerable)
	Barely credible	Low (acceptable)	Low (acceptable)	Low (acceptable)	Low (acceptable)	Low (acceptable)

Scenario	Value Adopted
High	Low (acceptable)
Median	Low (acceptable)
Maximum Credible	Low (acceptable)

7 STAGE 4 – ACTIVITY STATUS AND PLANNING IMPLICATIONS

Based on the assessment undertaken, we consider that landslide hazard result is Low (acceptable) under Appendix 24.

Under the Auckland Unitary Plan (Chapter E36), a low landslide hazard risk classification means that most proposed activities, including subdivision, can proceed as Permitted or Restricted Discretionary activities, provided that:

- A site-specific landslide hazard risk assessment prepared by a suitably qualified and experienced practitioner (SQEP) is submitted in accordance with E36.6 Standards and Appendix 24 methodology (this report).
- The development does not increase landslide risk beyond the site.
- Appropriate mitigation measures (engineered retaining walls, drainage, erosion and sediment controls, and surface water management) are implemented and maintained.

The proposed development therefore complies with the risk-based planning framework of E36 and meets the requirements for activities in natural hazard areas.

8 CLOSURE

Gibb Ritchie Geotechnical Engineers has prepared this report for Fulton Hogan Land Development Ltd in accordance with the agreed scope of work for the Milldale Stages 14-17 Water Reservoir project. It provides geotechnical information and recommendations to assist with consenting.

We view this report as part of an ongoing process. Our team can provide further input during detailed design and construction to help ensure that the recommendations are applied effectively and to provide advice should any unexpected ground conditions arise.

If you have any questions about the report, or if you would like to discuss the next steps for your project, please contact our team.

USING YOUR GIBB RITCHIE REPORT

Geotechnical reporting relies on interpretation of site information using experience, professional judgement, and opinion. As such, all geotechnical reports carry an inherent level of uncertainty, often greater than in other engineering disciplines. The notes below provide guidance on what can reasonably be expected from this report and its inherent limitations.

Purpose of this report

This report has been prepared specifically for Fulton Hogan Land Development Ltd and the Milldale Stages 14-17 Water Reservoir project. The contents may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted geotechnical engineering and engineering geology practices. The opinions and conclusions are based on those principles.

Dependence on available information

This report is based on the information available at the time of preparation, including investigation results and referenced data. If further information becomes available or the project scope changes, the findings may no longer be valid. In such cases, Gibb Ritchie Geotechnical Engineers should be engaged to review and update the report.

Applicability to your project

The findings and recommendations in this report relate solely to the site and project described. They should not be applied to other sites or projects, as subsurface conditions and requirements differ between locations and developments. Similarly, applying data or conclusions from other sites to this project may lead to incorrect assumptions.

Interpretation of subsurface condition

Site investigations provide information at discrete locations. Conditions between or beyond these points may differ. Geological interfaces may be more variable than inferred, and actual conditions may only become clear during construction. Engineering judgement has been applied to interpret the available data, but no investigation can remove all uncertainty.

Changes in subsurface conditions

Ground and groundwater conditions can change over time, whether due to natural processes (seasonal variation, settlement, erosion) or human activities (earthworks, adjacent development). This report reflects conditions observed at the time of investigation. Confirmation of conditions may be necessary if significant time has passed before construction.

Role during construction

Recommendations in this report are based on selective point sampling and interpretation. It is strongly recommended that Gibb Ritchie Geotechnical Engineers remain involved during construction to confirm assumptions, review any changes in conditions, and provide timely advice if unexpected ground conditions are encountered.

Use by other parties

This report has been prepared for the named client. Where other design professionals or third parties intend to rely on it, they must first seek consent from Gibb Ritchie Geotechnical Engineers. Misinterpretation of geotechnical reports can lead to costly design or construction issues, and our continued involvement helps reduce these risks.

Environmental matters

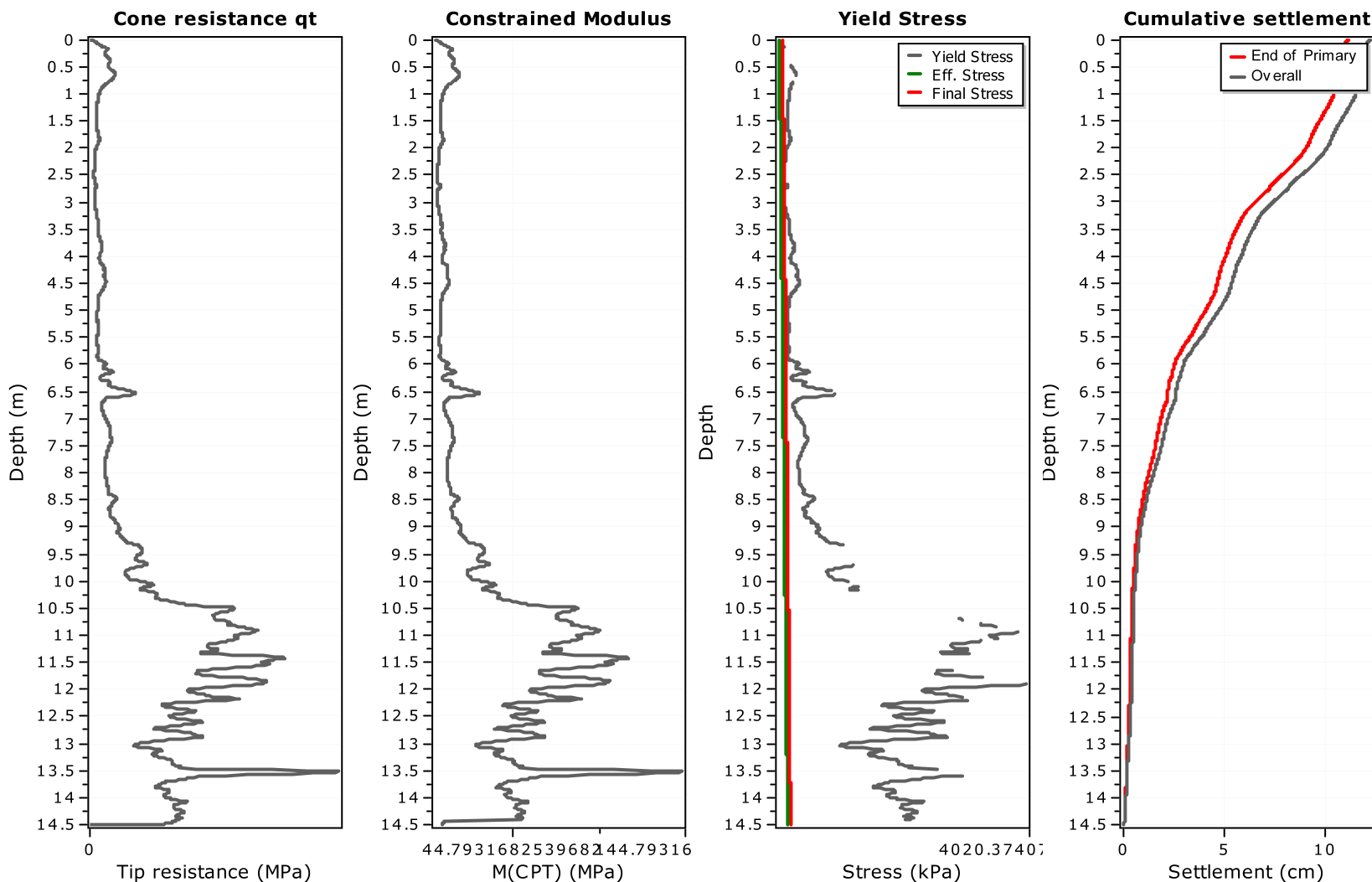
Unless explicitly stated, this report does not address environmental issues such as contamination, waste management, or disposal of materials. These require separate investigation and specialist advice.

If you have any questions about the content or use of this report, please contact Gibb Ritchie Geotechnical Engineers for clarification.

APPENDIX H

CPT-IT Outputs

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 54.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 24 months
Time period for second. settlements: 586 months

* Primary settlement calculation is performed according to the following formula:

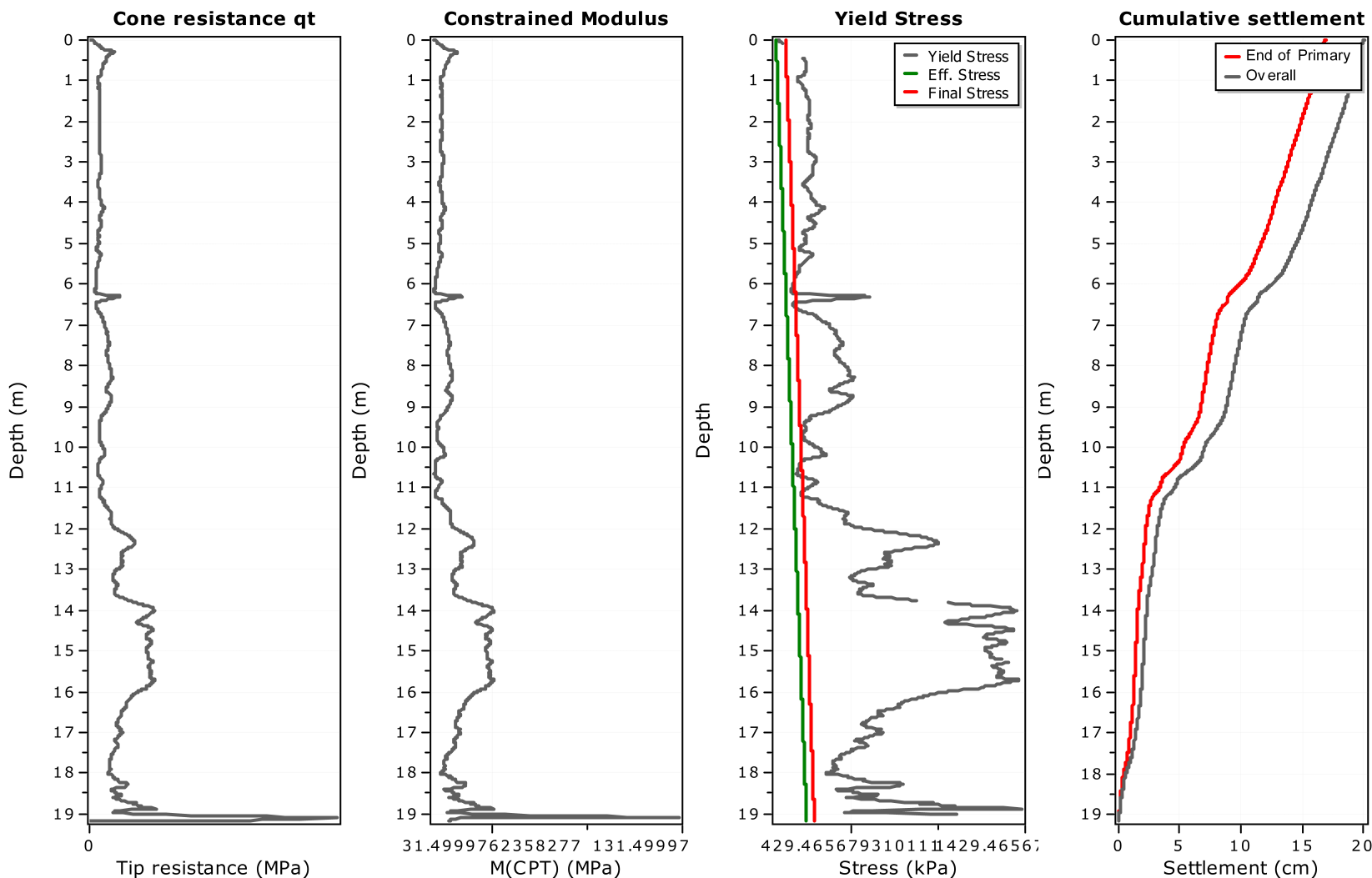
$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S_{sec} = S_{pri} \left(1 - e^{-\frac{t}{t_p}} \right)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 54.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 24 months
Time period for second. settlements: 576 months

* Primary settlement calculation is performed according to the following formula:

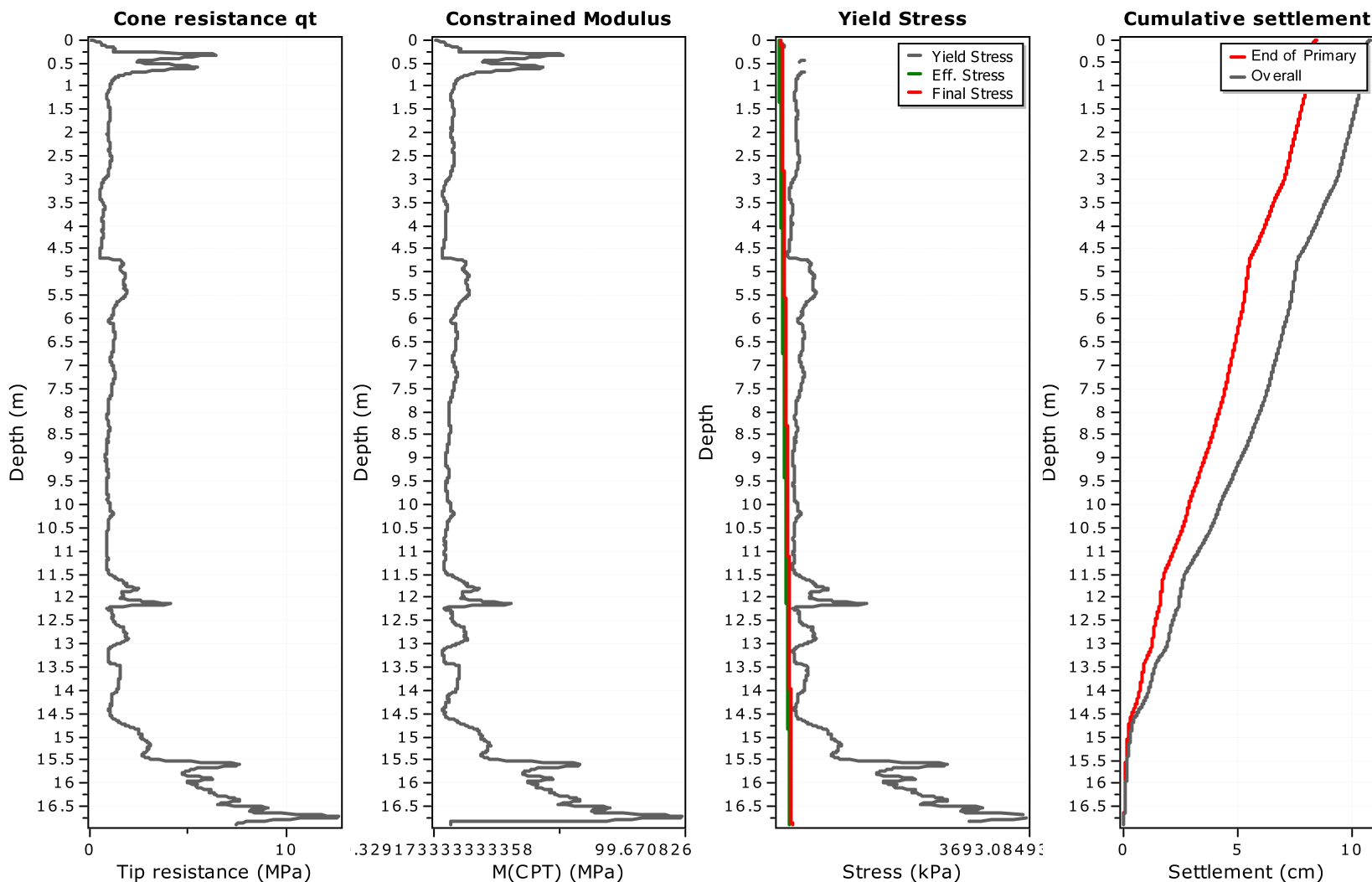
$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S_c = S_p \left(1 - e^{-\frac{t}{t_p}} \right)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 36.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 24 months
Time period for second. settlements: 576 months

* Primary settlement calculation is performed according to the following formula:

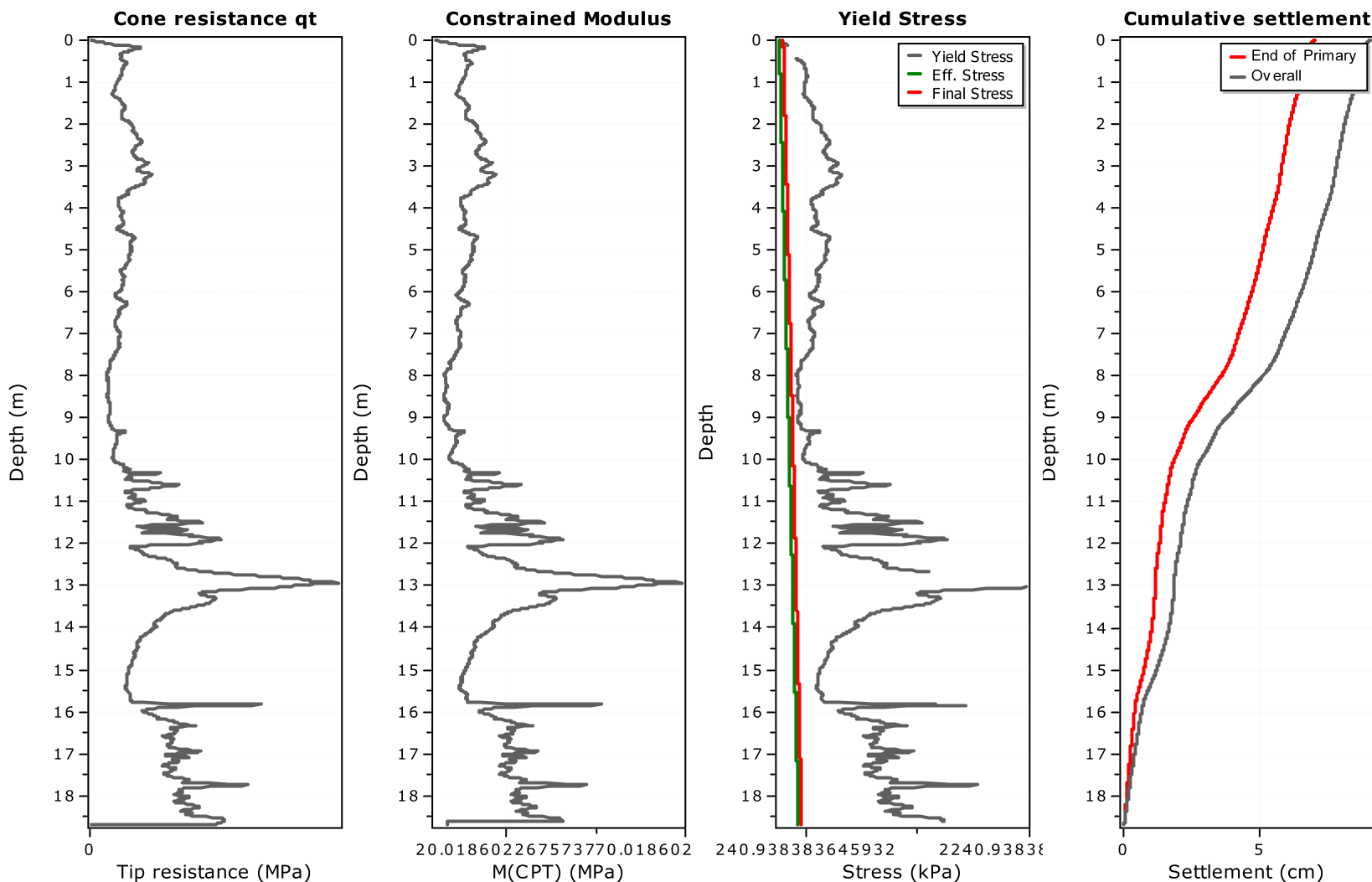
$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S_{sec} = S_{pri} \left(1 - e^{-\frac{t}{t_p}} \right)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 36.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 24 months
Time period for second. settlements: 576 months

* Primary settlement calculation is performed according to the following formula:

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where t_p is the duration of primary consolidation