Interpretive Report

Date Prepared: 31 January 2020

Prepared by: Ashe Cooper

Northwest HIF – Trig Road Geotechnical Interpretive Report

Purpose

This geotechnical interpretive report has been prepared to present the geotechnical interpretation of the geotechnical factual information retrieved during the ground investigation at Trig Road, Whenuapai. This report also provides recommendations for the proposed development.

Document Status

Responsibility	Name	Signature
Author	Ashe Cooper	
Reviewer	James Burr	
Approver	Rob Mason	

Revision Status

Version	Date	Reason for Issue
0.1	31/01/2020	For Client Comment
0.2	14/02/2020	For issue to Client

Disclaimer

This is a draft document for review by specified persons at Auckland Transport and the New Zealand Transport Agency. This draft will subsequently be updated following consideration of the comments from the persons at Auckland Transport and the New Zealand Transport Agency. This document is therefore still in a draft form and is subject to change. The document should not be disclosed in response to requests under the Official Information Act 1982 or Local Government Official Information and Meetings Act 1987 without seeking legal advice.

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1. Introduction

The Supporting Growth project aims to identify the transport networks required to connect Auckland's future growth areas over the next 30 years. A coordinated approach with land use development running in parallel with infrastructure planning is required.

An early indication of the viability of preferred networks is required to identify geotechnical opportunities and constraints to developing land.

The 'preferred networks' require the following criteria to be met:

- Include improved accessibility and transport options,
- Strong focus on public transport, including walking and cycling facilities,
- Connections to the wider strategic transport network, and
- Maximum benefit and value in management of existing network infrastructure

As part of the Supporting Growth Alliance (SGA), Beca Limited (Beca) are undertaking the geotechnical investigation and interpretation to inform the preliminary design of the roading upgrades along Trig Road. This report provides high level geotechnical interpretation of the factual ground investigation data and recommendations of design elements which may be considered for the project. Additional investigation and analyses will be required for later stages of the design.

2. Proposed Development

The proposed development along Trig Road is a road widening to accommodate future transportation requirements for the Auckland region. Trig Road is a Level 1, Arterial route road. The Trig Road upgrade would see:

- Two lane road with a flush or scour median
- Berm and footpath on either side of the road
- A cycleway along one side of the road

For the proposed road widening to take place, a combination of cut and fill earthworks along with retaining structures would be required in order to achieve the targeted road width (refer Figure 1).

Figure 1 - Trig Road Proposed Concept Design

3. Site Description

The site is located along Trig Road, which trends in a north-west south-east direction from Hobsonville Road in the south to Brigham Creek Road in the north. An overall Site Plan is also shown in Appendix 1.

Trig Road runs along a minor north to south trending ridge with slopes within the area considered flat to gently sloping, at less than 5°. Slopes up to 20° occur in localised areas immediately adjacent to the road alignment. Three streams are present within the site and exist on the eastern and western sides of Trig Road and are named Totara Stream, Trig Stream, and Rawiri Stream with various ephemeral water courses feeding into them.

4. Geotechnical Information

4.1. Geology

The published 1:250,000 geological map (QMAP) of the Auckland area (Edbrooke, 2001) indicates that the area comprises two main geological units as shown in Figure 2. From the ground investigation, it was found that the site is underlain by Puketoka Formation of the Tauranga Group overlying Waitemata Group material.

Figure 2 - Trig Road Geology (QMaps, 2019)

4.2. Ground Investigation Scope

Ground investigations were undertaken by Beca in November – December 2019. The information from the investigation is presented in the report titled *Northwest HIF – Trig Road Geotechnical Factual Report*

The scope of the investigations carried out is summarised below:

- 2 x Machine Boreholes with Standard Penetration Tests (SPT's) undertaken typically at 1.5m centres, to depths ranging between 13 and 22m
- 3 x Test Pits (TP's) to a maximum of 3.5m depth
- 1 x Hand Auger (HA) to 3.5m depth.

The upper 1.5m of both machine boreholes was vacuum excavated due to services being present in the investigation area.

4.3. Ground Profile

We provide a summary of the soil and rock profile derived from the ground investigation in Table 1 below. Two geological cross sections at the site are presented in Appendix B.

Table 1 – General Ground Profile[1]

Layer	Geological Unit	Soil Description	Thickness (m)	Undrained Shear Strength Range (kPa)	Typical SPT "N" Value Range (Blows/100mm)
1a	Puketoka Formation	Stiff/ Very Stiff Clayey SILT	5 – 10	43 – 191	3 – 5
1b	Puketoka Formation (recent alluvium)	Firm Clayey SILT	3.0+ ?	37 – 43	4 – 13
2a	Weathered Waitemata Group	Interbedded Hard Clayey SILT/Medium dense fine silty SAND	4 - 9	UTP	18 – 47
2b	Waitemata Group	Extremely Weak SANDSTONE/ SILTSTONE	-	-	50+

Unit 1b (recent colluvium) was only encountered in TP101/19 but may be found in other low-lying areas along the alignment.

4.4. Groundwater Conditions

Both boreholes were dipped following completion of drilling. At the time of the measurements the boreholes were fully open. Only borehole BH101/19 was able to be left to allow for dissipation o drilling muds or other fluids. Borehole BH102/19 was dipped following completion of drilling. The water level is indicative only and does not allow for the interpretation of water levels or vertical gradients between individual units.

Test pit 101/19 encountered groundwater at approximately 800mm depth. This test pit is located adjacent to an ephemeral watercourse and groundwater will likely be elevated at this location. Groundwater was measured at 3.0m below ground level in borehole BH101/19, and 2.5m below ground level in borehole BH102/19.

[1] Findings presented above are based on the ground investigation at chainages 140m and 420m. Variation in the ground profile along the length of the road is expected

4.5. Laboratory Testing

The laboratory testing was carried out on collected field samples and was undertaken by Geotest Ltd, an IANZ accredited laboratory. Full results are in the report titled *Northwest HIF – Trig Road Geotechnical Factual Report.*

Laboratory testing results are shown in the tables below.

Table 2 - Natural Moisture Content and Atterberg limits Test Results

Unit	Borehole ID	Sample Depth (m)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
1a	BH101/19	1.5	43.4	67	30	37
1a	BH102/19	3.0	47.5	79	37	42
1b	BH102/19	7.5 – 7.95	40.7	71	25	46

The soils plot as highly plastic clay/silt.

Table 3 - Particle Size Distribution - Wet Sieve/Hydrometer Method Test Results

Unit	Borehole ID	Sample Depth (m)	% Clay	% Silt	% Sand	% Gravel
1a	BH101/19	1.5	52	27	21	0
1a	BH102/19	3.0	36	51	13	0
1b	BH102/19	7.5 – 7.95	18	59	23	0

Table 4 - One Dimensional Consolidation Test Results

Unit	Borehole ID	Sample Depth (m)	Initial Bulk Density (t/m^3)	Initial Void Ratio	Applied Pressure Range (kPa)	Coefficient of Consolidation Range (C_v Log) (m^2/year)	Coefficient of Volume Compressibility Range (M_v) (m^2/MN)
1a	BH101/19	3.8	1.75	1.28	12.5 – 800	5.1 – 8.5	0.05 – 0.13
1b	BH101/19	6.0	1.51	2.32	12.5 – 800	28 – 6.1	0.45 – 0.25

5. Geotechnical Design Parameters

Preliminary material parameters have been assessed from the geotechnical investigations, laboratory testing, and moderated by our experience of similar soils in the Auckland area. These are provided in the Table 5 below.

Table 5 - Geotechnical Design Parameters

Layer	Soil Description	Density (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees) Φ'	Undrained Shear Strength (Su) (kPa)
1a	Stiff Clayey SILT	17	3	28	55
1b	Soft/Firm Clayey SILT	16	1	26	40
2a	Interbedded Hard Clayey SILT/Medium dense silty fine SAND	18	3	30	125
2b	Waitemata Group Rock	18	10	36	500
3	Engineered Fill	18	5	30	100

6. Design Standards and Criteria

6.1. Design Codes and Guidelines

The relevant design codes and standards for the Trig Road upgrade are summarised below:

- AS/NZS 1170 Structural Design Actions
- NZS 1170.5:2004 Structural Design Actions – Part 5: Earthquake Actions – New Zealand, incorporating Amendment 1, September 2016
- Bridge Manual, Manual Number SP/M/22, 3rd Edition, Amendment 3 (BM) (NZTA, 2018)
- MBIE New Zealand Building Code – B1 Structure/ Verification Method 4 Foundations (B1/VM4), incorporating Amendment 15, January 2017
- Auckland Unitary Plan – E25. Noise and Vibration, Auckland Council
- MBIE/NZGS Modules for Earthquake Geotechnical Engineering Practice

6.2. Seismic Design

6.2.1. Site Subsoil Class

The site subsoil class has been determined from the geotechnical site investigations in accordance with New Zealand Standard for Structural Design Actions NZS1170.5:2004.

The site subsoil class is classified as Class C – shallow soil sites.

6.2.2. PGA Design Values

The Peak Ground Acceleration (PGA) values for the earth slopes obtained from NZTA Bridge Manual Version 3.3, are presented in Table 6 below.

A 100-year design life has been assumed for the embankments and they are assumed to be no greater than 6m high.

Table 6 - Input for the Seismic Peak Ground Acceleration Calculation

Importance Level	Design Life (years)	Design Case	Annual Probability of Exceedance	Return Period Factor (Ru)	PGA Design Value (g)
3	100	ULS	1/500	1.0	0.19
3	100	MCE	1/1400	1.0	0.29

The calculation of the Peak Ground Acceleration is attached in Appendix D.

6.3. Liquefaction Susceptibility

Liquefaction is a phenomenon where saturated granular soil temporarily lose strength due to high pore water pressure development during and after significant earthquake shaking. Liquefaction predominantly occurs in loose non-plastic silts, sands and well-graded gravels below the water table.

Liquefaction susceptibility at the site is low due to the cohesive nature of the soils. This is confirmed by the laboratory testing.

7. Design Recommendations

Key geotechnical issues and risks for the Trig Road upgrade are:

- Property boundary constraints
- Geotechnical ground conditions
- Cut fill material balance
- Existing services

The following design recommendations are applicable across the Trig Road upgrade.

7.1. Earthworks

7.1.1. General

Topsoil needs to be stripped from the site before earthworks are undertaken. Tree stumps, old foundations, and any other obstructions or organic materials need to be removed and remediated. The existing road embankment fill may also need to be excavated and replaced, subject to further testing. These locations need to be excavated and backfilled with suitable compacted material to engineering standards. All unsuitable material should be excavated and removed from site and replaced with approved engineered fill (either compacted cohesive or granular hardfill).

Site won soils maybe used as engineered fill. The Unit 1 soils are likely to require drying back before they can be placed and compacted. The Unit 2 soils/rock may be usable without conditioning, but they are encountered at significant depth and so are unlikely to be available based on the earthworks current design.

Lime or cement stabilisation may be used to improve soil strength upon reworking and compacting. Prior to construction, laboratory testing would be required to confirm the suitability of lime and/or cement to provide drying and/or strength improvement. Alternatively, imported cohesive or granular hardfill or cohesive fill could be used for backfilling.

Unsuitable materials may be able to be used as landscape fill or temporary stormwater controls.

7.1.2. Cuts

Small cut slopes are required to widen to the west of Trig Road. These will encroach on existing footpaths, stormwater controls, and property boundaries. Unsupported cut slopes should be cut no steeper than 3H:1V.

It is recommended that cut slopes be dressed in vegetation to avoid frittering and scour from the wetter months. A geosynthetic product would be appropriate to encourage vegetation growth and provide a means for this.

7.1.3. Fills

Once any unsuitable material and existing topsoil has been stripped from the site, embankment construction could commence. Engineered fill embankments should be constructed using good, clean, engineered fill. Imported granular hardfill would also be appropriate for embankment construction. Fill should be compacted in a maximum 200mm lifts and benched into the existing slopes. For preliminary design purposes, embankments compacted using cohesive engineered fill should be no steeper than 3H:1V. and embankments constructed using granular hardfill could be constructed no steeper than 2H:1V.

Consolidation settlements will occur within the soils beneath the proposed concept embankments. Minor settlement of the fill embankment itself may occur if cohesive engineered fill is used. Settlements are expected to be in the order of 25 – 100mm. Further investigation and analysis should be undertaken during detailed design.

Settlement monitoring of fills should be undertaken during construction and for 6 months post-construction to confirm design assumptions. Monitoring beyond this point should be continued should settlements be trending toward greater than expected.

Engineered fill embankment slopes should be adequately dressed in vegetation to avoid local scour or failure of the topsoil layer. A geosynthetic product would be appropriate to encourage vegetation growth and provide a means for this.

7.1.4. Effects on Natural Groundwater Levels

The proposed concept earthworks design has cut slopes no greater than two metres in height and fills no greater than six metres in depth. From the ground investigation information, the observed groundwater levels are lower than the proposed cuts. Embankments will be constructed on top of the existing ground level.

The concept design for the Trig Road works are anticipated to have negligible effects on the natural groundwater level.

This conclusion should be reviewed as the design progresses to confirm that any changes do not result in significant effects to the current groundwater regime.

7.2. Slope Stability

Slope stability analyses have been assessed using GeoSlope Slope/W 2019 to assess, at a conceptual level, the stability of the proposed embankment. Stability cases assessed are:

- Static
- Elevated groundwater level
- Seismic, applying a peak ground acceleration to the stability model

Target factors of safety for each of the design cases are as below:

- Static – FoS > 1.5
- Elevated groundwater level – FoS > 1.3
- Seismic – FoS > 1.0 (or if <1.0, acceptable displacements as per Bridge Manual)

Stability analyses are presented in Appendix 4 and show that, for the conceptual embankment model constructed with engineered fill, target factors of safety are achieved.

7.3. Retaining Walls

Retaining walls may be required for local stability of cuts and fills on both sides of the road widening. Other small retaining structures might be desirable for landscaping and maintaining driveway access to existing properties. Timber pole walls may be an appropriate option to be explored for these applications, should a 50-year design life be acceptable.

Retaining walls may also be considered to support larger areas of the proposed road widening instead of large engineered fill embankments as they will allow a smaller footprint. The walls required for this height of retaining (in the order of 3 – 6m) would likely be MSE walls constructed using hardfill. MSE walls would also need to consider global stability and so may require undercut of the weaker Unit 1b soils.

Wall options could be considered in later stages as part of a costing and environmental impact analysis.

Drainage must be included behind all retaining walls to encourage any water to drain from behind the structure.

7.4. Pavements

For pavement design on in-situ soils, a California Bearing Ratio (CBR) of 3% is recommended. For the engineered fill a CBR of 5% is recommended. Testing of the subgrade is required during construction and minimum Scala Penetrometer results of 3 blows per 150mm and 5 blows per 150mm are required for design subgrades of 3% and 5% respectively.

The subgrade CBR is for insitu soils and will vary, meaning that undercutting of weaker soils and replacement with compacted granular hardfill may be required to achieve this CBR. Alternatively, weaker areas could be potentially be improved with lime and/or cement stabilisation if required, however laboratory testing is required to confirm the reactivity and improvement likely to be achieved.

7.5. Services

At present, services run down both sides of Trig Road. Services should be located and protected prior to beginning construction onsite.

Services should be located in berms and beneath footpaths to reduce traffic disruption during scheduled and unscheduled maintenance.

7.6. Sustainability

Reusing site won material, where suitable would reduce the carbon footprint of this project. Should materials need to be imported for construction, a study into locally available material should be carried out to reduce emissions from vehicles transporting material to the site. Existing chip seal could be recycled and utilised for the new pavement of the road. Alternatively, recycled aggregate products are also readily available for pavement construction.

The long-term maintenance of new assets should also be considered before proceeding into detailed design of any infrastructure.

8. Conclusions and Recommendation

Geotechnical site investigations were undertaken for the to inform the preliminary design of the proposed Trig Road upgrade. Based on the investigation, we provide the following high-level conclusions and recommendations:

- Trig Road is a Level 1 Arterial route road located in Whenuapai, Auckland road. The road runs along a minor north to south ridge. The site is predominately sloping from west to east.
- The 1:250,000 'Geology of the Auckland Area' map indicates the site is underlain by Puketoka Formation (Tauranga Group) soils overlying Waitemata Group soils and rock.

- Geological units across the site comprise firm to very stiff clayey silt from the Puketoka Formation overlying a weathered profile of the Waitemata Group.
- Groundwater has been measured across the site at 1 – 2.5mbgl.
- A seismic site subsoil of class C has been determined for Trig Road.
- The in-situ Unit 1 soils may require conditioning for reuse as engineered fill.
- All soft and/or unsuitable soils (organics, tree roots, and existing fill) should be removed from the site before the placing any fill material or construction of structures.
- Site susceptibility to liquefaction is considered to be low.
- The concept design for the Trig Road works are anticipated to have negligible effects on the natural groundwater level.
- The soils beneath the proposed concept embankments may settle under the embankment load. Settlements are expected to be between 25 – 100mm.
- Specific design such as retaining walls should be undertaken for any cuts >0.5m with adequate drainage provided.
- A design subgrade of CBR 3% for in-situ soils and 5% for engineered fill is recommended. This can vary across the site and some undercut may be required to achieve it.
- Further ground investigations and analyses will be required at detailed design stage.

9. Applicability

This report has been prepared by Beca on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

Should you be in any doubt as to the applicability of this report and/or its recommendations for the proposed development as described herein, and/or encounter materials on site that differ from those described herein, it is essential that you discuss these issues with the authors before proceeding with any work based on this document.

10. References

Beca Ltd, *January* 2020 '*Northwest HIF – Trig Road Geotechnical Factual Report.*

Edbrook, 2001 'Geology of the Auckland Area'

Standards New Zealand, 2004 NZS 1170.5: 2004 Structural Design Actions – Earthquake Actions

NZTA (2018), Bridge Manual 3, Third edition, Amendment 3

Appendix 1. Site Plans

Site Plan

TE TUPU NGĀTAHI Supporting Growth

AT

NZ TRANSPORT AGENCY

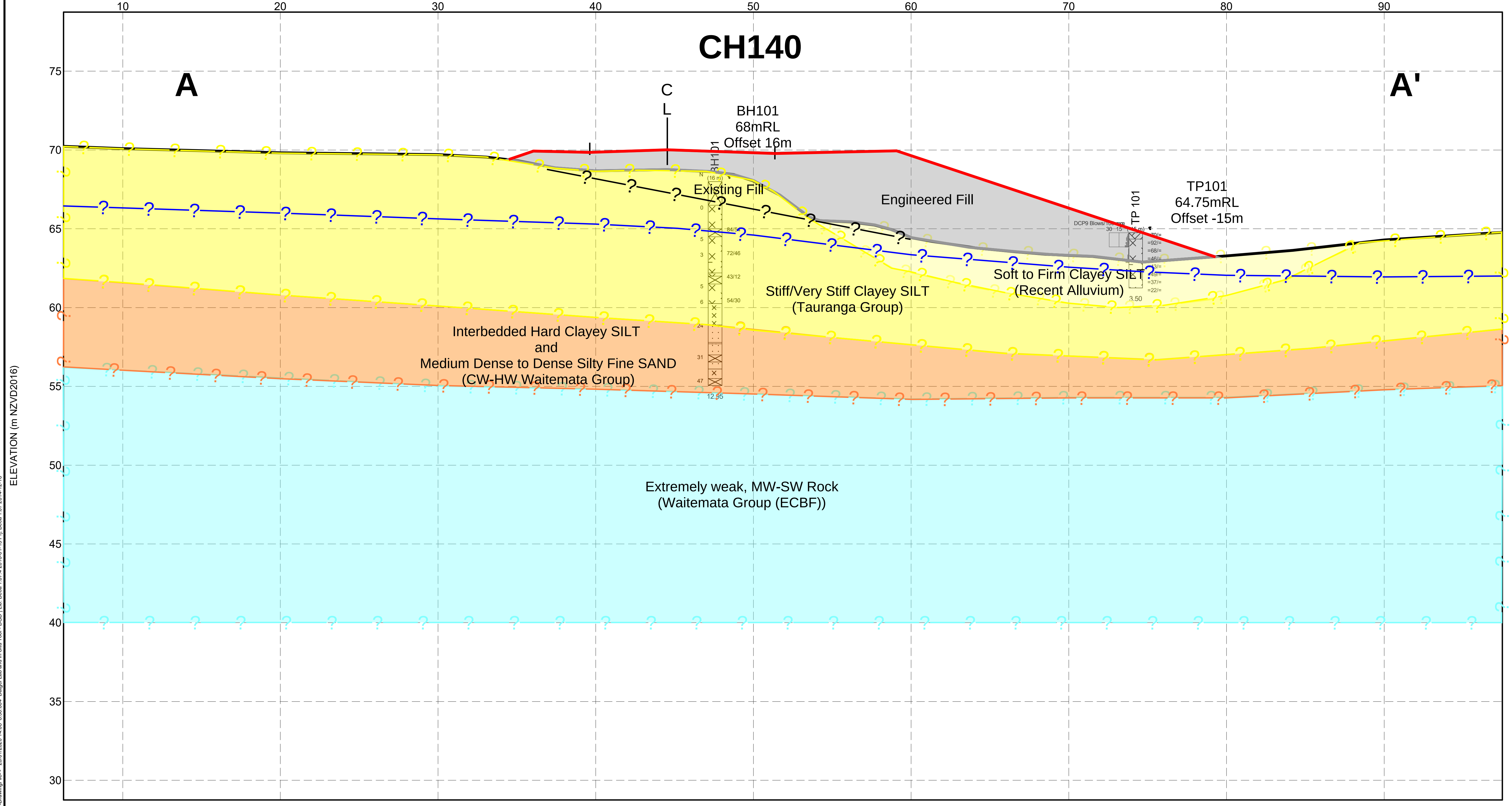
Drawing Status: DRAFT DETAILED BUSINESS CASE

A1 Scales	1:2000	A3 Scales	1:4000

Contract Number: 0000000

ORIGINAL SIZE A1

Appendix 2. Geological Cross-sections



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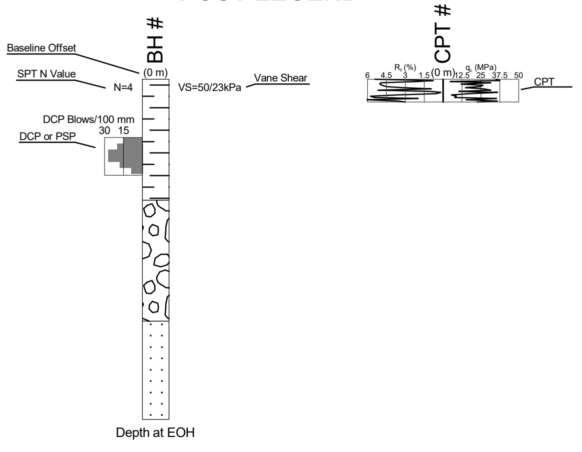


MATERIAL GRAPHIC

- No Core
- Clayey SILT
- SILT
- SILTSTONE
- SANDSTONE
- TOPSOIL

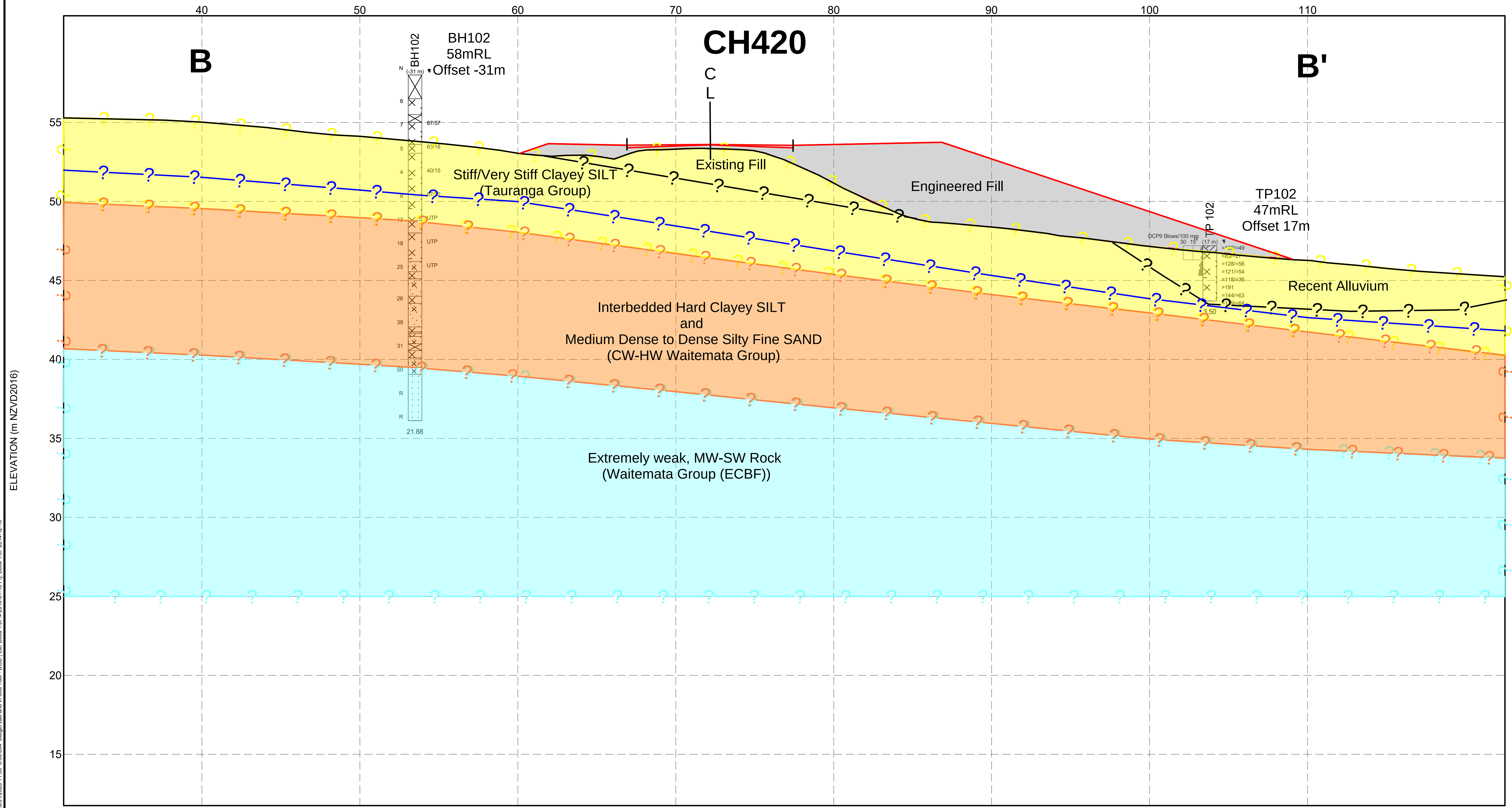
GEOLOGY

- Firm Clayey SILT
- Stiff/Very Stiff Clayey SILT
- Interbedded Hard Clayey SILT and Medium Dense Silty Fine SAND
- Extremely Weak, CW Rock
- Engineered Fill

H 1:250
0 2 4 6 8 10m
V 1:250
0 2 4 6 8 10m
Coord.System: Height Datum: NZVD2016

Beca

TITLE: Supporting Growth Alliance Trig Road Trig Road Investigations, Kumeu Subsurface Section A A'	DRAWN: AC	DATE: 20/01/2020	
	CHECKED: JZC	DATE: 20/01/2020	
	SCALE: H 1:250 V 1:250		A3
	PROJECT No: 3810934	FIGURE No	



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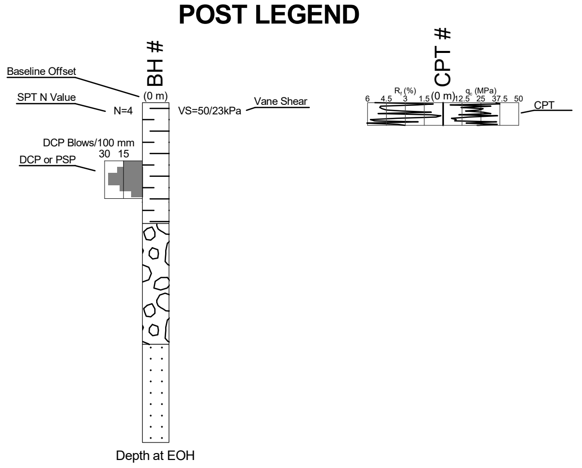

MATERIAL GRAPHIC

- No Core
- Clayey SILT
- SILT
- Silty SAND
- SILTSTONE
- SANDSTONE
- TOPSOIL

GEOLOGY

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- Extremely Weak, CW Rock
- Engineered Fill

H 1:250
0 2 4 6 8 10m
V 1:250
0 2 4 6 8 10m
Coord.System: Height Datum: NZVD2016

Beca

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	CHECKED: JZC	DATE: 20/01/2020
	SCALE: H 1:250 V 1:250	A3
	PROJECT No: 3810934	FIGURE No

BECA LIB 1.07.4.GLB Fence FENCE A3L NO PLAN TRIG ROAD INVESTIGATIONS.GPJ <<DrawingFile>> 20/01/2020 11:59 8.30.004 Datgel Lab and In Situ Tool - DGD | Lib: Beca 1.07.4 2016-01-15 Prj: Beca 1.07 2014-12-16

Appendix 3. Peak Ground Acceleration Calculation

Beca

Calculation datasheet

job name	Supporting Growth Alliance		
job no	3810934	by	AC
date	31/01/2020	page	1 of 2

Determination of Peak Ground Accelerations (Major/MCE/CALS, Design/ULS/DCLS, Minor and SLS) with Bridge Manual (BM) SP/M/022 Third addition Amendment 3, Section 6.2.2

6.2 Design Loadings and Analysis

PGA= $C_{0,1000}\frac{R_u}{1.3}fg$

PGA = Peak ground acceleration in combination with a corresponding earthquake magnitude

$C_{0,1000}$ = 1000 year return period PGA coefficient

R_u = return period factor determined from Table 3.5 NZS 1170.5

f = site subsoil class

cl. 3.1.3 site subsoil class

choose a suitable site subsoil class	→	**Class C - Shallow soil sites**
Site subsoil class factor f	→	**1.33**

Town/ City

Table 6A.1

choose an area closest to the site in question	→	**Auckland**
1000 year return period PGA coefficient, $C_{0,1000}$, for the area chosen	→	**0.15**

cl. 3.1.5 return period factor, R

1170.0 table 3.2 importance levels for building types - nz structures

refer to 1170.0 table 3.2 for importance level	→	**3**

1170.0 table 3.3 annual probability of exceedance - earthquakes

1170.5 table 3.5 return period factor, R

anticipated design working life of structure	→	**100 years or more**
Annual probability of exceedance for **Design/ULS/DCLS** refer BM Table 2.1 to 2.3	→	**1/500**
Return period factor based on **Design/ULS,** R_u =	→	**1**
Annual probability of exceedance for **SLS2** refer BM Table 2.1 to 2.3 for earth retaining or slopes; refer BM Section 6.1.2b for Road operational continuity requirements	→	**1/50**
Return period factor based on **SLS2**, R_s =	→	**0.35**
Annual probability of exceedance for minor event/**SLS1** see BM Table 5.1	→	1/25
Return period factor based on **Minor Event/SLS1 (Ru/4)**, R_{minor} =	→	**0.25**
Approximate annual probability of exceedance for Major/MCE/CALS event see BM Table 5.1	→	1/1400
Return period factor based on **Major/MCE/CALS Event**, $R_{MCE/CALS}$ =	→	**1.5**

Determination of Peak Ground Accelerations (Major/MCE/CALS, Design/ULS/DCLS, Minor and SLS) with Bridge Manual (BM) SP/M/022 Third addition Amendment 3, Section 6.2.2

Summary

A Class C - Shallow soil sites is selected to evaluate the PGA for this Auckland project.
An importance level of 3 has been allocated to the structure.
Design working life of structure is 100 years or more.
As such, the PGA has been evaluated based on MCE/CALS, ULS/DCLS and SLS1.

Limit State	Annual Propability of Exceedance	Earthquake Magnitude, M_w	Return Period Factor	Unweighted PGAs C(0) = PGHA
Major/MCE/CALS	1/1400	6.50	1.5	0.285g
Design/ULS/DCLS	1/500	6.50	1	0.19g
Minor/SLS1	1/25	5.90	0.75	0.115g
SLS2	1/50	5.90	0.35	0.054g

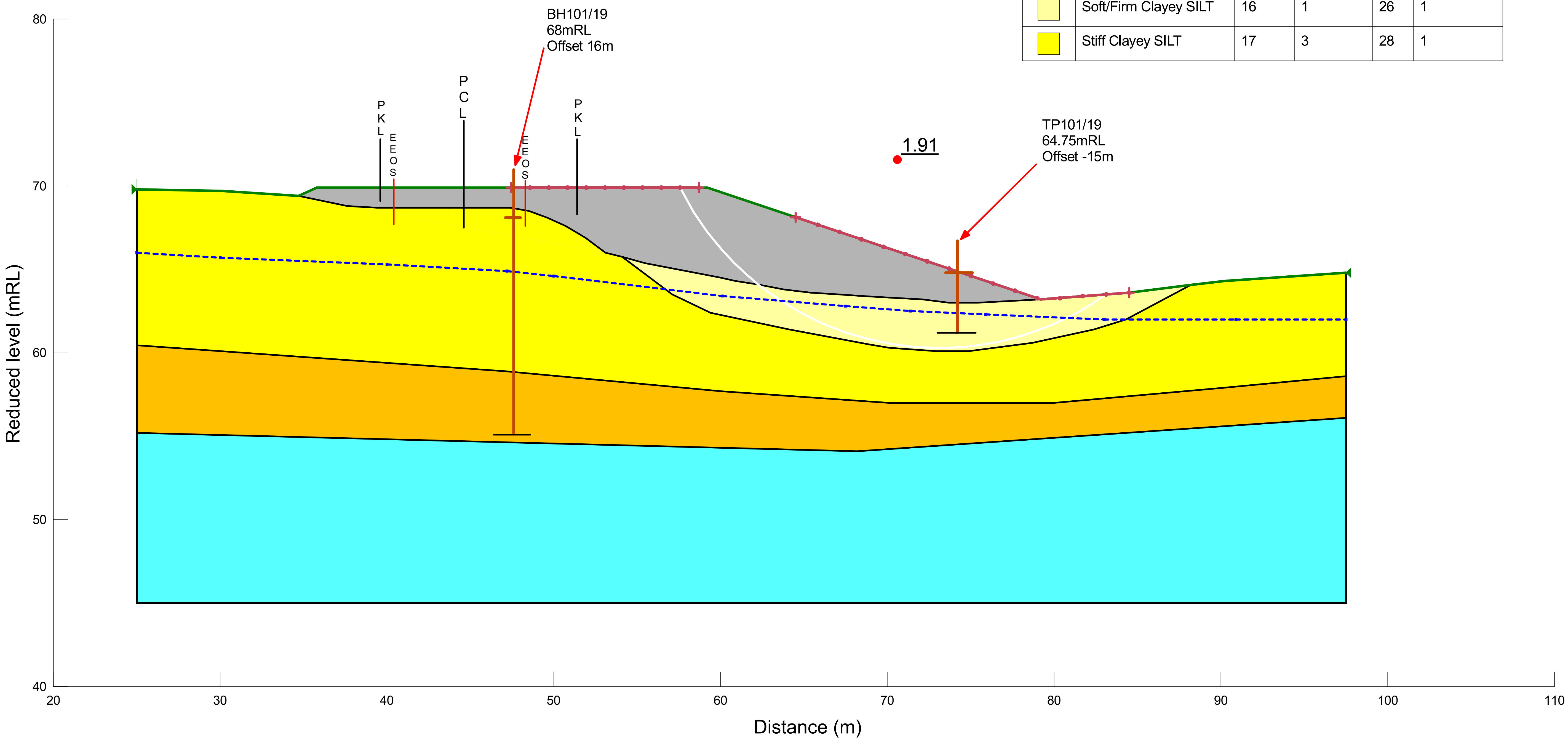
Appendix 4. Slope Stability Analysis

Horz Seismic Coef.:
Staged Pseudo Static Analysis Option: (none)

Method: Morgenstern-Price

Trig Road - CH140

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
	ECBF ROCK	18	10	36	1
	Engineered Fill	18	5	30	1
	Interbeded Hard Clayey SILT/Medium Dense Silty Fine SAND	18	3	30	1
	Soft/Firm Clayey SILT	16	1	26	1
	Stiff Clayey SILT	17	3	28	1



Beca

Supporting Growth Alliance
Trig Road

Supporting Growth Alliance - Trig Road.gsz
1.0 Static

Job Number: 3810934	Date: 30/01/2020
Scale: 1:250	Figure 4.1

Version: 10.0.1.17733

Horz Seismic Coef.:
Staged Pseudo Static Analysis Option: (none)

Method: Morgenstern-Price

Trig Road - CH140

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
	ECBF ROCK	18	10	36	1
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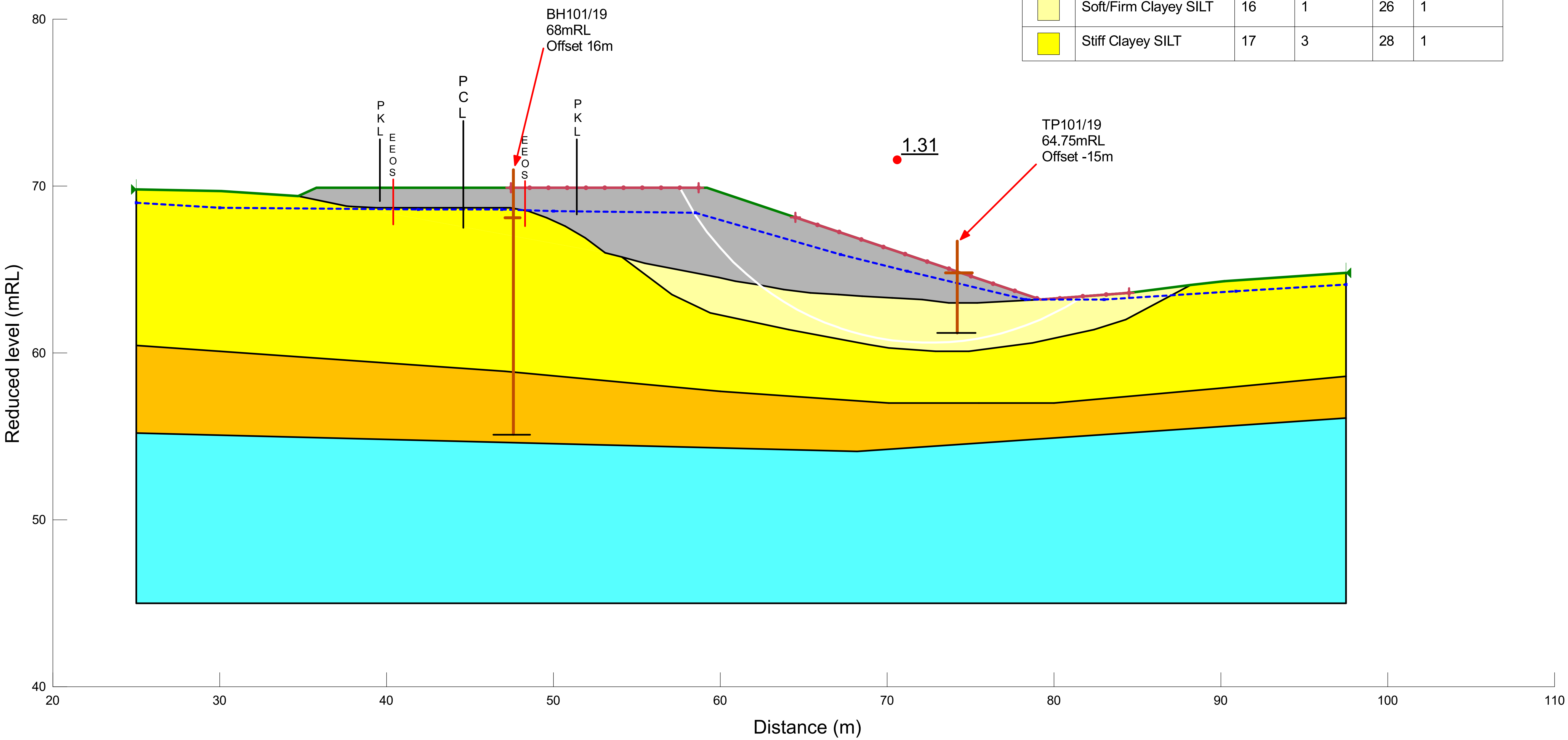


Beca	Supporting Growth Alliance Trig Road	Supporting Growth Alliance - Trig Road.gsz 2.0 Elevated Water Level	Job Number: 3810934 Scale: 1:250	Date: 30/01/2020 Figure 4.2

Version: 10.0.1.17733

P:\381\3810934\TGE\Trig Road Investigation\Interpretive Reporting\Stability Analysis\Supporting Growth Alliance - Trig Road.gsz, Ashe Cooper, 30/01/2020,02:45:31 p.m.

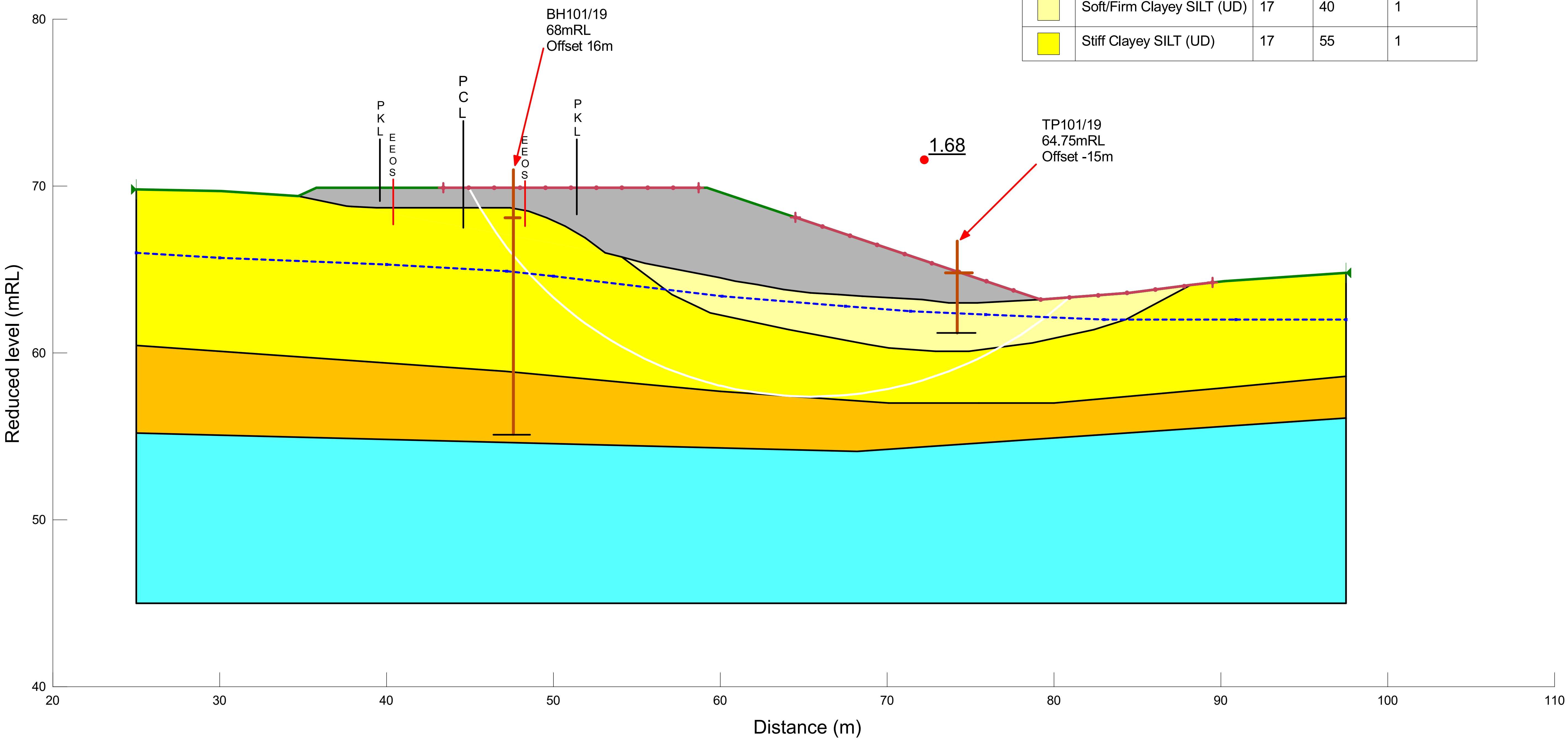
DO NOT SCALE

Horz Seismic Coef.: 0.19
Staged Pseudo Static Analysis Option: (none)

Method: Morgenstern-Price

Trig Road - CH140

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Piezometric Line
	ECBF ROCK (UD)	18	500	1
	Engineered Fill (UD)	18	100	1
	Interbeded Hard Clayey SILT/Medium Dense Silty Fine SAND (UD)	18	125	1
	Soft/Firm Clayey SILT (UD)	17	40	1
	Stiff Clayey SILT (UD)	17	55	1



Beca	Supporting Growth Alliance Trig Road	Supporting Growth Alliance - Trig Road.gsz 3.0 Seismic ULS	Job Number: 3810934	Date: 30/01/2020
			Scale: 1:250	Figure 4.3

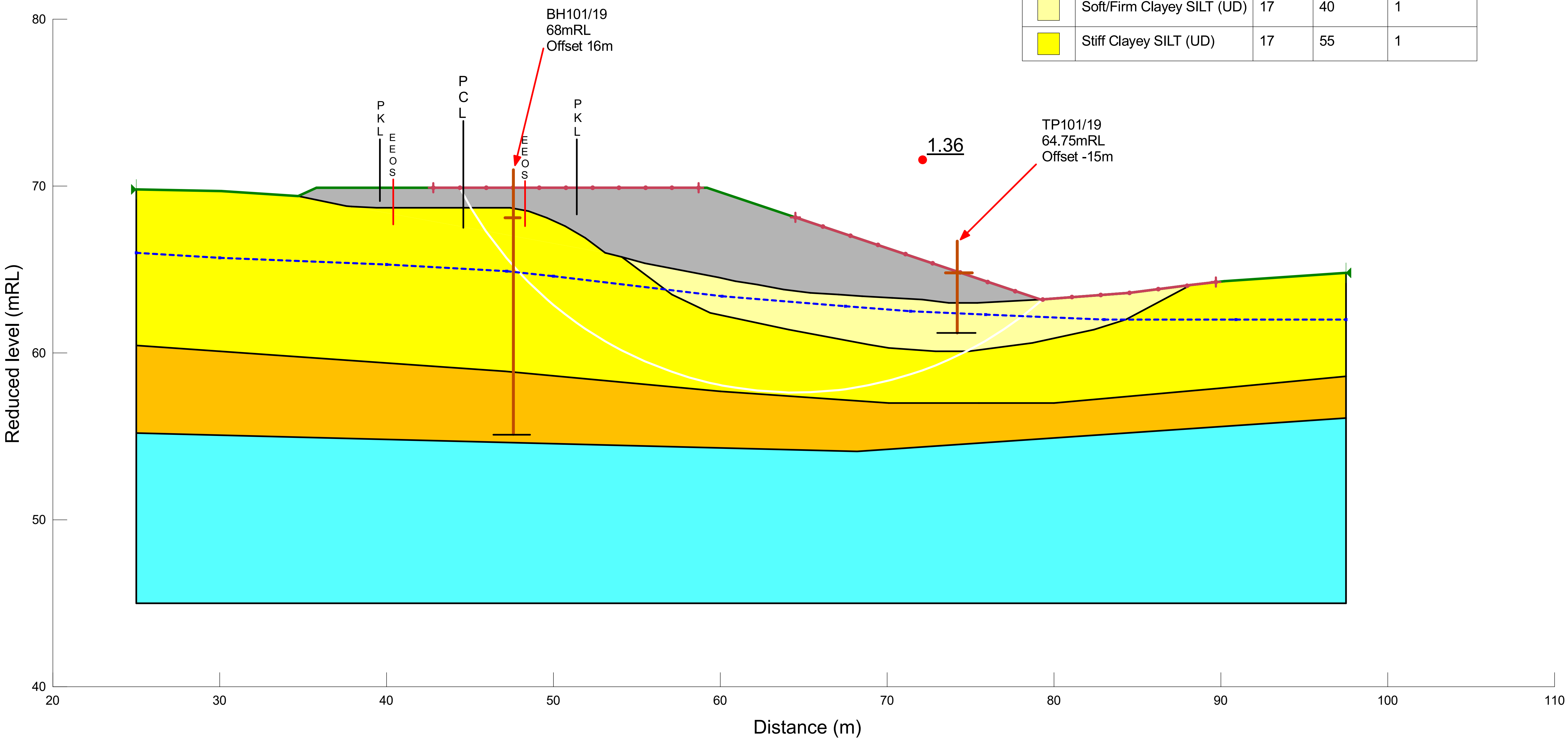
Version: 10.0.1.17733

Horz Seismic Coef.: 0.29
Staged Pseudo Static Analysis Option: (none)

Method: Morgenstern-Price

Trig Road - CH140

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Piezometric Line
	ECBF ROCK (UD)	18	500	1
	Engineered Fill (UD)	18	100	1
	Interbeded Hard Clayey SILT/Medium Dense Silty Fine SAND (UD)	18	125	1
	Soft/Firm Clayey SILT (UD)	17	40	1
	Stiff Clayey SILT (UD)	17	55	1



Beca	Supporting Growth Alliance Trig Road	Supporting Growth Alliance - Trig Road.gsz 3.1 Seismic MCE	Job Number: 3810934	Date: 30/01/2020
			Scale: 1:250	Figure 4.4

Version: 10.0.1.17733

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DO NOT SCALE