10 April 2025 Document Ref: AKL2022-0128AM | Rev 0

East Coast Heights Limited
32 Henwood Road, Taupaki
Auckland 0782

Attention: Liang

Dear Liang

RE: RESOURCE CONSENT PLAN REVIEW (RESIDENTIAL LOTS)
53 SMALL ROAD, SILVERDALE

1.0 INTRODUCTION

CMW Geosciences has been engaged by East Coast Heights Limited to undertake a geotechnical review of resource consent plans for a site located at 53 Small Road, Silverdale, which is being considered for the construction in-part of a residential subdivision.

This letter is intended to be used to support resource consent application to Auckland Council.

2.0 PROPOSED DEVELOPMENT

CMW have been provided the following plan sets:

- Draft architectural plans for Proposed Residential Development at Spine Road, Silverdale, prepared by Woodhams Meikle Zhan Architects, job number 1469-02, dated 25 March 2025.
- Civil engineering plans for proposed 17 Lot Residential Subdivision at 53 Small Road, Silverdale, prepared by Aspire Consulting Engineers, job number 1927, dated March 2025.

These plans depict the creation of 17 new residential building platforms located at the eastern end of the 53 Small Road development, and future two-storey dwelling typologies proposed to be constructed on the platforms. Access to the lots is via future “Spine Road” off the neighbouring Stages 3 & 4 development to the east (same developer). The lots are bound to the west by the industrial portion of the 53 Small Road development that is part of a separate consent.

Due to the prevailing site contour, the residential platforms are depicted to form terraces with elevations reducing towards the south. The terraces are proposed to be separated by retaining walls supporting both cuts and fills of up to 2.5m. These cut and fill thicknesses are relative to the future finished contour of the underlying bulk earthworks consent LUC60423965 described below.

Stormwater and wastewater are depicted to be connected into the future reticulated systems constructed as part of the underlying consent.

3.0 BACKGROUND INFORMATION

The following geotechnical reports have been prepared by CMW throughout the various stages of the 53 Small Road Development and the adjacent East Coast Heights Stages 3 & 4 development:

- Geotechnical Investigation Report for Silverdale South Stage 3 & 4, referenced AKL2020-0125AI Rev. 0, dated 17 December 2021.
- Preliminary Geotechnical Investigation Report for 53 Small Road, Silverdale, referenced AKL2022-0128AB Rev. 0.
- Geotechnical Earthworks Design Report for 53 Small Road, Silverdale, referenced AKL2022-0128AD Rev. 1, dated 4 October 2023.

Those reports included extensive site investigation within and adjacent the proposed residential development area including hand auger boreholes and test pits. Remediation within the eastern portion of the site specified in the AD report is currently under construction under the direction of CMW (under the bulk earthworks consent LUC60423965) including uncontrolled fill undercuts, rock buttressing and subsoil drain construction, as described in that report. In addition, the Stage 3 & 4 bulk earthworks along this boundary are largely complete, which will be certified in a forthcoming Geotechnical Completion Report for that stage of the East Coast Heights development.

4.0 REVIEW OF PROPOSED DEVELOPMENT PLANS

Full geohazards assessments were undertaken for both the East Coast Heights Stages 3 & 4 development and the underlying 53 Small Road development described in the reports referenced above and appended. In addition, a Geotechnical Works Specification was prepared as appended to the Geotechnical Earthworks Design Report covering the required remediation works and associated earthworks for the 53 Small Road site, which includes the area where the proposed residential stage is located. The earthworks to form the residential stage are required to comply with that Geotechnical Earthworks Specification.

The mitigation measures addressing the geohazards of the underlying subdivision are considered applicable to the proposed residential development. Future retaining walls for the residential platforms will address retaining wall interactions and temporary stability at building consent stage. Accordingly, we consider the plans reviewed to be in compliance with the recommendations of the underlying reports.

5.0 CLOSURE

This letter has been prepared for use by East Coast Heights Limited and Auckland Council in relation to the 53 Small Road, Silverdale project in accordance with the scope, proposed uses and limitations described in the letter. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than East Coast Heights Limited seeks to rely upon or otherwise use this letter, the consent of CMW should be sought prior to any such use. CMW can then advise whether the letter and its contents are suitable for the intended use by the other party.

For and on behalf of CMW Geosciences

Prepared by:

Henry Nagel
Senior Engineering Geologist

Reviewed and authorised by:

Sam Gibb
Principal Geotechnical Engineer, CPEng, CMEngNZ

Distribution: 1 electronic copy to East Coast Heights Limited via email
Original held at CMW Geosciences

Attachments: Supplied Plans
AKL2020-0125AI Geotechnical Investigation Report
AKL2022-0128AB Preliminary Geotechnical Investigation Report
AKL2022-0128AD Geotechnical Earthworks Design Report (including Geotechnical Works Specification)

CMW Geosciences
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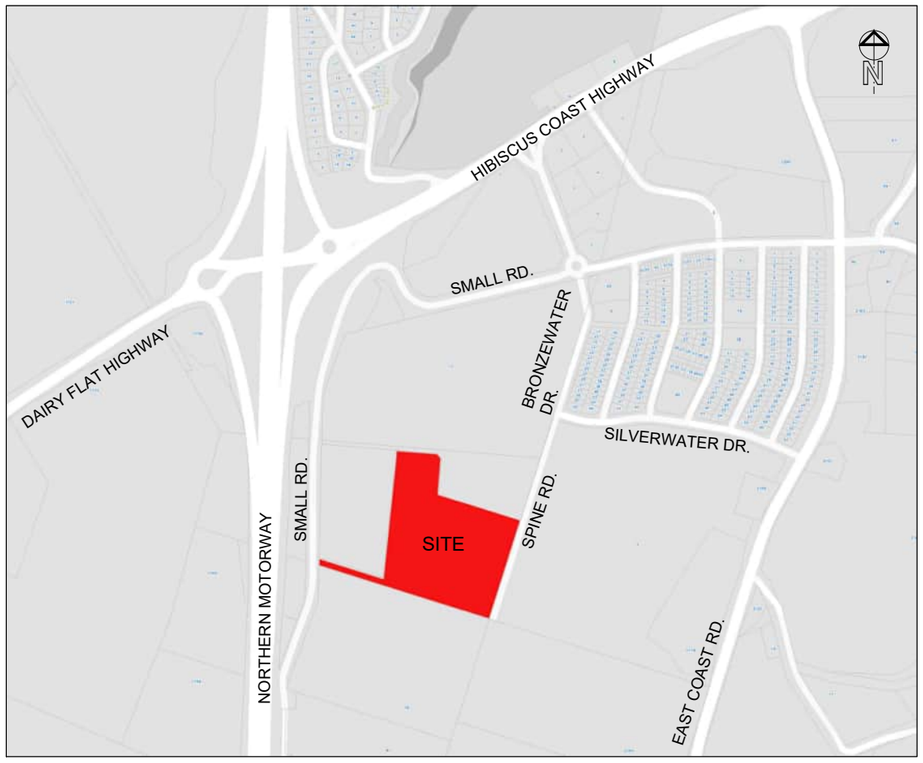
ATTACHMENT 1
Supplied Plans

1469-02

RESIDENTIAL DEVELOPMENT
SPINE ROAD, SILVERDALE, AUCKLAND



LOCALITY PLAN - NTS

RESOURCE CONSENT - DRAFT
March 2025

DRAWING LIST	
RC001	COVER PAGE
RC101	PROPOSED SITE PLAN
RC102	PROPOSED SITE COMPLIANCE PLAN
RC211	PROPOSED TYPE L1 FLOOR PLANS
RC212	PROPOSED TYPE L2 FLOOR PLANS
RC213	PROPOSED TYPE J1 FLOOR PLANS
RC214	PROPOSED TYPE N1 FLOOR PLANS
RC215	PROPOSED TYPE N2 FLOOR PLANS
RC216	PROPOSED TYPE H1 FLOOR PLANS
RC401	PROPOSED EAST ELEVATION
RC402	PROPOSED WEST ELEVATION
RC403	PROPOSED NORTH & SOUTH ELEVATIONS
RC501	PROPOSED SECTION 1
RC502	PROPOSED SECTIONS 2, 3 & 4
RC901	PROPOSED COLOUR & MATERIAL MATRIX
RC902	PROPOSED LETTERBOX DETAIL
RC951	PERSPECTIVE

NOTE:

DEVELOPMENT BOUNDARY, ALL DIMENSIONS ARE TO BE CHECKED AND VERIFIED BY SURVEYOR.

REQUIRES THE ENGAGEMENT OF A TOWN PLANNER TO VERIFY ALL PLANNING RULES.

DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS

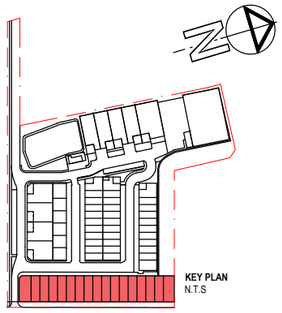
1. ALL DEVELOPMENT BOUNDARIES AND DIMENSIONS ARE TO BE CHECKED AND VERIFIED BY A REGISTERED SURVEYOR.
2. SITE AND BUILDING LEVELS TO BE VERIFIED BY A TOPOGRAPHICAL SURVEY PROVIDED BY A REGISTERED SURVEYOR.
3. A PLANNING CONSULTANT IS REQUIRED TO VERIFY ALL PLANNING RULES AND ASSUMPTIONS.
4. A CERTIFICATE OF TITLE IS REQUIRED TO VERIFY EXISTING SITE CONSTRAINTS, EASEMENTS AND LEGAL RESTRICTIONS.

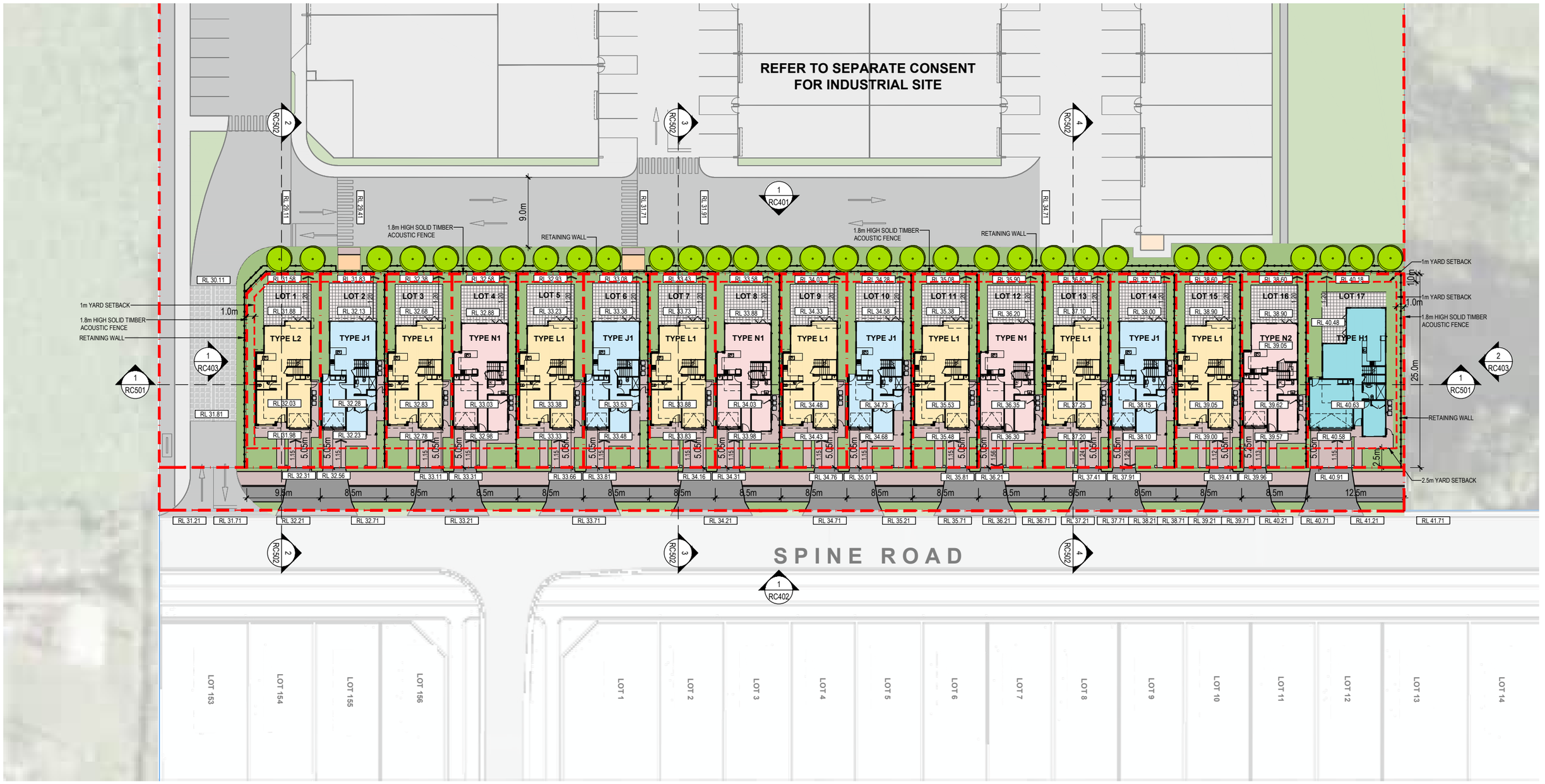
NOTE

VERTICAL DATUM : NZVD2016

Schedule of Calculation

Lot		House				Carparks		Building Coverage				Impervious Surface Area				Landscape Area			
No.	Area (m²)	Typology	Ground Floor (m²)	First Floor (m²)	Total Area (m²)	Garage	External	Max (MHU)	BC Area (m²)	BC (%)	COMPLIANCE	Max (MHU)	Area (m²)	IS + BC (%)	COMPLIANCE	Min (MHU)	Landscape Area (m²)	Landscape (%)	COMPLIANCE
1	234.4	L2	93	80	173	1	1	45%	96	41%	comply	60%	126	54%	comply	35%	89.0	38%	comply
2	212.3	J1	92	82	174	1	1	45%	98	46%	not comply	60%	128	60%	comply	35%	66.0	31%	not comply
3	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
4	212.3	N1	96	78	174	1	1	45%	99	47%	not comply	60%	126	59%	comply	35%	66.0	31%	not comply
5	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
6	212.3	J1	92	82	174	1	1	45%	98	46%	not comply	60%	128	60%	comply	35%	66.0	31%	not comply
7	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
8	212.3	N1	96	78	174	1	1	45%	99	47%	not comply	60%	126	59%	comply	35%	66.0	31%	not comply
9	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
10	212.3	J1	92	82	174	1	1	45%	98	46%	not comply	60%	128	60%	comply	35%	66.0	31%	not comply
11	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
12	212.3	N1	96	78	174	1	1	45%	99	47%	not comply	60%	126	59%	comply	35%	66.0	31%	not comply
13	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
14	212.3	J1	92	82	174	1	1	45%	98	46%	not comply	60%	128	60%	comply	35%	66.0	31%	not comply
15	212.3	L1	93	80	173	1	1	45%	96	45%	comply	60%	126	59%	comply	35%	67.0	32%	not comply
16	212.3	N2	95	78	173	1	1	45%	99	47%	not comply	60%	126	59%	comply	35%	66.0	31%	not comply
17	311.3	H1	130	110	240	2	2	45%	133	43%	comply	60%	173	56%	comply	35%	114.0	37%	comply





SITE PLAN Scale 1:250 @ A1, 1:500 @ A3

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC101

DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS

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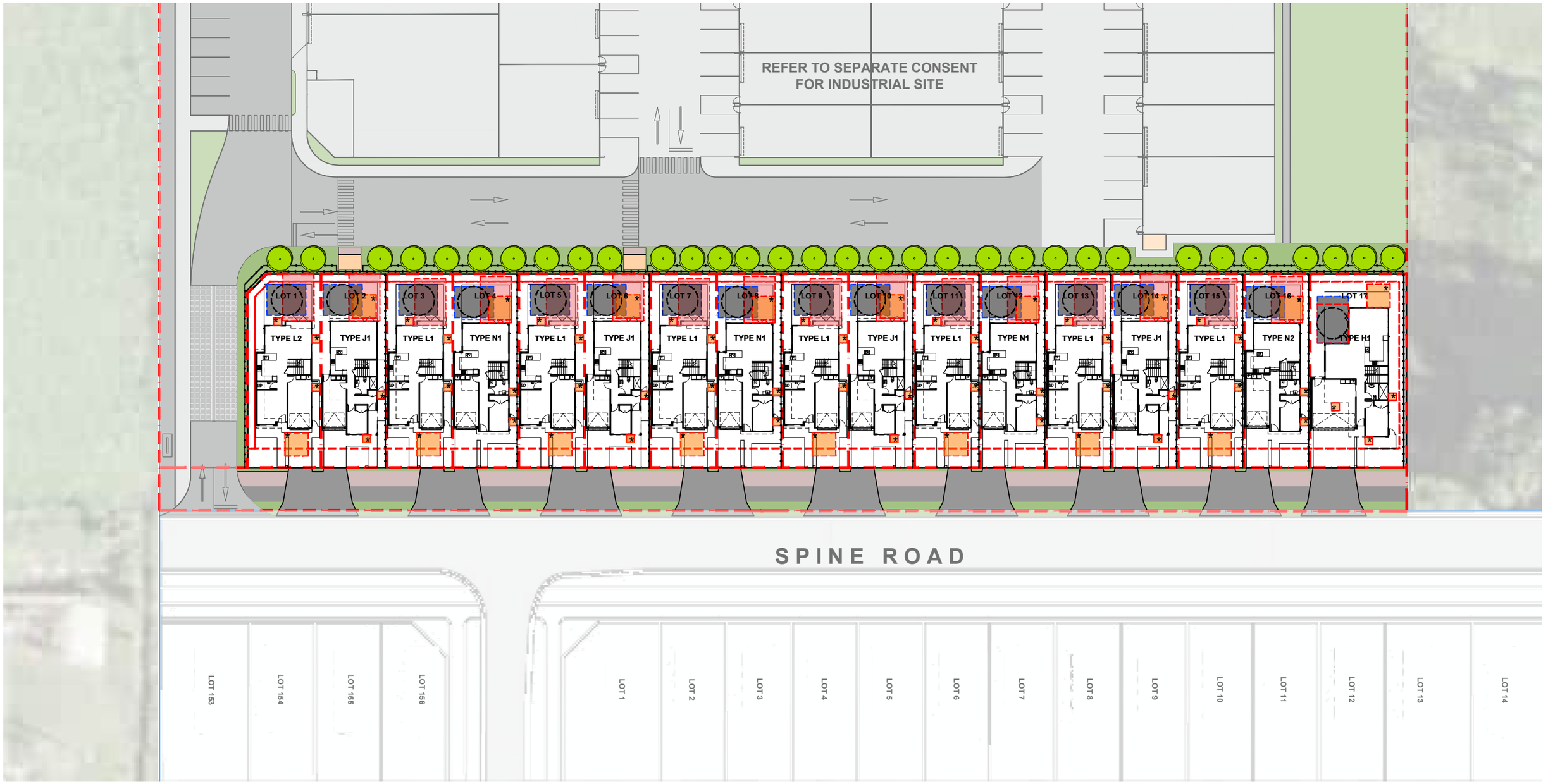

SITE COMPLIANCE PLAN Scale 1:250 @ A1, 1:500 @ A3

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC102

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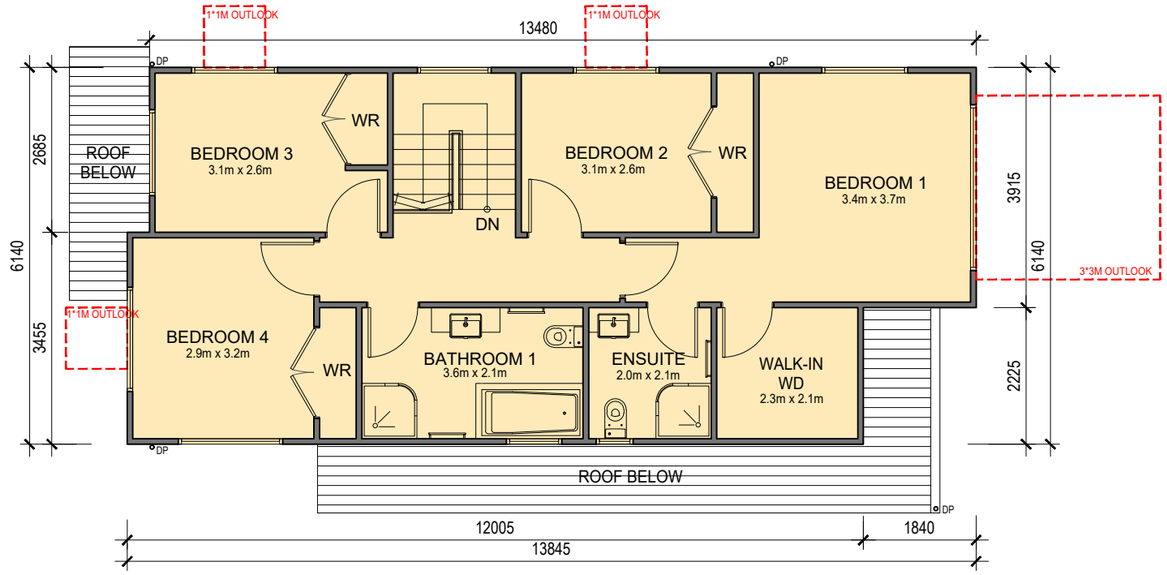
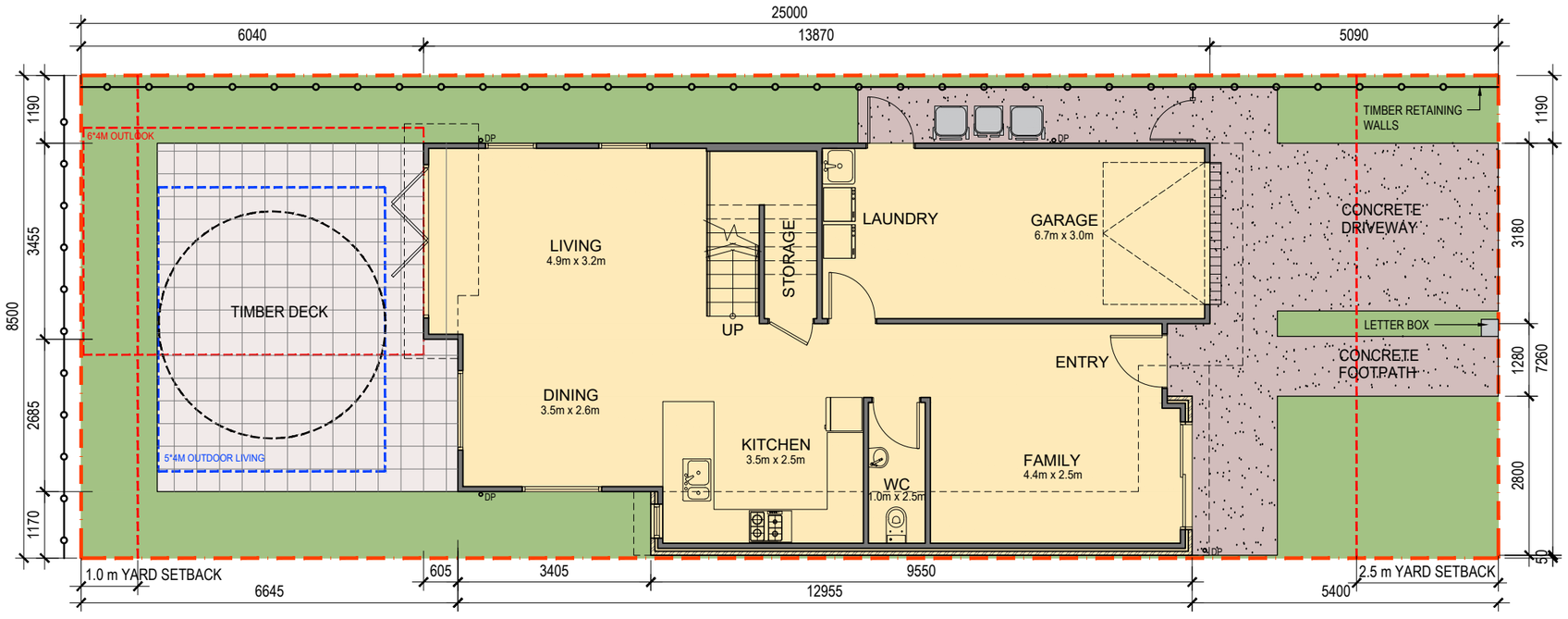


TYPE L1 FIRST FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3



TYPE L1 GROUND FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3

TYPE L1

TYPOLOGY SUMMARY

TYPOLOGY
LOT 3, 5, 7, 9, 11, 13 & 15

BEDROOMS	4
BATHROOMS	3
GARAGE	1
STOREYS	2

AREA

GROUND FLOOR	93 m^2
FIRST FLOOR	80 m^2
TOTAL AREA	**173 m^2**

BUILDING COVERAGE

SITE AREA	212.3 m^2
BC PERMITTED	96 m^2(45%)
BC PROVIDED	96 m^2(45%)

LEGEND

- OUTLOOK SPACE
- OUTDOOR LIVING SPACE
- OUTDOOR LIVING SPACE
- YARD SETBACK
  1.0 m rear
  2.5 m front

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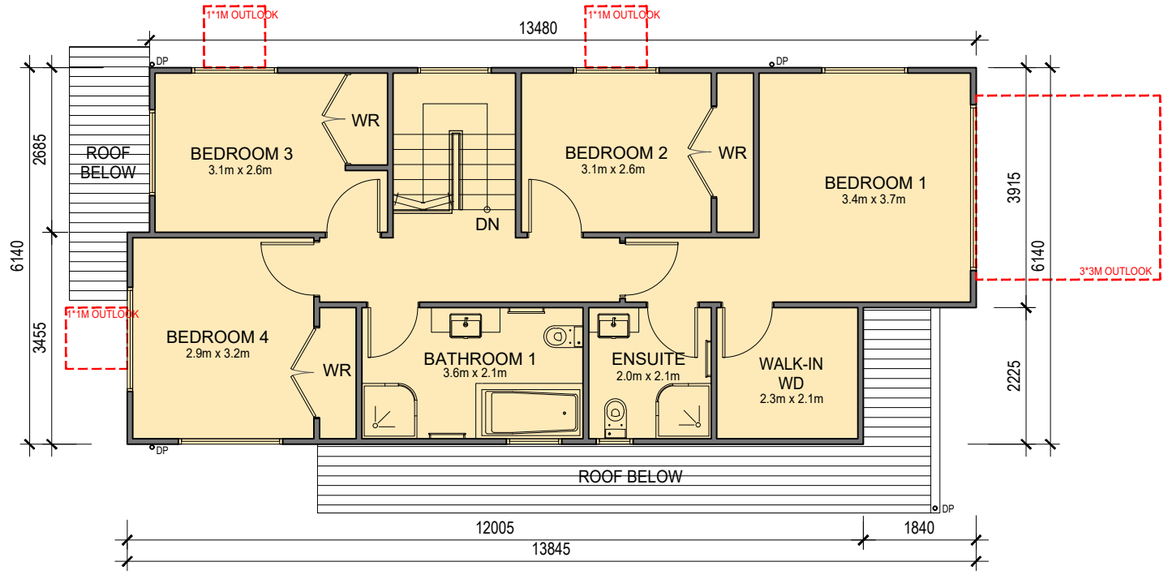
SILVERDALE RESIDENTIAL DEVELOPMENT

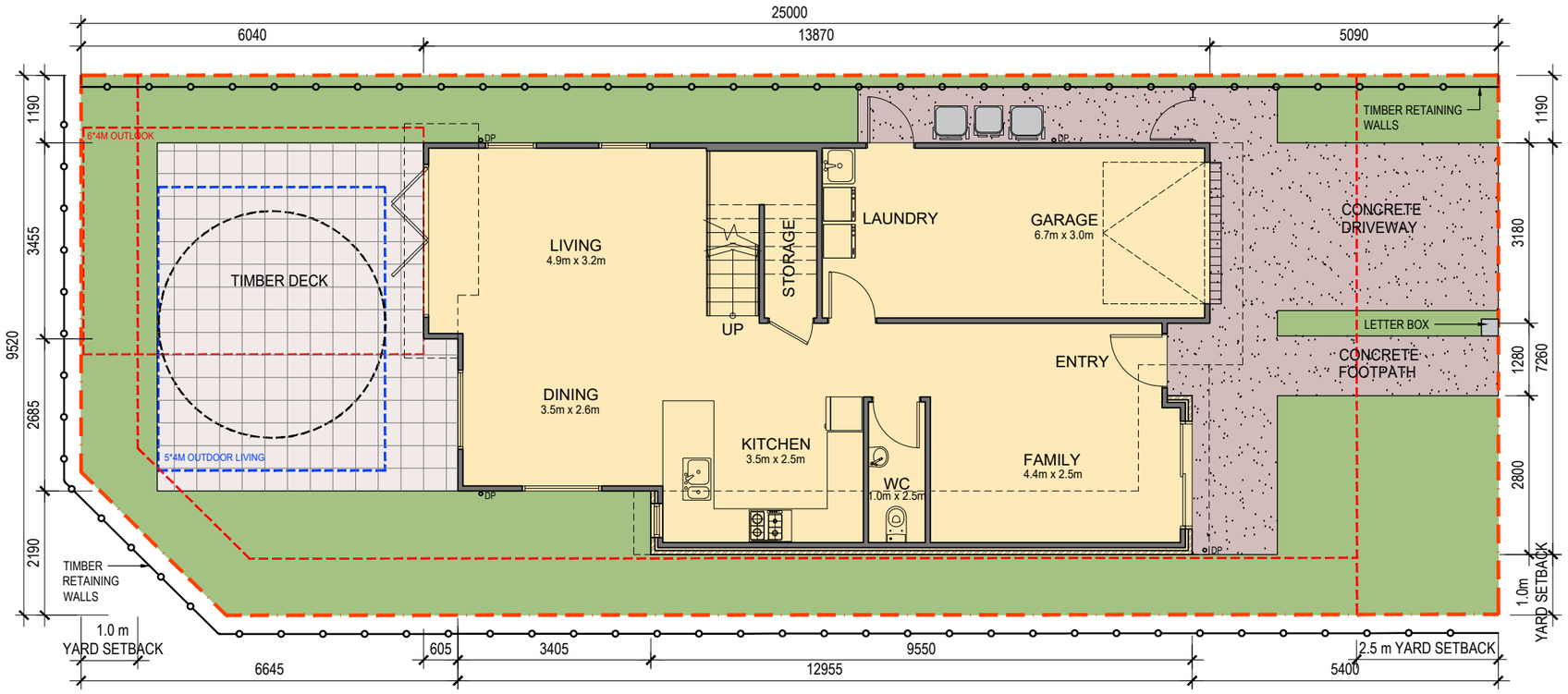
| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC211

DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS



TYPE L2 FIRST FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3



TYPE L2 GROUND FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3

TYPE L2

TYPOLOGY SUMMARY

TYPOLOGY
LOT 1

BEDROOMS	4
BATHROOMS	3
GARAGE	1
STOREYS	2

AREA

GROUND FLOOR	93 m^2
FIRST FLOOR	80 m^2
TOTAL AREA	**173 m^2**

BUILDING COVERAGE

SITE AREA	234.4 m^2
BC PERMITTED	105 m^2(45%)
BC PROVIDED	96 m^2(41%)

LEGEND

- OUTLOOK SPACE
- OUTDOOR LIVING SPACE
- OUTDOOR LIVING SPACE
- YARD SETBACK
  1.0 m rear
  2.5 m front

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SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC212

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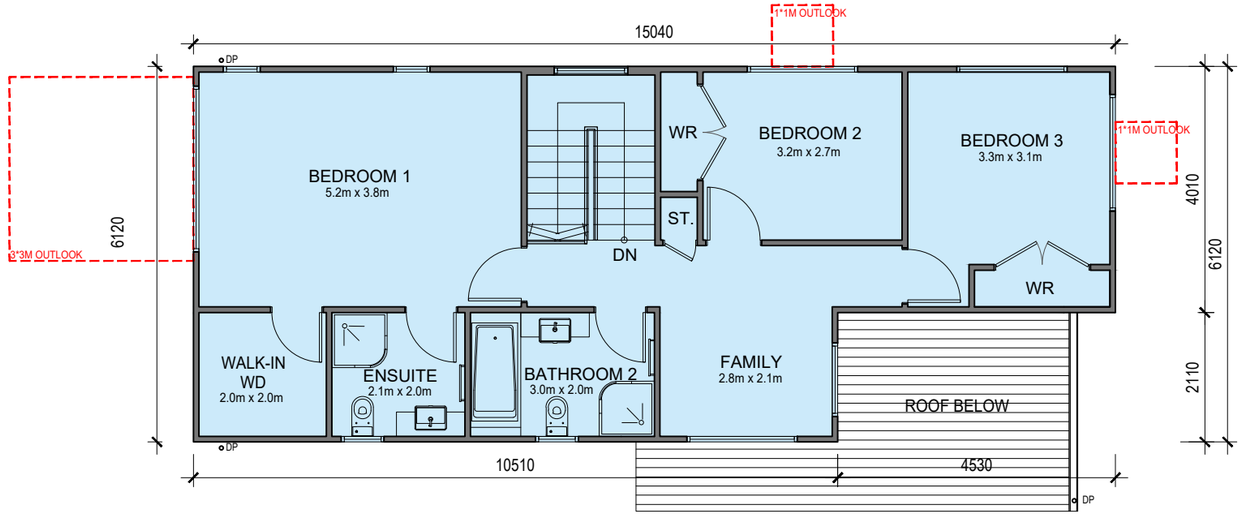
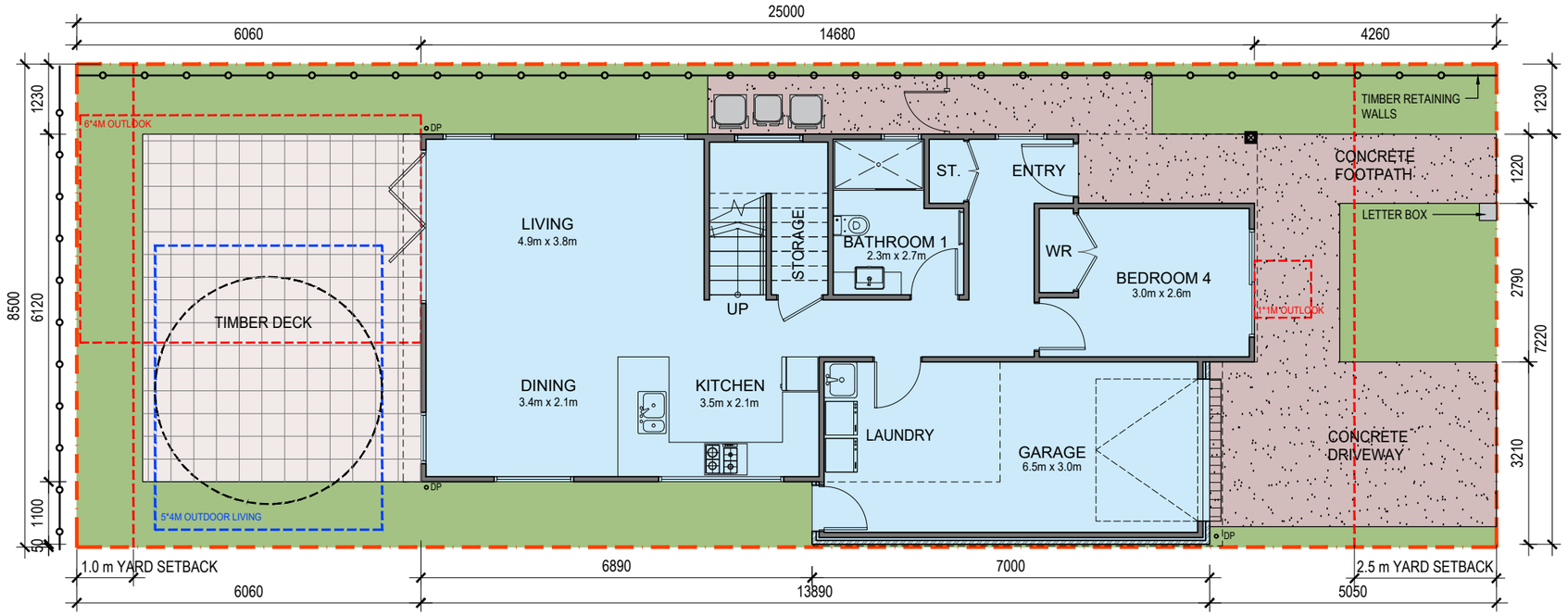


TYPE J1 FIRST FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3



TYPE J1 GROUND FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3

TYPE J1

TYPOLOGY SUMMARY

TYPOLOGY
LOT 2, 6, 10 & 14

BEDROOMS	4
BATHROOMS	3
GARAGE	1
STOREYS	2

AREA

GROUND FLOOR	92 m^2
FIRST FLOOR	82 m^2
TOTAL AREA	**174 m^2**

BUILDING COVERAGE

SITE AREA	212.3 m^2
BC PERMITTED	96 (45%)
BC PROVIDED	98 (46%)

LEGEND

- OUTLOOK SPACE
- OUTDOOR LIVING SPACE
- OUTDOOR LIVING SPACE
- YARD SETBACK
  1.0 m rear
  2.5 m front

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SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC213-1

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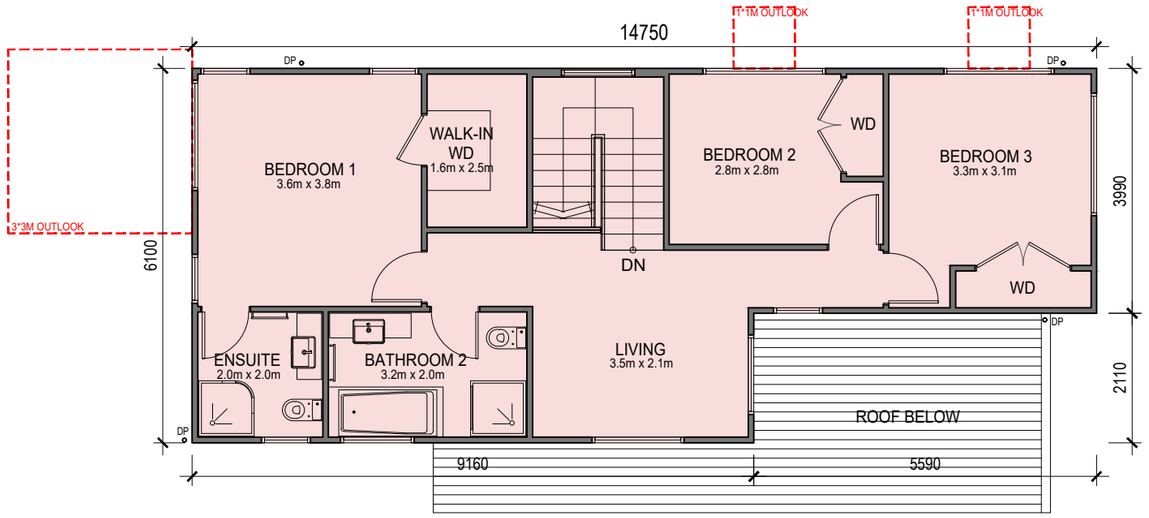
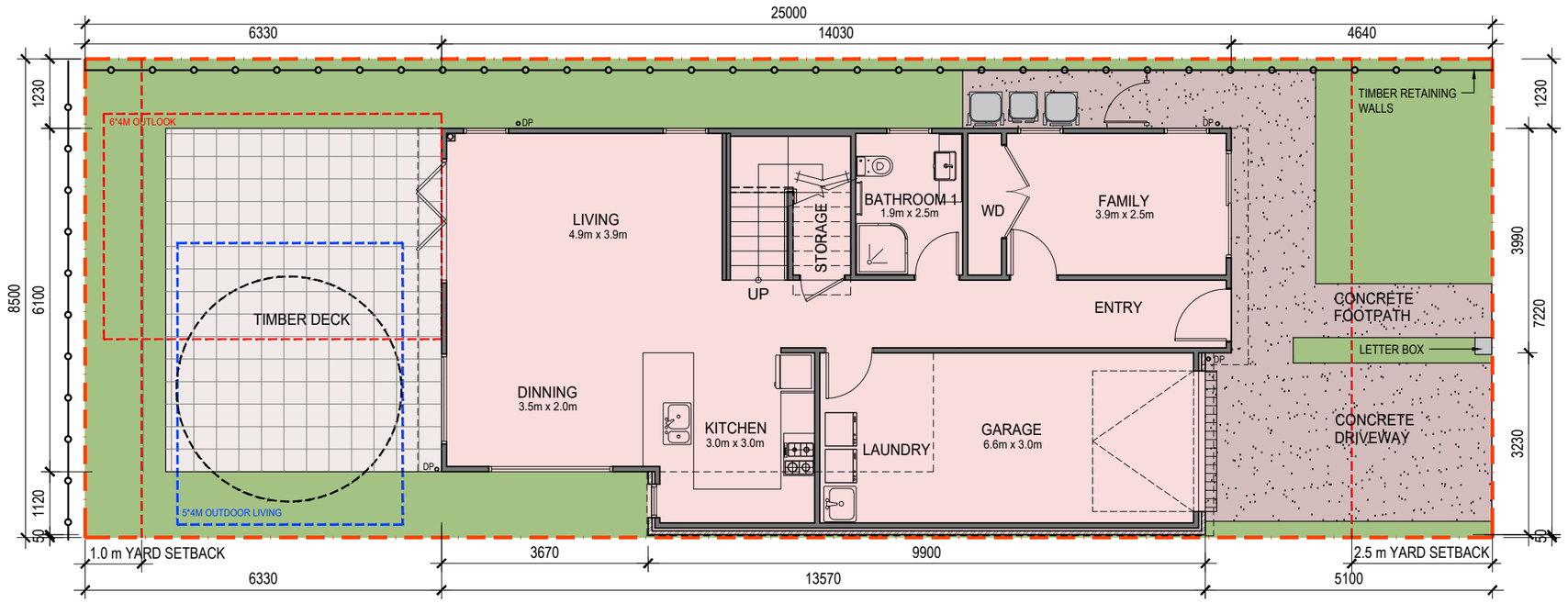
WOODHAMS MEIKLE ZHAN ARCHITECTS



TYPE N1 FIRST FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3



TYPE N1 GROUND FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3

TYPE N1

TYPOLOGY SUMMARY

TYPOLOGY
LOT 4, 8 & 12

BEDROOMS	3
BATHROOMS	3
GARAGE	1
STOREYS	2

AREA

GROUND FLOOR	96 m^2
FIRST FLOOR	78 m^2
TOTAL AREA	**174 m^2**

BUILDING COVERAGE

SITE AREA	212.3 m^2
BC PERMITTED	96 (45%)
BC PROVIDED	99 (47%)

LEGEND

- OUTLOOK SPACE
- OUTDOOR LIVING SPACE
- OUTDOOR LIVING SPACE
- YARD SETBACK
  1.0 m rear
  2.5 m front

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SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC214-1

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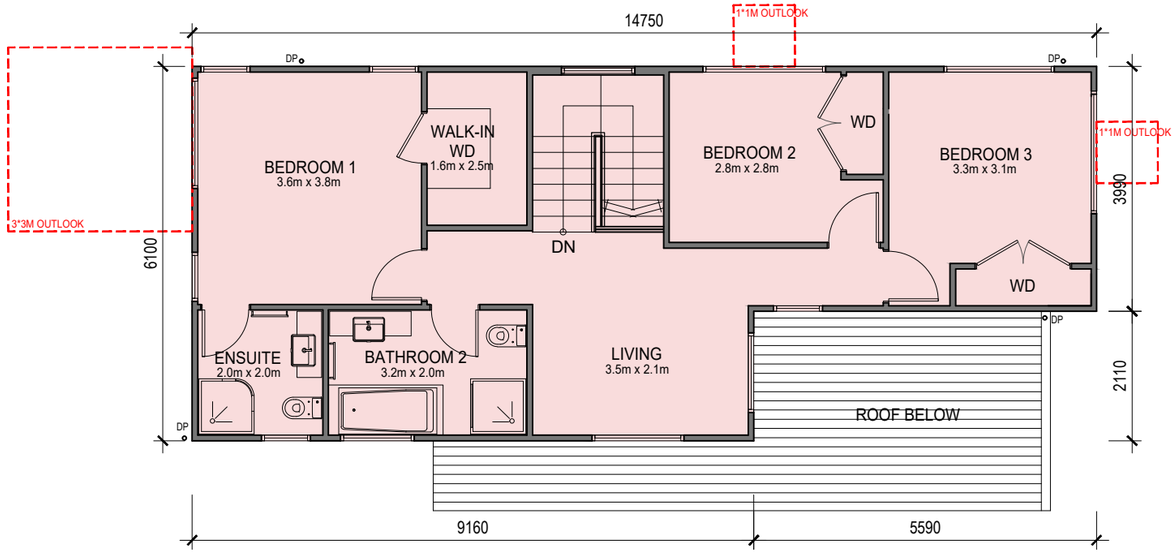
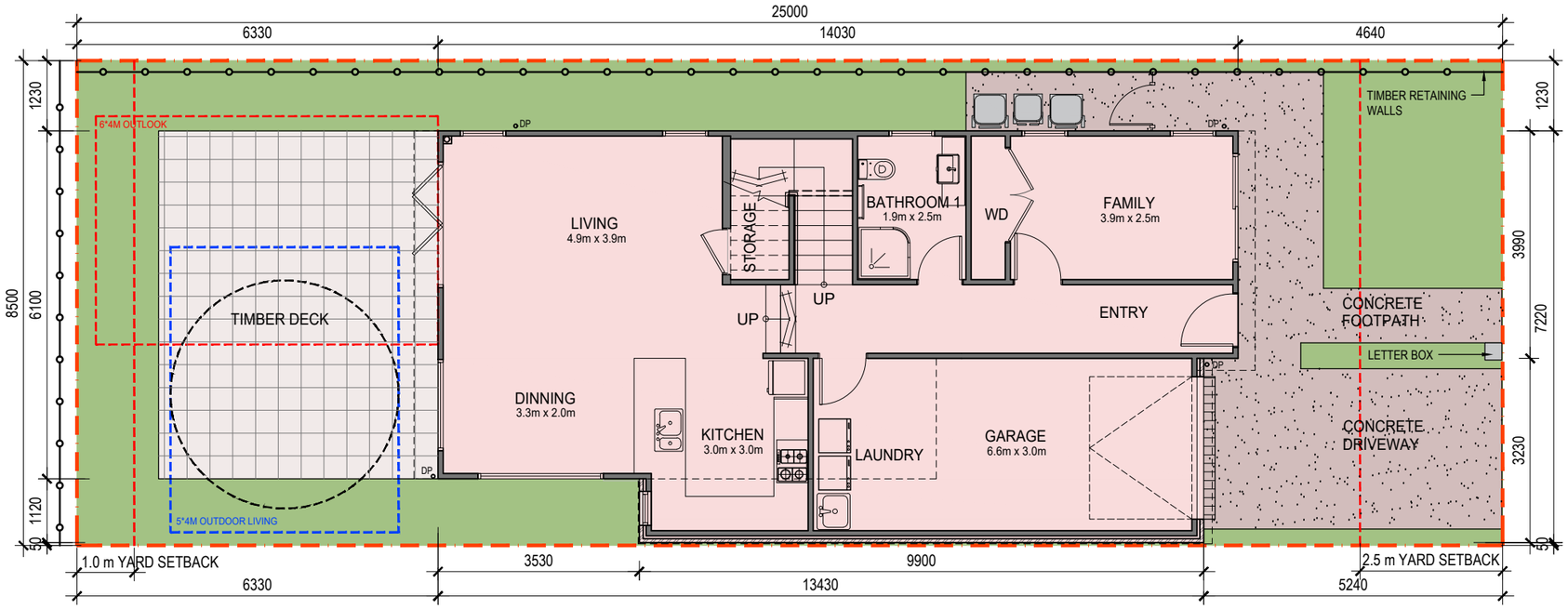


TYPE N2 FIRST FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3



TYPE N2 GROUND FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3

TYPE N2

TYPOLOGY SUMMARY

TYPOLOGY
LOT 16

BEDROOMS	3
BATHROOMS	3
GARAGE	1
STOREYS	2

AREA

GROUND FLOOR	95 m^2
FIRST FLOOR	78 m^2
TOTAL AREA	**173 m^2**

BUILDING COVERAGE

SITE AREA	212.3 m^2
BC PERMITTED	96 (45%)
BC PROVIDED	99 (47%)

LEGEND

- OUTLOOK SPACE
- OUTDOOR LIVING SPACE
- OUTDOOR LIVING SPACE
- YARD SETBACK
  1.0 m rear
  2.5 m front

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SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC215-1

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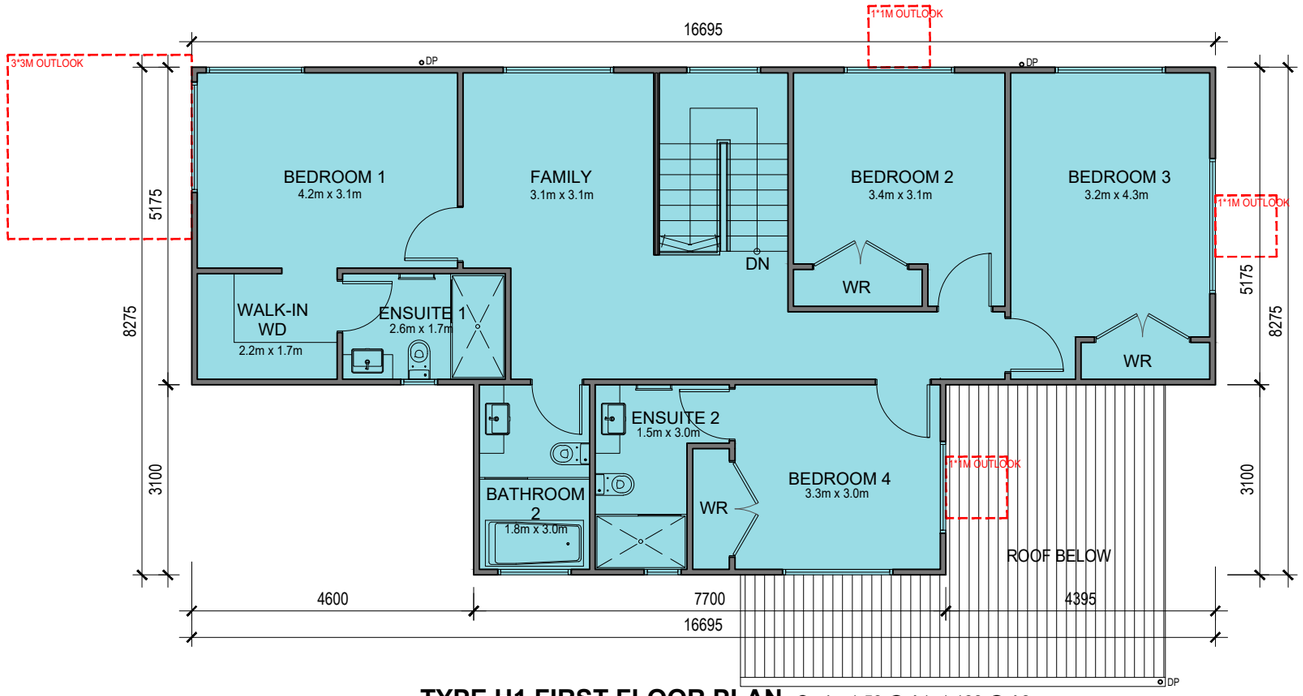
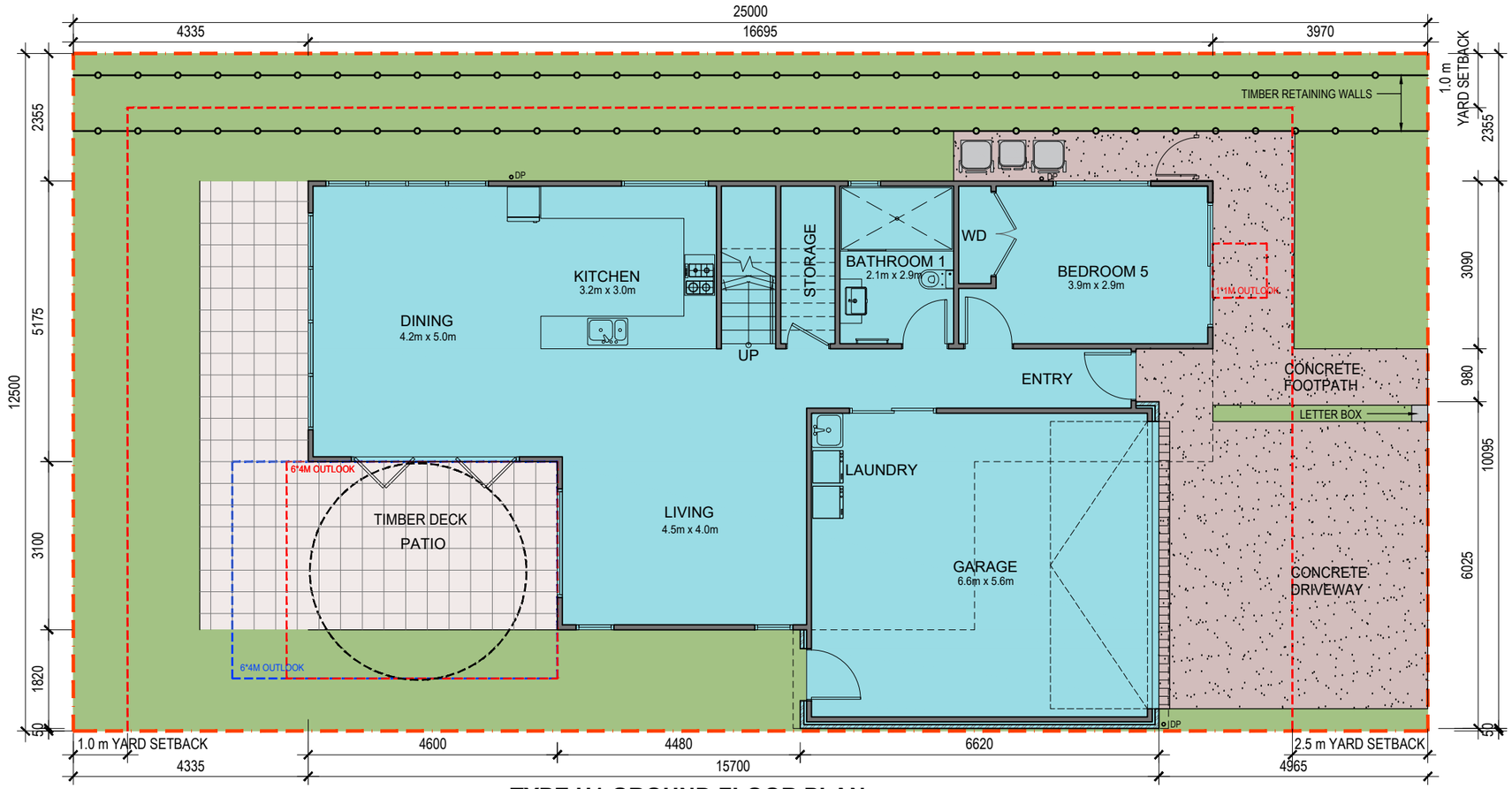
WOODHAMS MEIKLE ZHAN ARCHITECTS



TYPE H1 FIRST FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3



TYPE H1 GROUND FLOOR PLAN Scale 1:50 @ A1, 1:100 @ A3

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC216-1

DRAFT

TYPE H1

TYPOLOGY SUMMARY

TYPOLOGY
LOT 17

BEDROOMS	5
BATHROOMS	4
GARAGE	2
STOREYS	2

AREA

GROUND FLOOR	130 m^2
FIRST FLOOR	110 m^2
TOTAL AREA	**240 m^2**

BUILDING COVERAGE

SITE AREA	311.3 m^2
BC PERMITTED	140 (45%)
BC PROVIDED	133 (43%)

LEGEND

- OUTLOOK SPACE
- OUTDOOR LIVING SPACE
- OUTDOOR LIVING SPACE
- YARD SETBACK
  1.0 m rear
  2.5 m front

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WOODHAMS MEIKLE ZHAN ARCHITECTS

EAST ELEVATION (PART 1) Scale 1:100 @ A1, 1:200 @ A3

EAST ELEVATION (PART 2) Scale 1:100 @ A1, 1:200 @ A3

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC401

DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS
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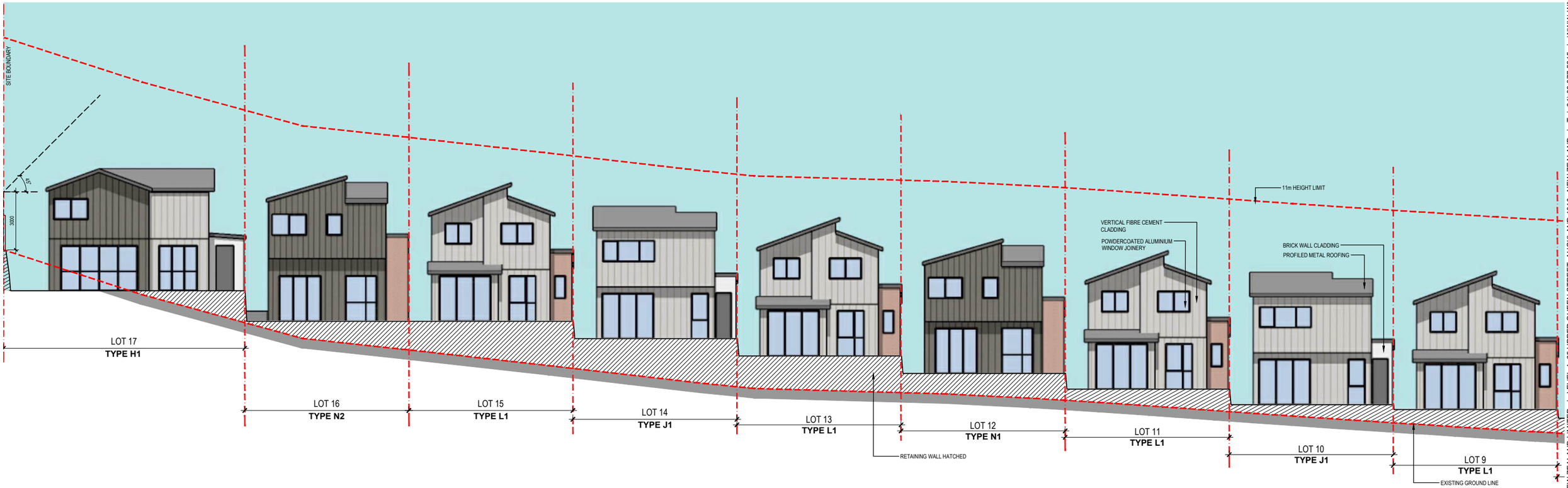


WEST ELEVATION (PART 1) Scale 1:100 @ A1, 1:200 @ A3

WEST ELEVATION (PART 2) Scale 1:100 @ A1, 1:200 @ A3

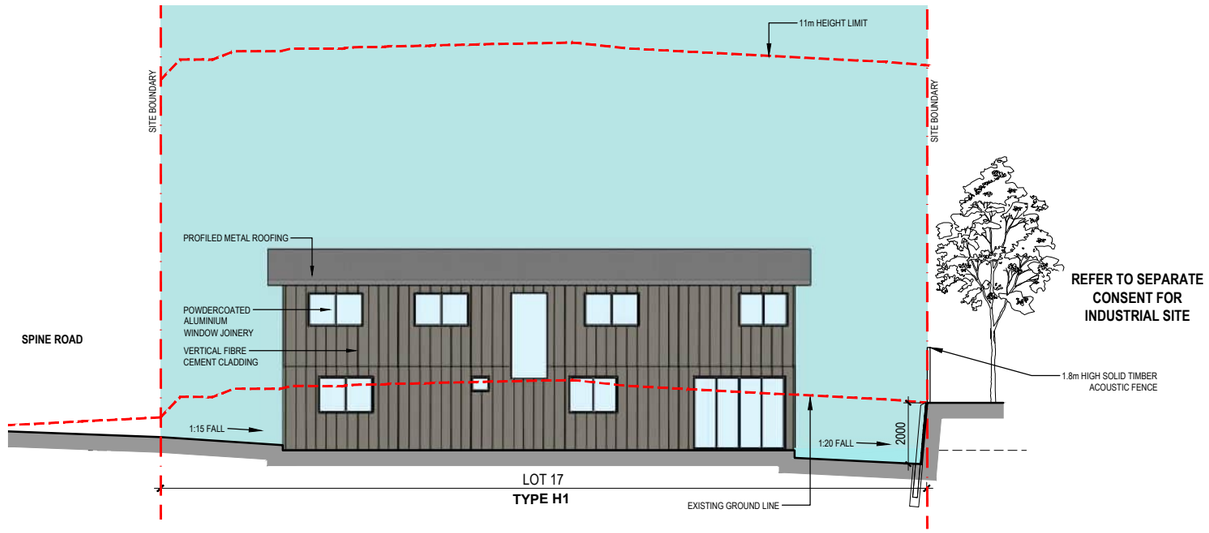
SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC402

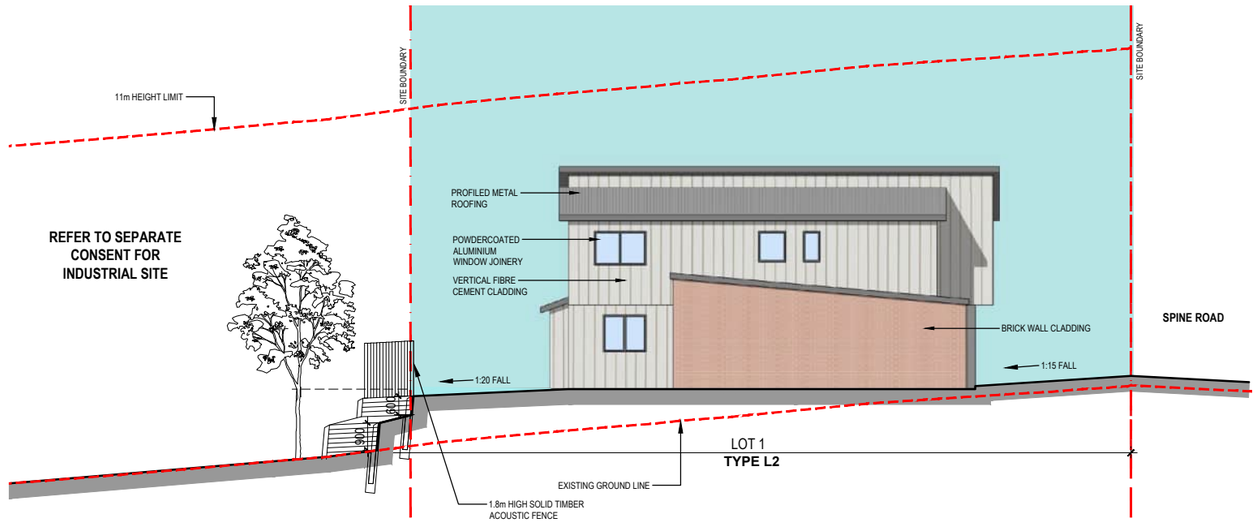
DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS

WOODHAMS MEIKLE ZHAN ARCHITECTS AN NEW ZEALAND LIMITED | LEVEL 4, 65 UPPER QUEEN STREET, AUCKLAND 1010 . NEW ZEALAND | T (+64) 09 377 5215 | WWW.WMZA.CO.NZ



NORTH ELEVATION Scale 1:100 @ A1, 1:200 @ A3



SOUTH ELEVATION Scale 1:100 @ A1, 1:200 @ A3

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC403

DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS

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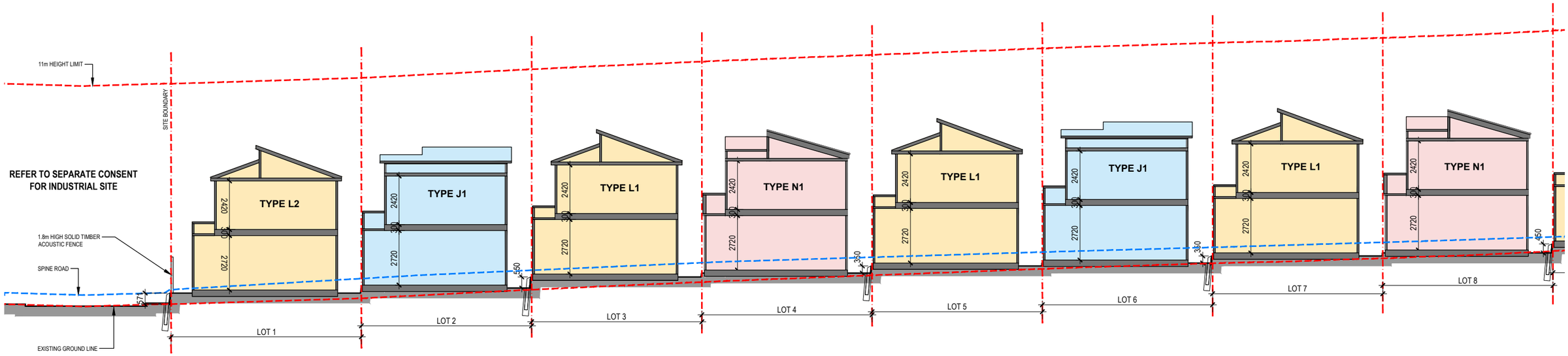
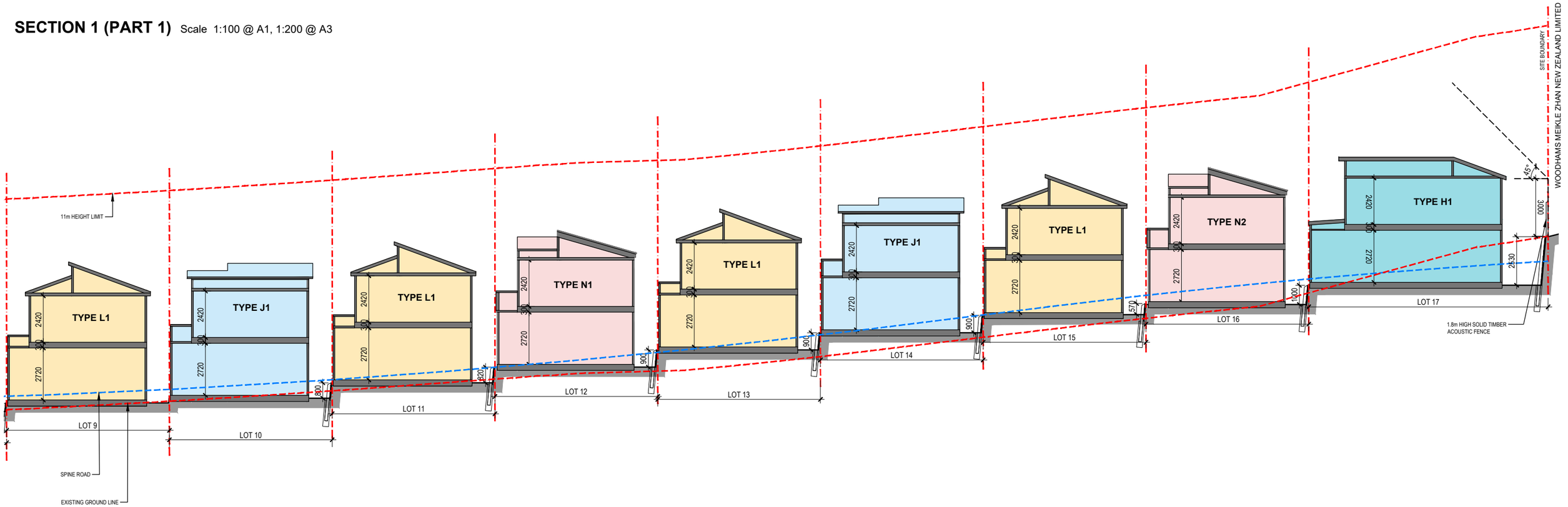


SECTION 1 (PART 1) Scale 1:100 @ A1, 1:200 @ A3



SECTION 1 (PART 2) Scale 1:100 @ A1, 1:200 @ A3

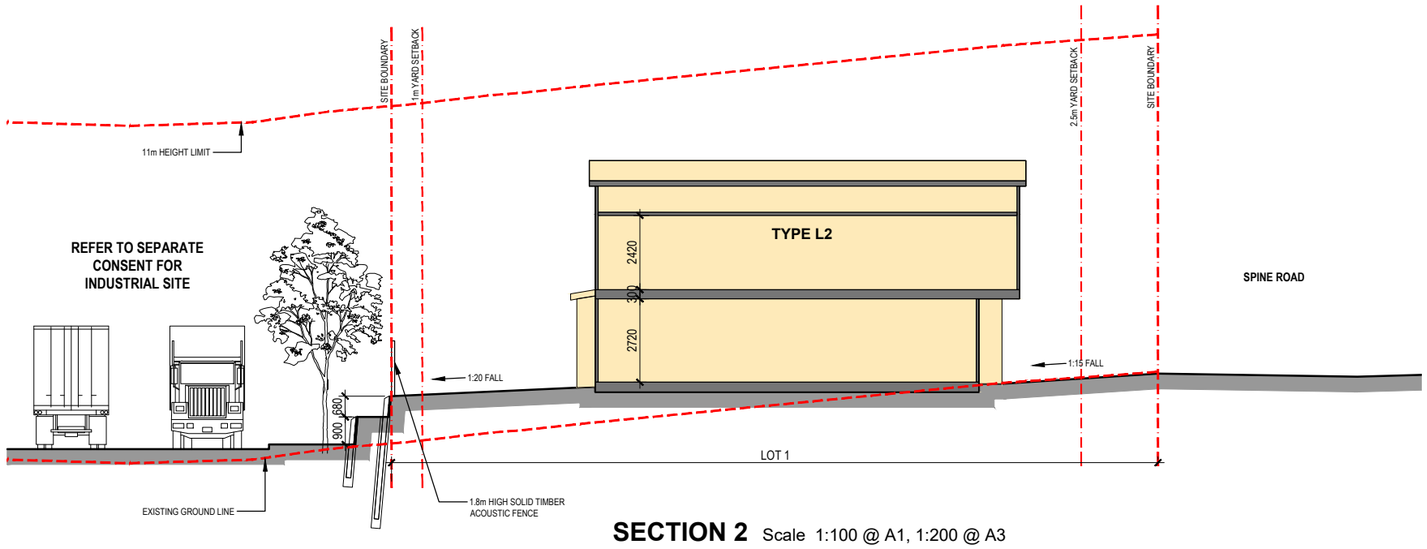
SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC501-1

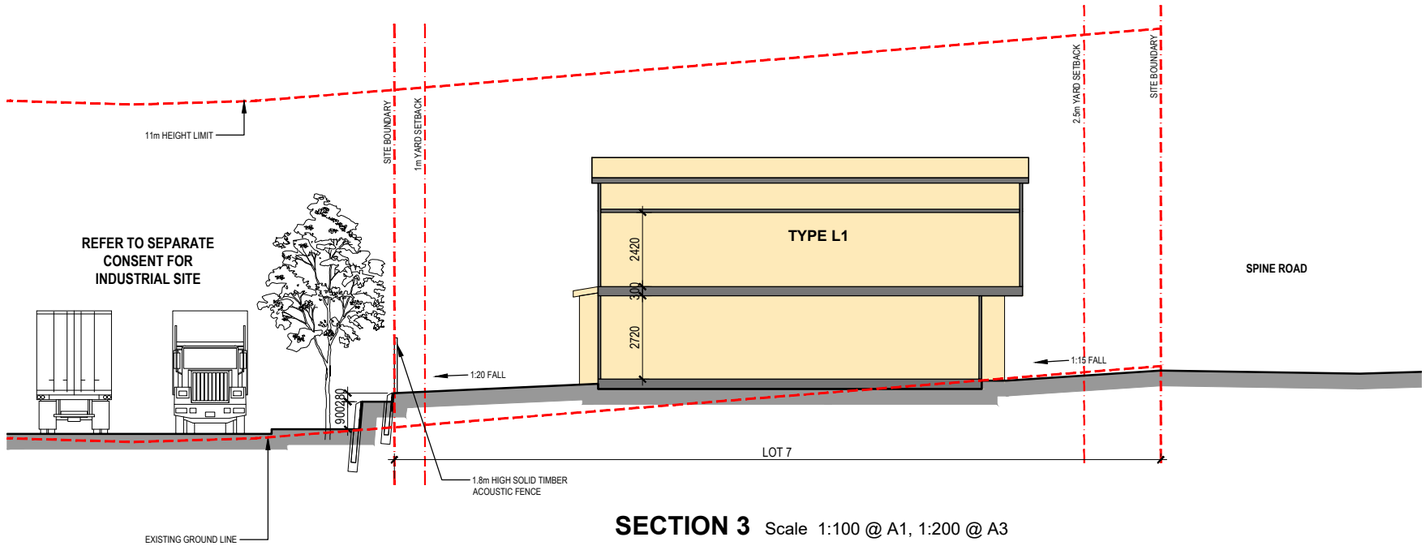
DRAFT

WOODHAMS MEIKLE ZHAN NEW ZEALAND LIMITED | LEVEL 4, 65 UPPER QUEEN STREET, AUCKLAND 1010 , NEW ZEALAND | T (+64) 09 377 5215 | WWW.WMZA.CO.NZ

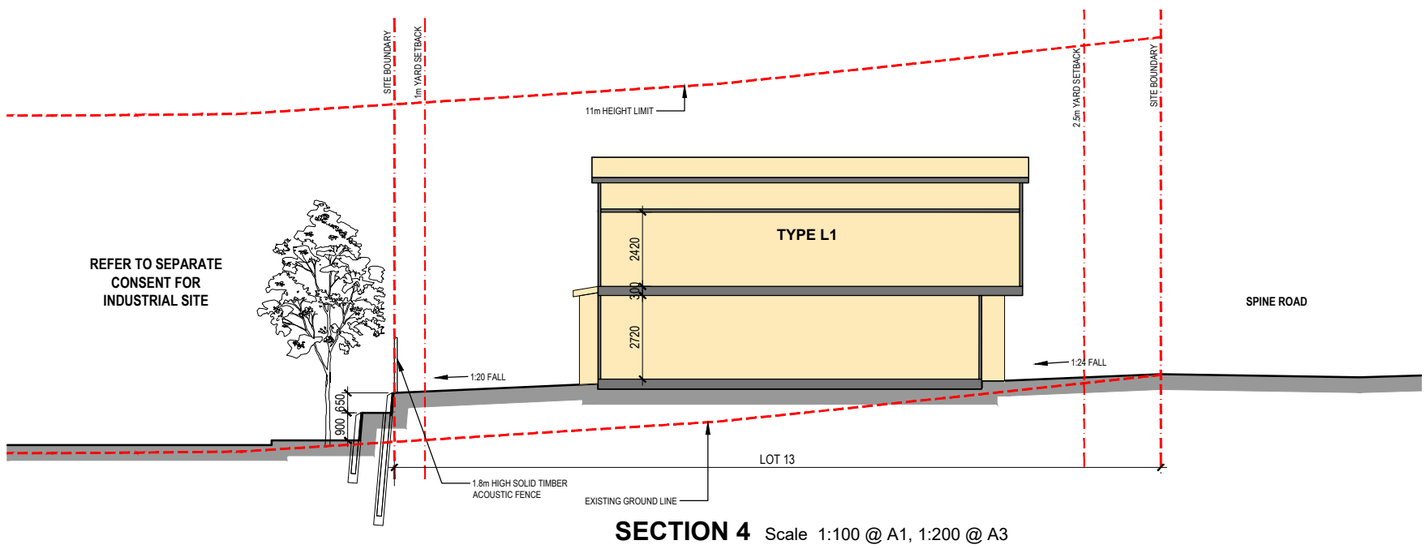
WOODHAMS MEIKLE ZHAN ARCHITECTS



SECTION 2 Scale 1:100 @ A1, 1:200 @ A3



SECTION 3 Scale 1:100 @ A1, 1:200 @ A3



SECTION 4 Scale 1:100 @ A1, 1:200 @ A3

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC502

DRAFT

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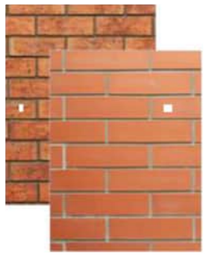
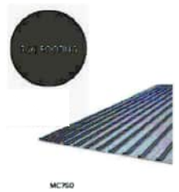
WOODHAMS MEIKLE ZHAN ARCHITECTS

CLADDING SCHEMES

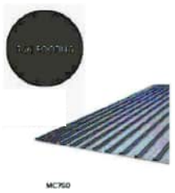
INDICATIVE DESIGN ONLY - NOT FOR CONSTRUCTION

TYPE L1 & L2

CLADDING 1	CLADDING 2	JOINERY	ROOFING
			
CLADDING Brick	CLADDING Vertical Fibre cement cladding	MATERIAL Aluminium Joinery	MATERIAL Profile Metal Roofing
FINISH Natural	FINISH Paint Finish	FINISH Powdercoat	PROFILE MC 760
COLOUR Gypsy - Rose/ Billbao-La Paloma	COLOUR Resene Sea Fog	COLOUR Matt Iron Sand	COLOUR Lignite

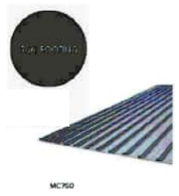
Note: DP to match to cladding colour

TYPE N1 & N2

CLADDING 1	CLADDING 2	JOINERY	ROOFING
			
CLADDING Brick	CLADDING Vertical Fibre cement cladding	MATERIAL Aluminium Joinery	MATERIAL Profile Metal Roofing
FINISH Natural	FINISH Paint Finish	FINISH Powdercoat	PROFILE MC 760
COLOUR Gypsy - Rose/ Billbao-La Paloma	COLOUR Iron Sand	COLOUR Matt Iron Sand	COLOUR Lignite

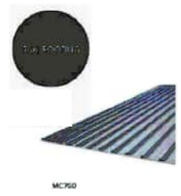
Note: DP to match to cladding colour

TYPE J1

CLADDING 1	CLADDING 2	JOINERY	ROOFING
			
CLADDING Brick	CLADDING Vertical Fibre cement cladding	MATERIAL Aluminium Joinery	MATERIAL Profile Metal Roofing
FINISH Natural	FINISH Paint Finish	FINISH Powdercoat	PROFILE MC 760
COLOUR White- Madrid with white grout	COLOUR Resene Sea Fog	COLOUR Matt Iron Sand	COLOUR Lignite

Note: DP to match to cladding colour

TYPE H1

CLADDING 1	CLADDING 2	CLADDING 3	JOINERY	ROOFING
				
CLADDING Brick	CLADDING Vertical Fibre cement cladding	CLADDING Vertical Fibre cement cladding	MATERIAL Aluminium Joinery	MATERIAL Profile Metal Roofing
FINISH Natural	FINISH Paint Finish	FINISH Paint Finish	FINISH Powdercoat	PROFILE MC 760
COLOUR White- Madrid	COLOUR Iron Sand	COLOUR Resene Sea Fog	COLOUR Matt Iron Sand	COLOUR Lignite

Note: DP to match to cladding colour

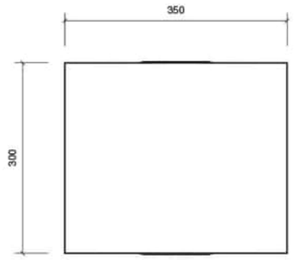
COLOUR AND MATERIAL MATRIX

SILVERDALE RESIDENTIAL DEVELOPMENT

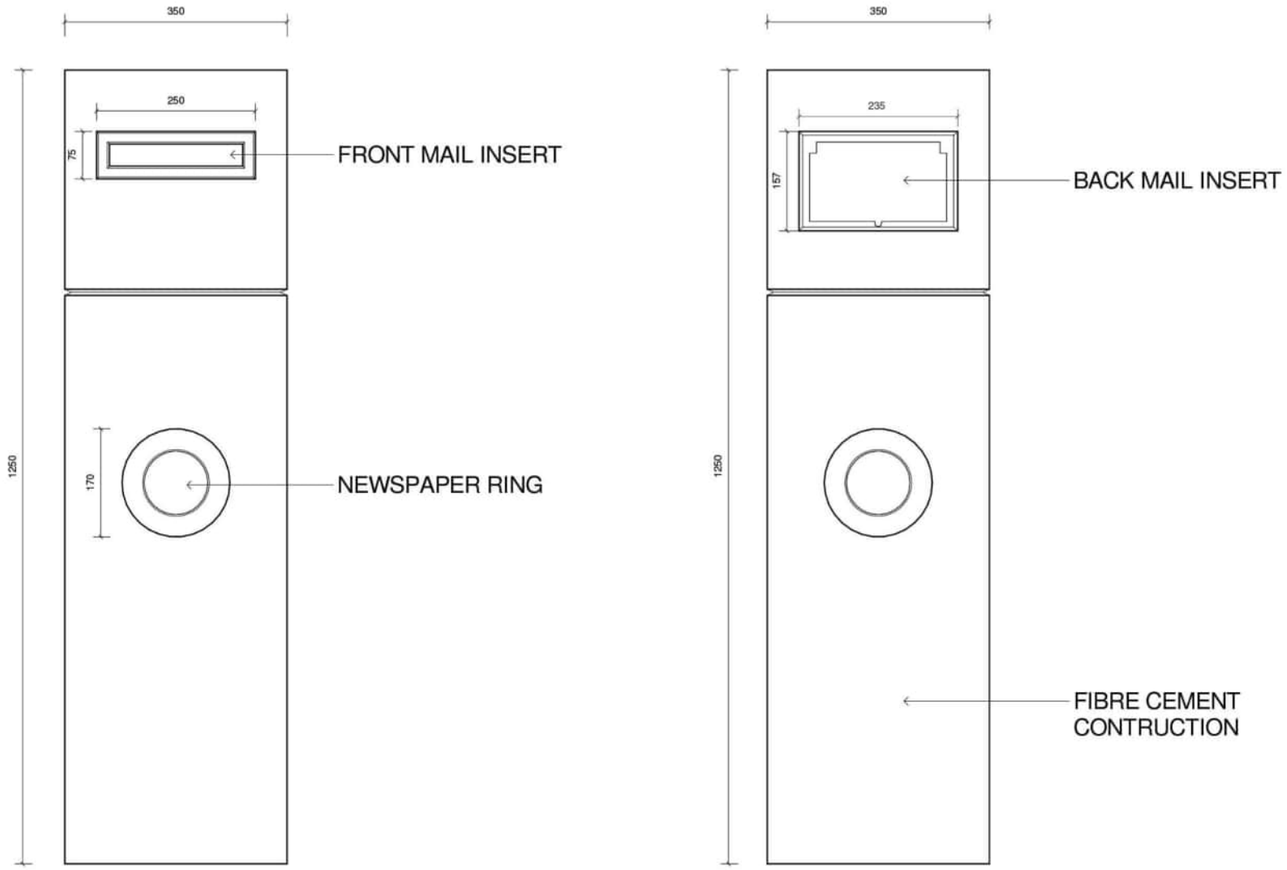
| LOCATION: SPINE ROAD, SILVERDALE | DATE: 14-09-2023 | JOB: 1469-02 | DWG: RC901

DRAFT

WOODHAMS MEIKLE ZHAN NEW ZEALAND LIMITED | LEVEL 4, 65 UPPER QUEEN STREET, AUCKLAND 1010 , NEW ZEALAND | T (+64) 09 377 5215 | WWW.WMZA.CO.NZ



Plan



TYPICAL LETTERBOX DETAIL

SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 14-09-2023 | JOB: 1469-02 | DWG: RC902

DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS

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SILVERDALE RESIDENTIAL DEVELOPMENT

| LOCATION: SPINE ROAD, SILVERDALE | DATE: 25-03-2025 | JOB: 1469-02 | DWG: RC951

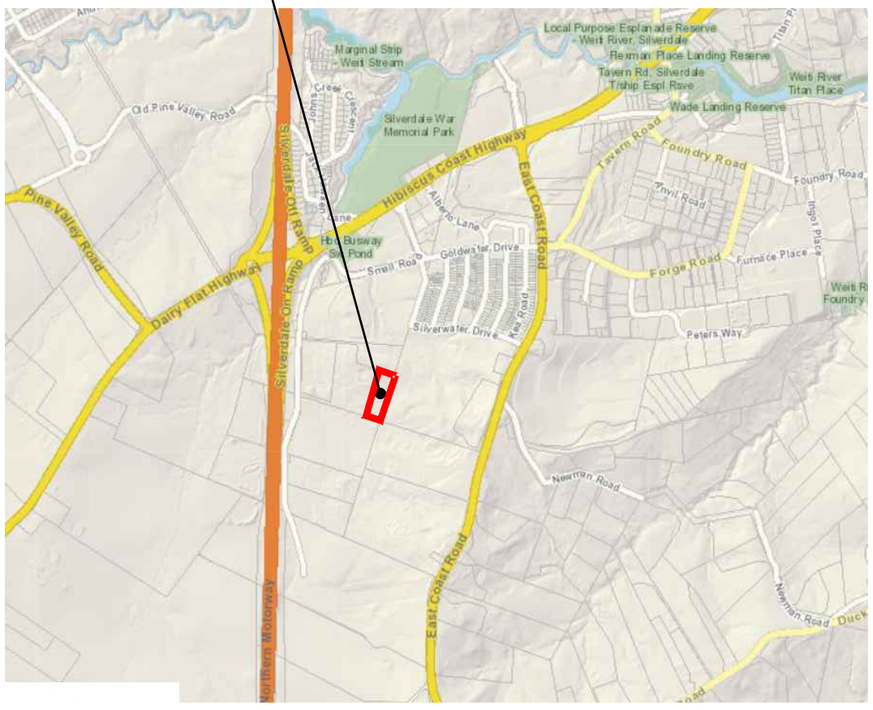
DRAFT

WOODHAMS MEIKLE ZHAN ARCHITECTS

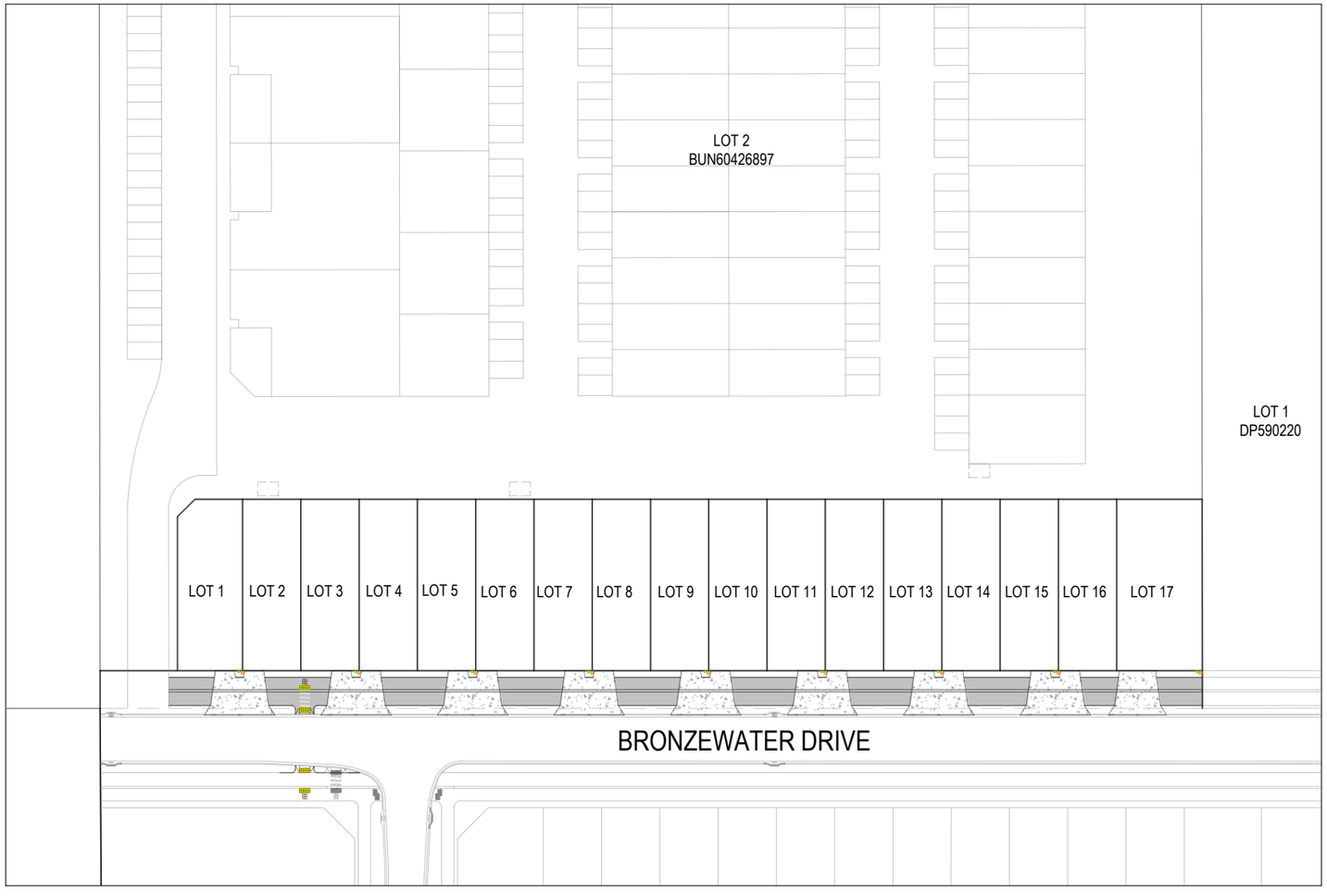
EAST COAST HEIGHTS LIMITED
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD, SILVERDALE

ASPIRE CONSULTING ENGINEERS

SITE LOCATION



SITE LOCALITY PLAN



NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

COVER SHEET PG101

JOB NUMBER: 1927

RESOURCE CONSENT DRAWINGS:

PRELIMINARY & GENERAL

PG101	COVER SHEET
PG102	CONTENTS PAGE
PG103	EXISTING SITE PLAN
PG104	PROPOSED DEVELOPMENT PLAN

EARTHWORKS

EW201	PROPOSED CONTOUR PLAN
EW202	PROPOSED CUT & FILL DEPTH CONTOUR PLAN
EW203	EROSION & SEDIMENT CONTROL PLAN
EW204-206	EROSION & SEDIMENT CONTROL DETAILS
EW207	PROPOSED RETAINING WALL PLAN

ROADING

RD301	PROPOSED ROADING PLAN
RD302	TYPICAL VEHICLE CROSSING DETAIL
RD303	TYPICAL ROAD CROSS SECTION PLAN

STORMWATER

SW401	PROPOSED STORMWATER OVERVIEW PLAN
SW402	PROPOSED STORMWATER PLAN

WASTEWATER

WW501	PROPOSED WASTEWATER OVERVIEW PLAN
WW502	PROPOSED WASTEWATER PLAN

WATER SUPPLY

WS601	PROPOSED WATER SUPPLY PLAN

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE N.T.S

	NAME	DATE
DESIGN	MJ	03.25
DRAWN	KC	03.25
DRAWING CHECK	MJ	03.25
DESIGN CHECK	MJ	03.25
APPROVED	PF	03.25

CLIENT
EAST COAST HEIGHTS LIMITED

Conditions of Use:
These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.

SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
CONTENTS PAGE

DRAWING NUMBER
1927 - RC - PG102

DATE
MAR 2025

REVISION
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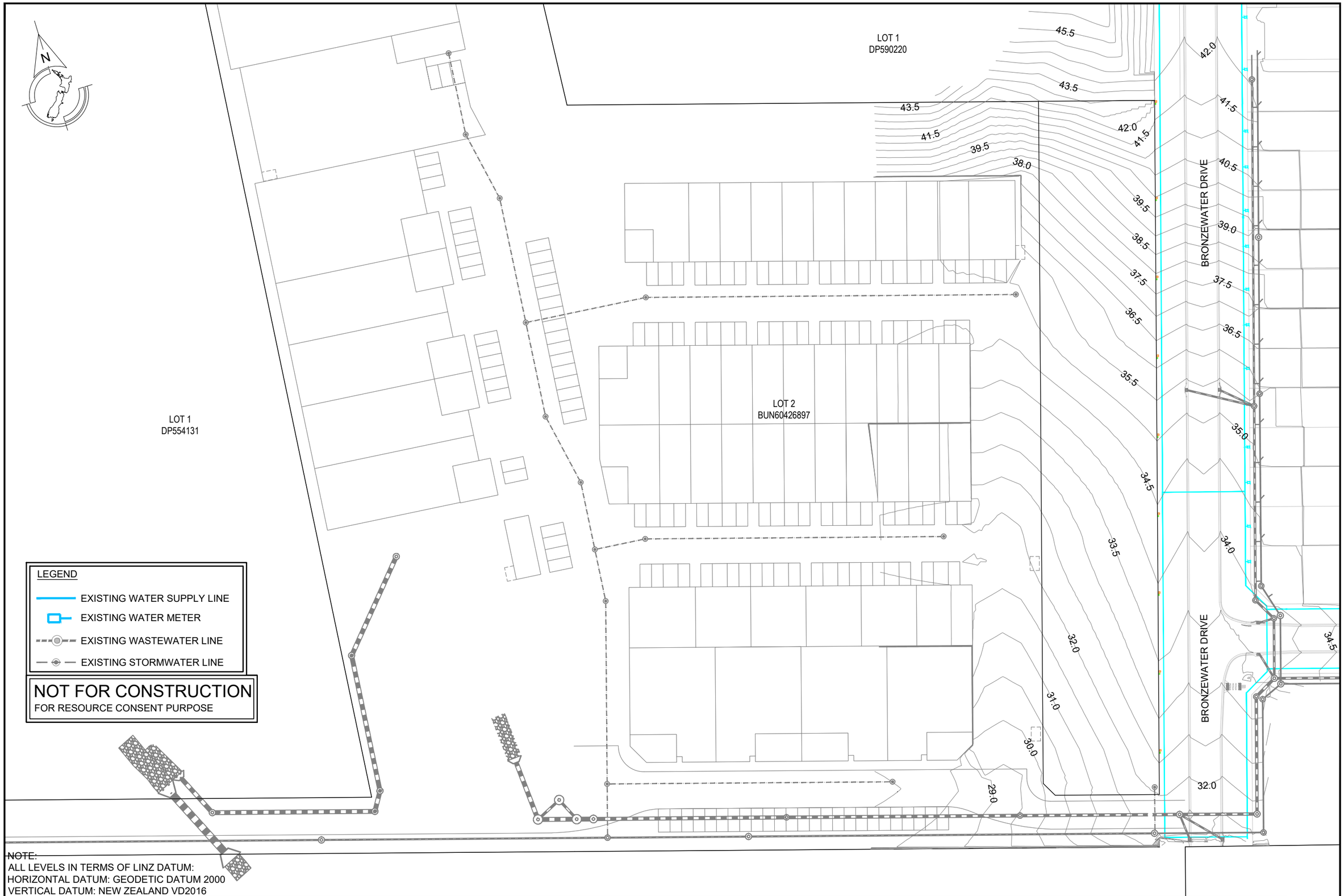
Ph: 09 426 6552
Web: www.aspireconsulting.co.nz



LEGEND

- EXISTING WATER SUPPLY LINE
- EXISTING WATER METER
- EXISTING WASTEWATER LINE
- EXISTING STORMWATER LINE

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:750 AT A3	NAME	DATE
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					DRAWN	KC	03.25
					DRAWING CHECK	MJ	03.25
					DESIGN CHECK	MJ	03.25
					APPROVED	PF	03.25

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EAST COAST HEIGHTS LIMITED

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
EXISTING SITE PLAN

DRAWING NUMBER
1927 - RC - PG103

DATE
MAR 2025

REVISION
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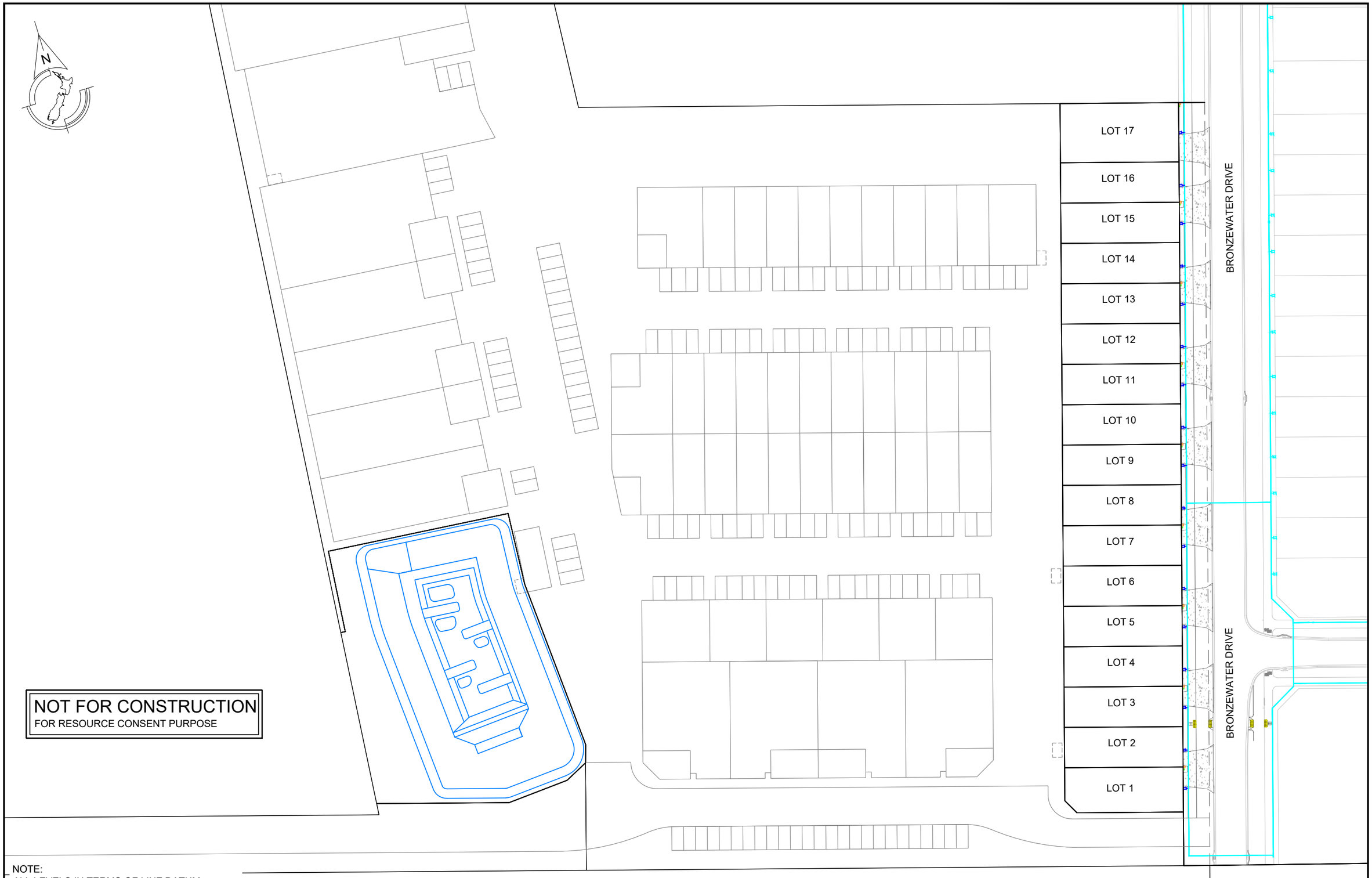
Web: www.aspireconsulting.co.nz



NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:750 AT A3		
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					DESIGN CHECK	MJ	03.25
					APPROVED	PF	03.25

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EAST COAST HEIGHTS LIMITED

Conditions of Use:
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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED DEVELOPMENT PLAN

DRAWING NUMBER
1927 - RC - PG104

DATE
MAR 2025

REVISION
-

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Web: www.aspireconsulting.co.nz

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NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:750 AT A3

	NAME	DATE
DESIGN	MJ	03.25
DRAWN	KC	03.25
DRAWING CHECK	MJ	03.25
DESIGN CHECK	MJ	03.25
APPROVED	PF	03.25

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EAST COAST HEIGHTS LIMITED

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED CONTOUR PLAN

DRAWING NUMBER
1927 - RC - EW201

DATE
MAR 2025

REVISION
-

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Ph: 09 426 6552
Web: www.aspireconsulting.co.nz

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:750 AT A3		
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					DRAWN	KC	03.25
					DRAWING CHECK	MJ	03.25
					DESIGN CHECK	MJ	03.25
					APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED CUT TO FILL DEPTH CONTOUR PLAN

DRAWING NUMBER
1927 - RC - EW202

DATE
MAR 2025

REVISION
-

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Ph: 09 426 6552
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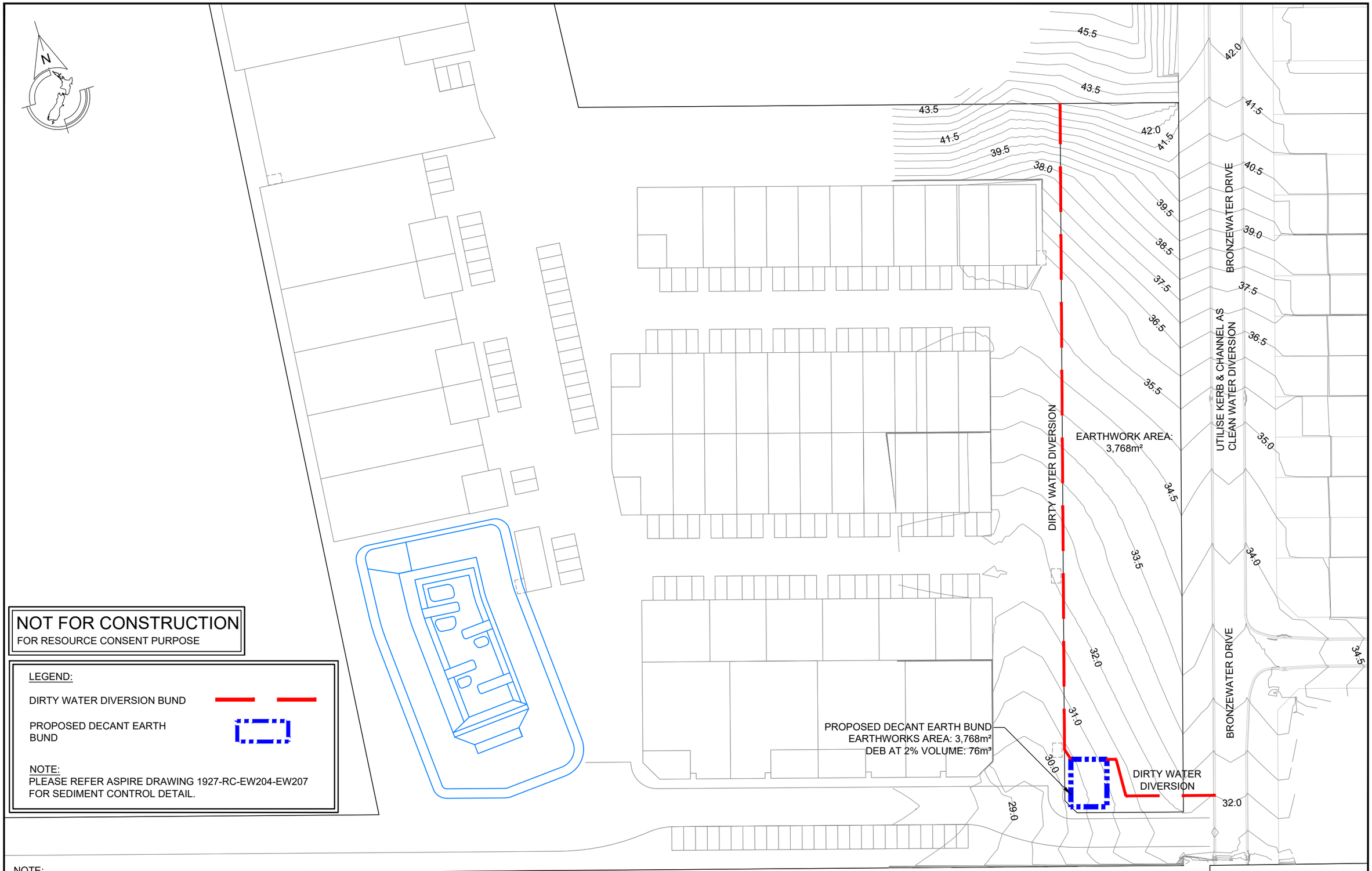

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

LEGEND:

DIRTY WATER DIVERSION BUND

PROPOSED DECANT EARTH BUND

NOTE:
PLEASE REFER ASPIRE DRAWING 1927-RC-EW204-EW207 FOR SEDIMENT CONTROL DETAIL.

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:750 AT A3

	NAME	DATE
DESIGN	MJ	03.25
DRAWN	KC	03.25
DRAWING CHECK	MJ	03.25
DESIGN CHECK	MJ	03.25
APPROVED	PF	03.25

CLIENT
EAST COAST HEIGHTS LIMITED

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

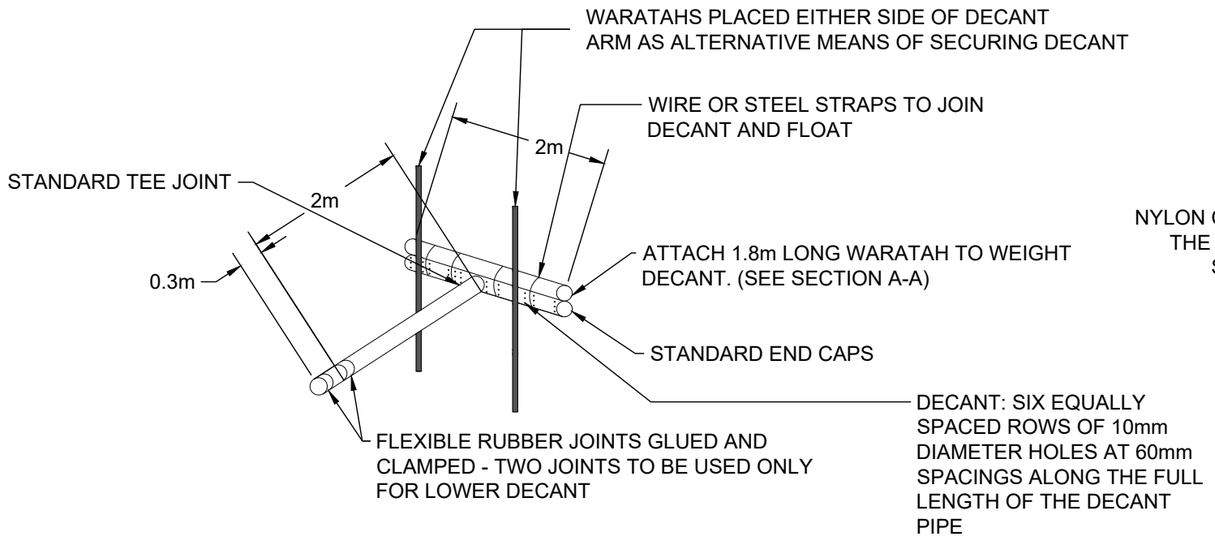
DRAWING TITLE
PROPOSED SEDIMENT AND EROSION CONTROL PLAN

DRAWING NUMBER
1927 - RC - EW203

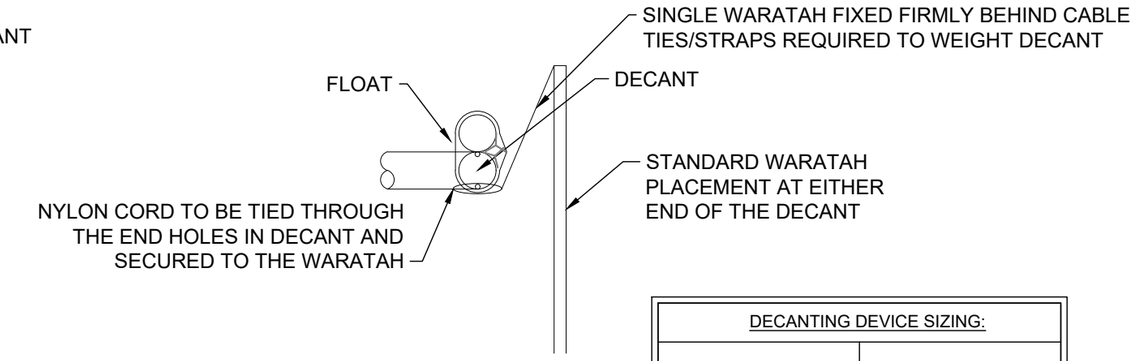
DATE
MAR 2025

REVISION
-

ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspireconsulting.co.nz

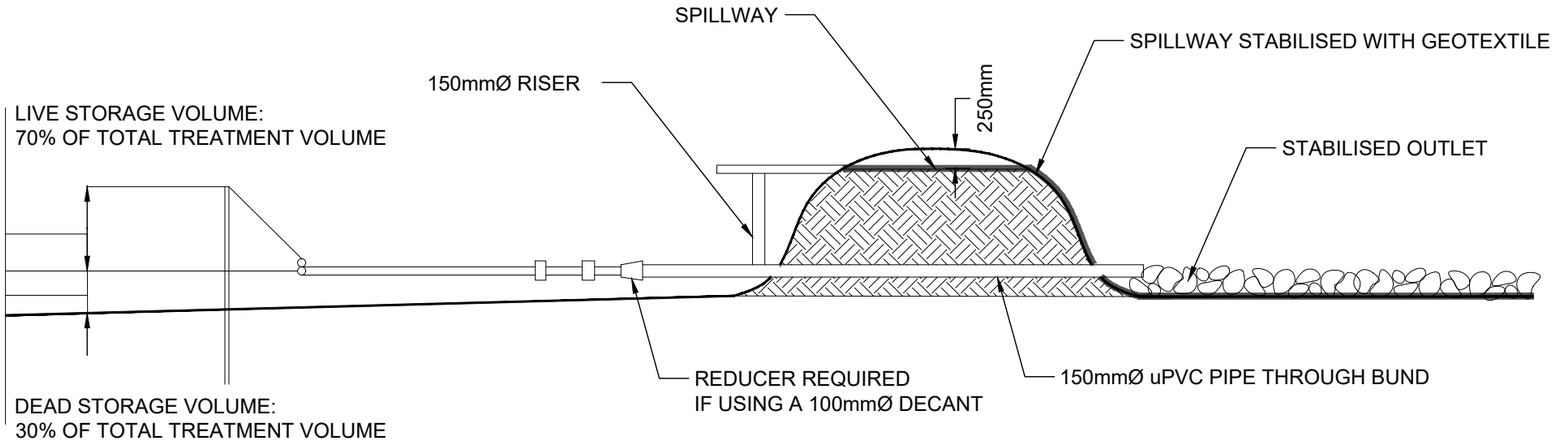


STANDARD T-BAR DESIGN SCHEMATIC



SECTION A-A

DECANTING DEVICE SIZING:	
CONTRIBUTING AREA	STORAGE VOLUME 2%
200m²	4m³
400m²	8m³
600m²	12m³
800m²	16m³
1000m²	20m³
1200m²	24m³
1400m²	28m³
1600m²	32m³
1800m²	36m³
2000m²	40m³
2200m²	44m³
2400m²	48m³
2600m²	52m³
2800m²	56m³
3000m²	60m³



DECANTING EARTH BUND CROSS-SECTION

DEB SIZING:

- DEB SIZING IS BASED ON CONTRIBUTING CATCHMENT AREA
- DECANTING EARTH BUND TO HAVE A MINIMUM VOLUME OF 2% OF THE CONTRIBUTING CATCHMENT AREA (20m³ FOR EACH 1,000m²)
- THE SLOPE ANGLE IS DETERMINED BY THE SLOPE IMMEDIATELY ABOVE THE DEB, OR BY THE AVERAGE SLOPE OVER THE CONTRIBUTING CATCHMENT, WHICHEVER IS GREATER. THE SLOPE ANGLE SHOULD ALSO BE THE GREATER OF THE PRE- OR POST-CONSTRUCTION SLOPE.
- THE ABOVE CALCULATION DEFINES THE TOTAL STORAGE VOLUME WHICH IS MEASURED FROM THE BASE OF THE DEB TO THE TOP OF THE PRIMARY SPILLWAY.
- BASE OF THE DEB TO BE MINIMUM OF 2m WIDE
- LENGTH-TO-WIDTH RATIO TO BE NO LESS THAN 3:1 AND NO GREATER THAN 5:1. LENGTH TO WIDTH RATIO IS MEASURED AT THE HEIGHT OF THE PRIMARY SPILLWAY.
- THE LENGTH OF THE DEB IS MEASURED AS THE DISTANCE BETWEEN THE INLET AND THE OUTLET. THE LENGTH BETWEEN THE INLET AND THE OUTLET SHOULD BE A MINIMUM OF 5m.

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE N.T.S	NAME	DATE
					DESIGN	MJ	03 2025
					DRAWN	KC	03 2025
					DRAWING CHECK	MJ	03 2025
					DESIGN CHECK	MJ	03 2025
					APPROVED	EP	03 2025

CLIENT
EAST COAST HEIGHTS LIMITED

Conditions of Use:
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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED EROSION & SEDIMENT CONTROL DETAILS 1

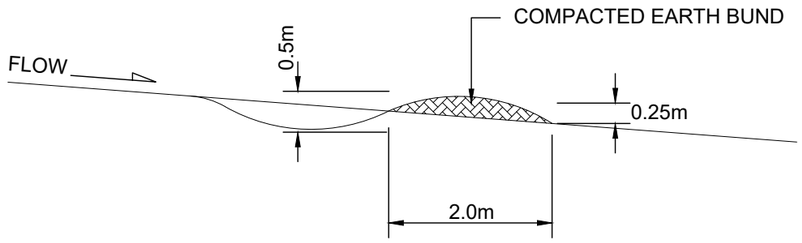
DRAWING NUMBER
1927 - RC - EW204

DATE
MAR 2025

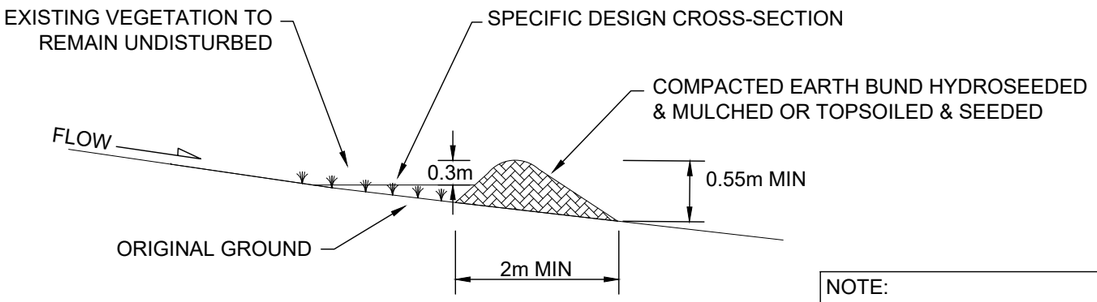
REVISION
-

ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspireconsulting.co.nz

CONTOUR DRAIN SPACING	
SLOPE OF SITE (%)	SPACING (m) OF CONTOUR DRAINS
LESS THAN 5%	50
5 - 10%	40
10 - 15%	30
15 - 30%	20



CONTOUR DRAIN CROSS-SECTION



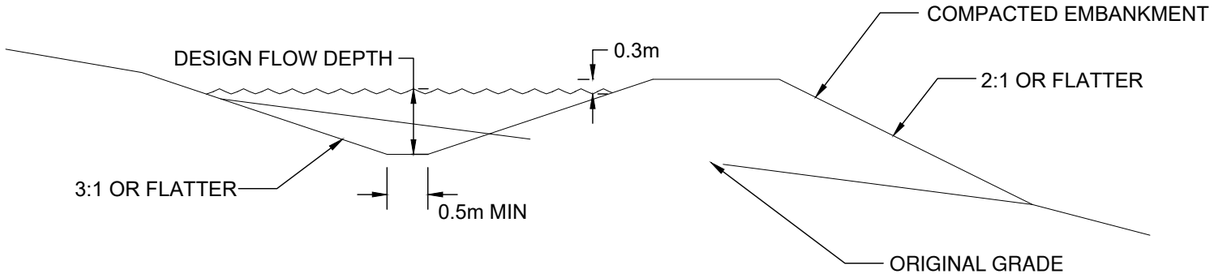
CLEAN WATER DIVERSION CROSS-SECTION

NOTE:

- THE DIVERSION CHANNELS SHOULD BE PARABOLIC OR TRAPEZOIDAL IN SHAPE
- ENSURE INTERNAL SIDES OF THE BUND ARE NO STEEPER THAN 3:1, AND EXTERNAL SIDES NO STEEPER THAN 2:1, AS OUTLINED BELOW

DIRTY WATER DIVERSION
FOR CONSTRUCTION AND OPERATION OF DIRTY WATER DIVERSION CHANNELS AND BUNDS:

- PLAN AND CONSTRUCT ALL DIRTY WATER DIVERSION WORKS AS PART OF THE INITIAL SITE ESTABLISHMENT/ DEVELOPMENT ACTIVITIES
- DEFINE THE ROUTE AND SURVEY IT TO ACHIEVE THE CORRECT GRADIENT
- CONSTRUCT DRAINS WITH A UNIFORM GRADE ALONG THE INVERT, AS SUDDEN DECREASES MAY CAUSE SEDIMENT TO ACCUMULATE CAUSING THE BANK TO OVERTOP
- ENSURE THE BUNDS ASSOCIATED WITH THE DIVERSIONS ARE WELL COMPACTED AND STABILISED. IN SOME INSTANCES, THIS MAY REQUIRE SPECIFIC GEOTECHNICAL DESIGN TO ENSURE THE STABILITY AND INTEGRITY OF THE STRUCTURE
- MONITOR DIVERSIONS FOR EROSION. SUBJECT TO THE SOILS ON SITE IT IS LIKELY THAT EROSION CONTROL WILL BE NEEDED WHERE THE GRADIENTS ARE GREATER THAN 2% OR WHERE THE DESIGN VELOCITIES EXCEED 1m/SEC
- ENSURE THE FINISHED CROSS-SECTION MEETS ALL DESIGN REQUIREMENTS
- PROVIDE AN ADEQUATE OUTLET FOR EACH DIVERSION (i.e DIRTY WATER TO A SEDIMENT CONTROL DEVICE).



DIRTY WATER DIVERSION CROSS-SECTION

NOTE: BASED ON 0.5m WIDE BASE WITH 1:3 SIDE SLOPES

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE N.T.S	NAME	DATE
DESIGN	MJ	03 2025
DRAWN	KC	03 2025
DRAWING CHECK	MJ	03 2025
DESIGN CHECK	MJ	03 2025
APPROVED	EP	03 2025

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED EROSION & SEDIMENT CONTROL DETAILS 2

DRAWING NUMBER
1927 - RC - EW205

DATE
MAR 2025

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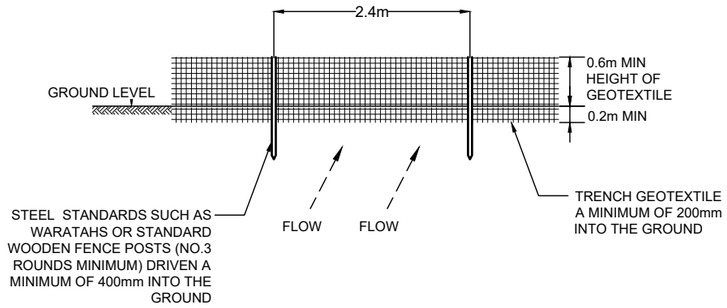
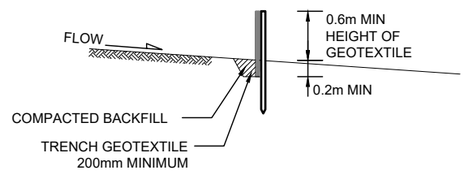
Slope steepness %	Slope length (m) (maximum)	Spacing of returns (m)	Silt fence length (m) (maximum)
Flatter than 2%	Unlimited	N/A	Unlimited
2 – 10%	40	60	300
10 – 20%	30	50	230
20 – 33%	20	40	150
33 – 50%	15	30	75
> 50%	6	20	40

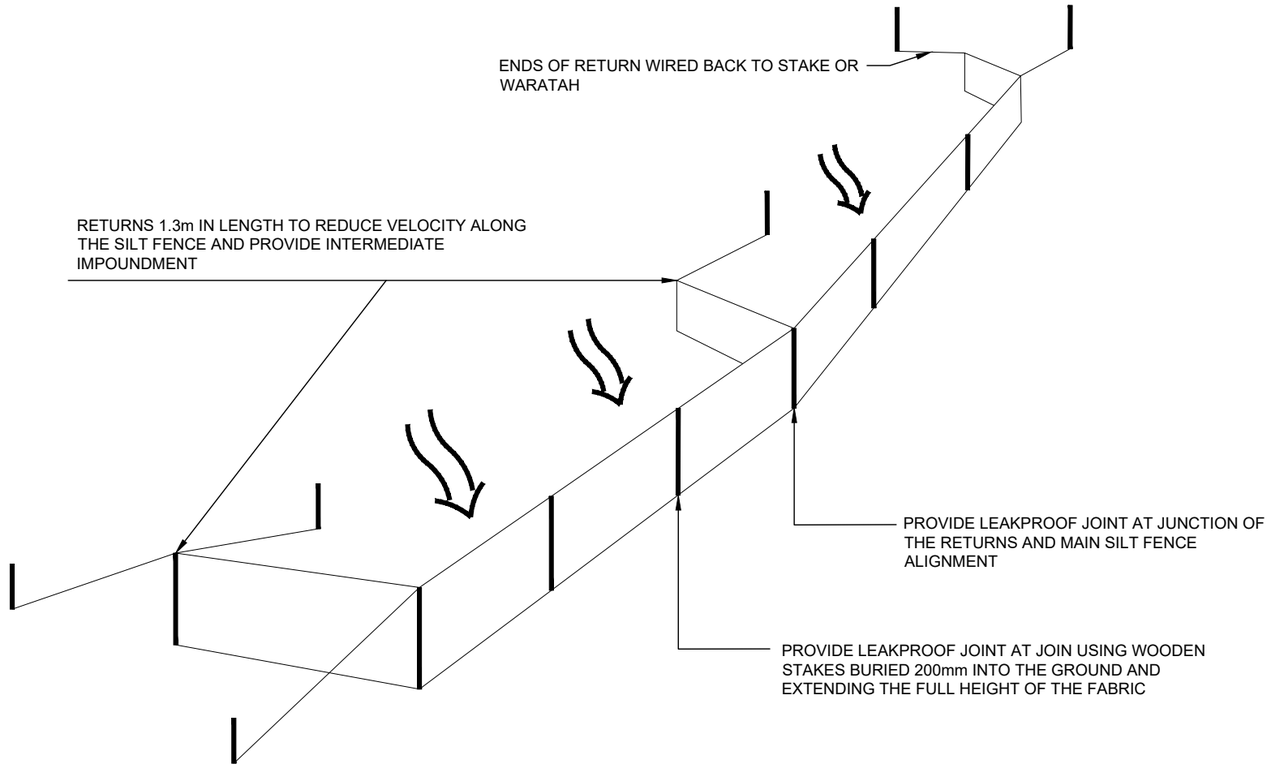
SILT FENCE DESIGN CRITERIA TABLE



SILT FENCE ELEVATION



SILT FENCE CROSS-SECTION



SILT FENCE WITH RETURNS AND SUPPORT WIRE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE N.T.S		
						NAME	DATE
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					DRAWN	KC	03 2025
					DRAWING CHECK	MJ	03 2025
					DESIGN CHECK	MJ	03 2025
					APPROVED	EP	03 2025

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED EROSION &
SEDIMENT CONTROL DETAILS 3

DRAWING NUMBER
1927 - RC - EW206

DATE
MAR 2025

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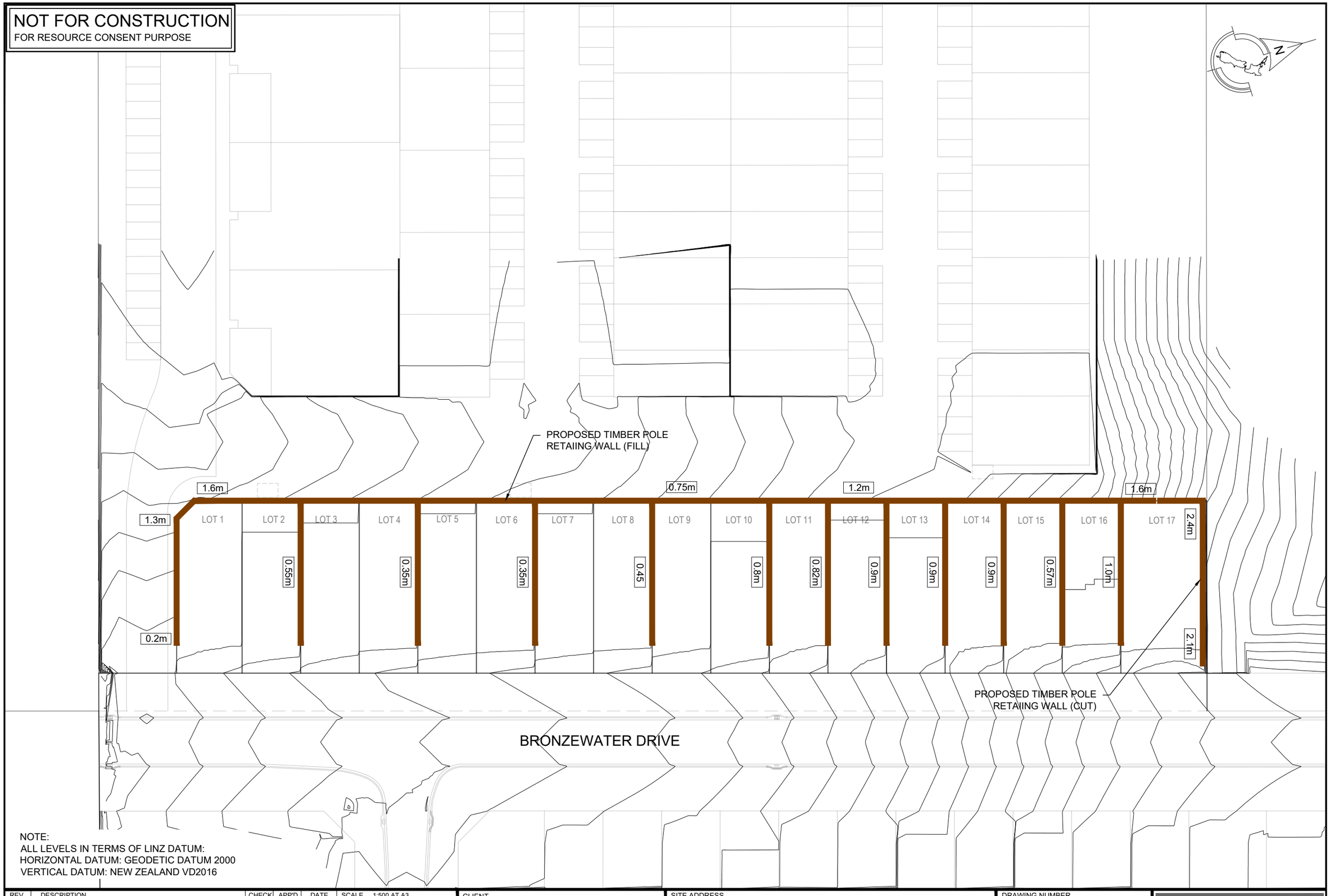

NOTE:
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HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:500 AT A3		
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					DRAWN	KC	03.25
					DRAWING CHECK	MJ	03.25
					DESIGN CHECK	MJ	03.25
					APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED RETAINING WALL PLAN

DRAWING NUMBER
1927 - RC - EW207

DATE
MAR 2025

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LEGEND

- PROPOSED POWER
- PROPOSED TELECOM
- PROPOSED TACTILE
- EXISTING CESSPIT
- PROPOSED FOOTPATH/ CYCLE LANE
- EXISTING PRAM CROSSING TO BE RELOCATED

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

N

LOT 1 LOT 2 LOT 3 LOT 4 LOT 5 LOT 6 LOT 7 LOT 8 LOT 9 LOT 10 LOT 11 LOT 12 LOT 13 LOT 14 LOT 15 LOT 16 LOT 17

PROPOSED VEHICLE CROSSING AS PER AT TDM DETAIL VX0103

PROPOSED 2m WIDE CYCLE LANE

PROPOSED 1.8m WIDE FOOTPATH

PROPOSED TYPE-15 MOUNTABLE KERB

BRONZEWATER DRIVE

354 340 320 300 280 260 240 220 200 180

PROPOSED NEW PRAM CROSSING

EXISTING PRAM CROSSING TO BE RELOCATED

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VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:500 AT A3

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DESIGN CHECK	MJ	03.25
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PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED ROADING PLAN

DRAWING NUMBER
1927 - RC - RD301

DATE
MAR 2025

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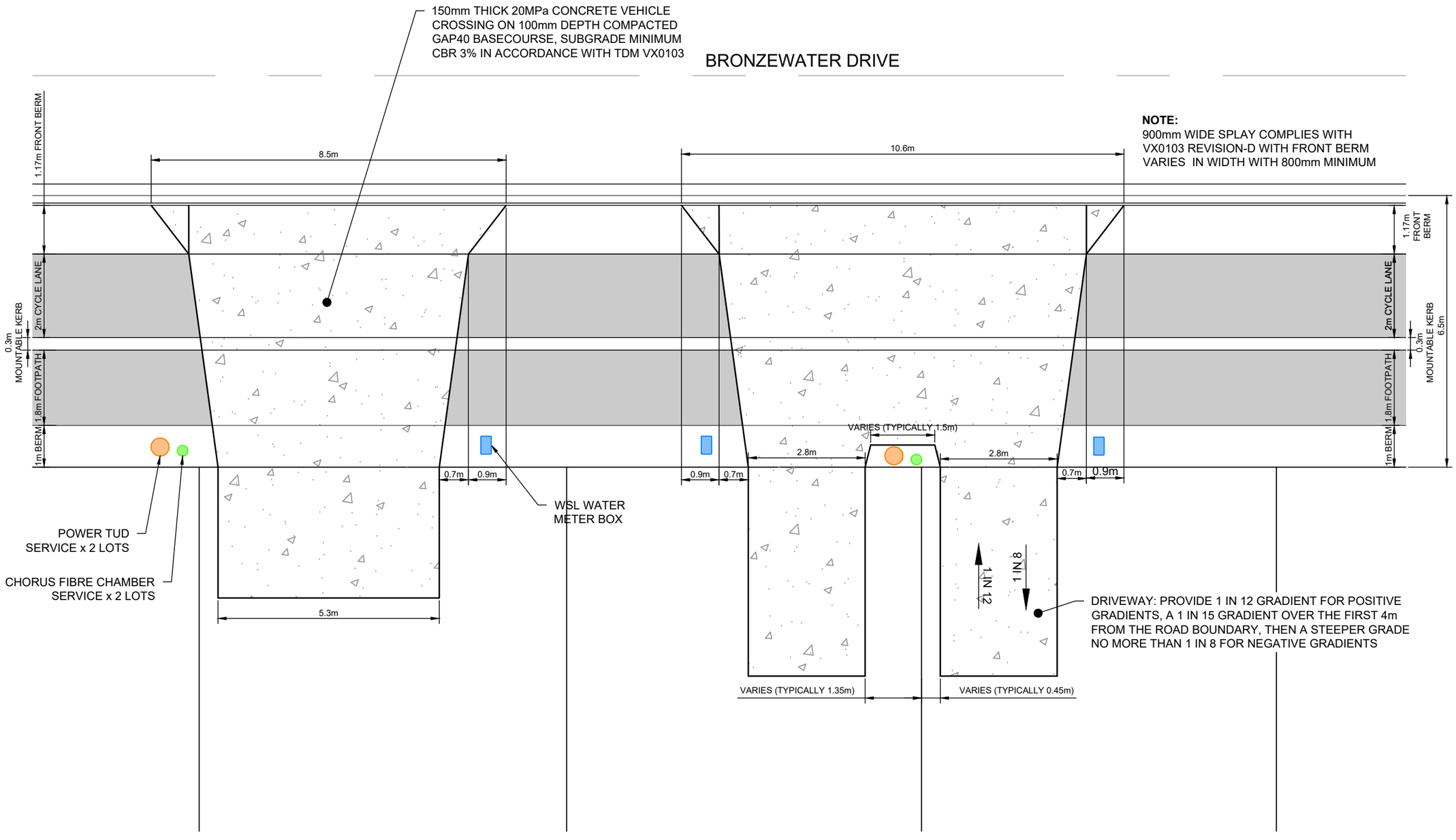

TYPICAL VEHICLE CROSSING

TYPICAL COMBINDED VEHICLE CROSSING

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:100 AT A3		
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					DRAWN	KC	03.25
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					APPROVED	PF	03.25

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PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
TYPICAL VEHICLE CROSSING DETAIL

DRAWING NUMBER
1927 - RC - RD302

DATE
MAR 2025

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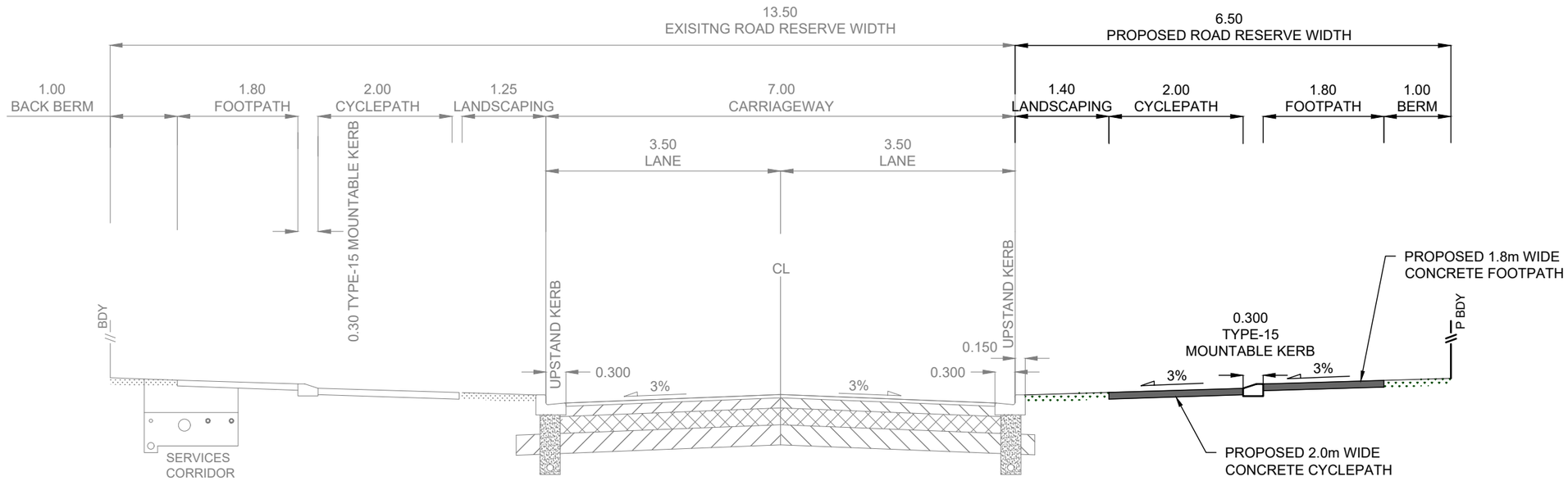

TYPICAL BRONZEWATER DRIVE SECTION
WITH CYCLEPATH & FOOTPATH

NOTE:
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VERTICAL DATUM: NEW ZEALAND VD2016

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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:75 AT A3	NAME	DATE
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					DRAWING CHECK	MJ	03.25
					DESIGN CHECK	MJ	03.25
					APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED TYPICAL ROAD CROSS SECTION PLAN

DRAWING NUMBER
1927 - RC - RD303

DATE
MAR 2025

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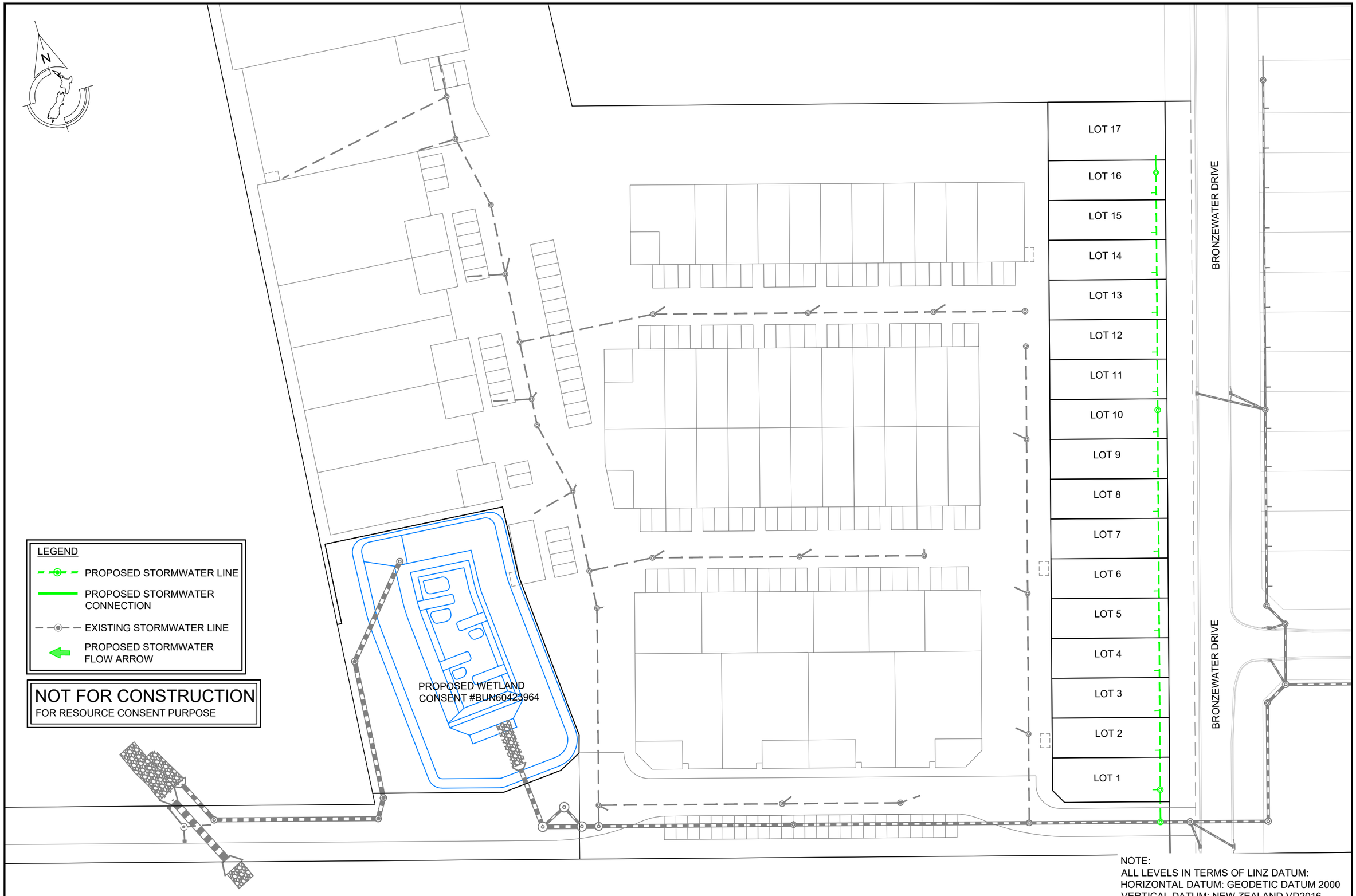

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
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DRAWING CHECK	MJ	03.25
DESIGN CHECK	MJ	03.25
APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED STORMWATER OVERVIEW PLAN

DRAWING NUMBER
1927 - RC - SW401

DATE
MAR 2025

REVISION
-

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LEGEND

PROPOSED STORMWATER LINE

PROPOSED STORMWATER CONNECTION

EXISTING STORMWATER LINE

PROPOSED STORMWATER FLOW ARROW

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

N

LOT 1 LOT 2 LOT 3 LOT 4 LOT 5 LOT 6 LOT 7 LOT 8 LOT 9 LOT 10 LOT 11 LOT 12 LOT 13 LOT 14 LOT 15 LOT 16 LOT 17

P SWMH 1A

P SW 225mmØ RCRRJ CLASS 4 PIPE

P SWMH 2A

P SWMH 3A

P SWMH 4A

P SW 225mmØ RCRRJ CLASS 2 PIPE

P SW 225mmØ RCRRJ CLASS 2 PIPE

BRONZEWATER DRIVE

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
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VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:500 AT A3

	NAME	DATE
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DRAWING CHECK	MJ	03.25
DESIGN CHECK	MJ	03.25
APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED STORMWATER PLAN

DRAWING NUMBER
1927 - RC - SW402

DATE
MAR 2025

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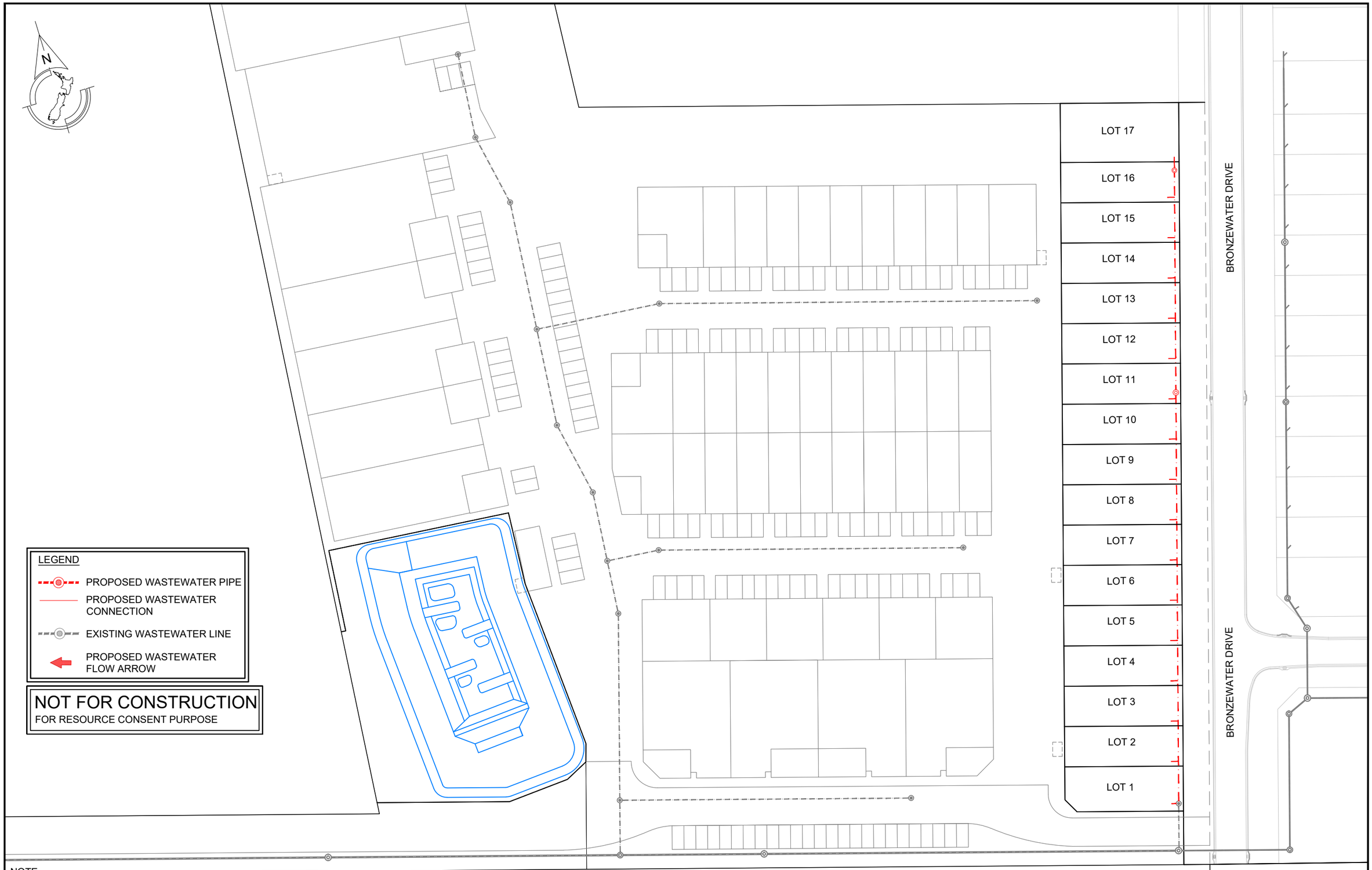

LEGEND

- PROPOSED WASTEWATER PIPE
- PROPOSED WASTEWATER CONNECTION
- EXISTING WASTEWATER LINE
- PROPOSED WASTEWATER FLOW ARROW

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

NOTE:
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VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE

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DRAWING CHECK	MJ	03.25
DESIGN CHECK	MJ	03.25
APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED WASTEWATER OVERVIEW PLAN

DRAWING NUMBER
1927 - RC - WW501

DATE
MAR 2025

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LEGEND

PROPOSED WASTEWATER PIPE

PROPOSED WASTEWATER CONNECTION

EXISTING WASTEWATER LINE

PROPOSED WASTEWATER FLOW ARROW

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

LOT 1 | LOT 2 | LOT 3 | LOT 4 | LOT 5 | LOT 6 | LOT 7 | LOT 8 | LOT 9 | LOT 10 | LOT 11 | LOT 12 | LOT 13 | LOT 14 | LOT 15 | LOT 16 | LOT 17

EX WWMH A1

P WWMH A2

P WWMH A3

P WW 150mmØ uPVC SN16

P WW 150mmØ uPVC SN16

BRONZEWATER DRIVE

BRONZEWATER DRIVE

NOTE:
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VERTICAL DATUM: NEW ZEALAND VD2016

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					APPROVED	PF	03.25

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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED WASTEWATER PLAN

DRAWING NUMBER
1927 - RC - WW502

DATE
MAR 2025

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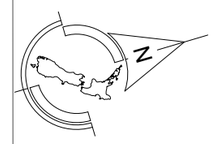
LEGEND

- EXISTING WATER SUPPLY LINE
- EXISTING WATER METER
- PROPOSED WATER METER



LOT 1 LOT 2 LOT 3 LOT 4 LOT 5 LOT 6 LOT 7 LOT 8 LOT 9 LOT 10 LOT 11 LOT 12 LOT 13 LOT 14 LOT 15 LOT 16 LOT 17

P WATER METER

EXISTING 180mmØ OD (150mmNB)

EXISTING 180mmØ OD (150mmNB)

BRONZEWATER DRIVE

EX WATER METER

FH

FH

EXISTING 180mmØ OD (150mmNB)

EXISTING 180mmØ OD (150mmNB)

NOTE:
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VERTICAL DATUM: NEW ZEALAND VD2016

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:500 AT A3

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DESIGN CHECK	MJ	03.25
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SITE ADDRESS
PROPOSED 17 LOT RESIDENTIAL SUBDIVISION
53 SMALL ROAD,
SILVERDALE

DRAWING TITLE
PROPOSED WATER SUPPLY PLAN

DRAWING NUMBER
1927 - RC - WS601

DATE
MAR 2025

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ATTACHMENT 2

AKL2020-0125AI Geotechnical Investigation Report

17 December 2021

SILVERDALE SOUTH

STAGE 3 & 4

GEOTECHNICAL INVESTIGATION REPORT

Build Rich

AKL2020-0125AI Rev.0

AKL2020-0125AI		
Date	**Revision**	**Comments**
29 August 2021	A	Initial draft for internal review
1 September 2021	B	Final draft for client review
17 December 2021	0	Final issue to client

	Name	**Signature**	**Position**
Prepared by	Jasmine Walden		Project Engineering Geologist
Prepared by	Steven Phillips		Senior Engineering Geologist
Reviewed by	Sam Gibb		Principal Geotechnical Engineer, CPEng
Authorised by	Richard Knowles		Principal Geotechnical Engineer, CPEng

EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation, geohazards assessment and specific geotechnical recommendations to supplement the resource consent application for the proposed subdivision to be undertaken at the Silverdale South, Stage 3 & 4 development.

The site is to be an extension of the previously constructed Silverdale South, Stage 1 & 2 subdivision located directly to the north. It is roughly rectangular in shape with the majority of the land in open pasture or covered in gorse bushes. The landform is characterised by a series of tributary ridges and gullies which traverse the site from the main East Coast Road ridgeline located along the eastern boundary. The site generally slopes to the west and north-west from this ridgeline with the highest elevation at approximately RL 84.0m grading down to RL 31.0m along the western boundary. The site also includes the residential property at 2150 East Coast Road.

Design details for geotechnical aspects of the development are summarised as follows:

- The subsoils encountered as part of this investigation are generally consistent with the published geological records;
- Mapped geomorphological features such as head scarps, gullies, hummocky ground, soil creep and tomos are all present on site and will all be remediated during the earthwork's development by subsoil drainage, site stripping and cut to fill operations;
- Given the geological age of the subsoils and soil fabric/consistency, there is considered to be a low risk of liquefaction at this site;
- Key remediation elements to support the earthworks scheme plan are underfill drains, shear keys or undercutting at the toe of fill along the southern and western boundaries, shear key in cut areas below the MSE wall. The base width of these keys is 5 metres with embedment of the base into rock. Counterfort drainage on sloping lots below the property at 2118 East Coast Road with future palisade wall and shear pile remediation required.
- Bedrock within the locations identified on the Remediation Plan (Drawing 7) is likely to be exposed at finished levels and will require undercutting and capping with engineered clay fill to a minimum depth of 1m. This will require careful planning by the earthworks contractor to set aside sufficient clay fill from the surface of the topography at the commencement of the works programme to ensure appropriate sequencing of the works;
- Based on the findings of our investigation, including the presence of hard deposits at relatively shallow depths, the seismic site subsoil category defined in Section 3.1.3 of NZS 1170.5 is assessed to be C (shallow soil site);
- Specific engineering design of specific remediation elements such as MSE Slopes, retaining walls and palisade walls will be required at detailed design stage;
- The scheme plans illustrate near level lot platforms which will require subdivisional retaining walls to be designed and constructed for each of these terraced sections. The terraced layout of the proposed development is not considered to detrimentally effect the global stability of the site.

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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Build Rich Limited to carry out a geotechnical investigation of a site located at 2182 East Coast Road, Silverdale which is being considered for proposed construction of a 318 Lot residential subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2020-0125AF Rev.1 dated 22 July 2021.

This report is to support a Resource Consent application to Auckland Council.

1.2 Scope of Work

As detailed in our proposal letter the instructed scope of work to be conducted by CMW was defined as follows:

- A desktop study, including review of related reports, aerial photographs and published geology.
- Site walkover and geomorphology mapping.
- Geotechnical site investigation, comprising the drilling of machine boreholes, hand auger boreholes and excavation test pits.
- Update the existing geological and geotechnical model,
- Identify any geohazards to the proposed development, including instability, groundwater issues, and provide strategies to mitigate;
- Compile all of the above detail into a concise geotechnical investigation report, incorporating relevant plans, field investigation data and recommendations.

2 SITE DESCRIPTION

2.1 Site Location

The site comprises an area of approximately 10.3 hectares and is located at 2182 East Coast Road, legally described as Lot 7 DP 545151 as shown in ***Figure 1*** below. The site also includes 2150 East Coast Road, legally described as Pt Lot 1 DP 44249 with an approximate area of 3100m^2.

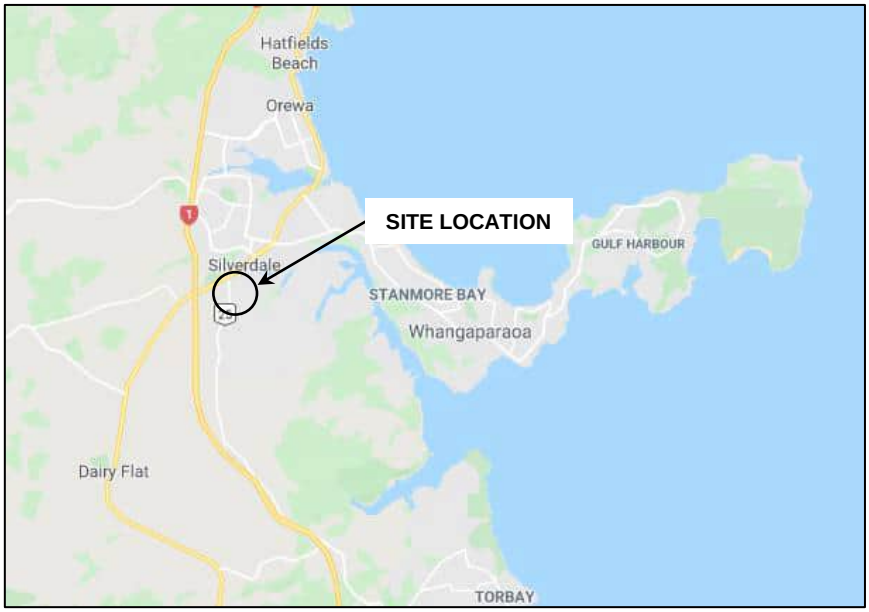

Figure 1: Site Location Plan (Google Maps)

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on the attached Site Investigation Plan as ***Drawing 01***.

The site is roughly rectangular in shape with the majority of the land in open pasture or covered in gorse bushes. The landform is characterised by a series of tributary ridges and gullies which traverse the site from the main East Coast Road ridgeline located along the eastern boundary. The site generally slopes to the west and north-west from this ridgeline with the highest elevation at approximately RL 84.0m grading down to RL 31.0m along the western boundary. The gradients are initially steep off the ridgeline at around 1(V):3(H) from approximately RL 80.0m to RL 65.0m with lessening grade towards the western boundary from approximately RL 65.0m to RL 31.0m and gradients of roughly 1(V):6(H) to 1(V):9(H).

Two of the northern most incised gullies extend down into a wetland and intermittent stream in the north western corner of the site. A number of farm ponds have formed in the gullies and near some of the ridgelines, with several of the ponds now offline since the more recent aerial photos. Several of the gullies have tunnel erosional features such as piping especially below the farm ponds. A number of small stockpiles from felled trees and vegetation are located in the top north-eastern corner of the site, assumed to originate from trees that were located in this area as seen in 2010 to 2011 aerial photographs.

The site is bound to the South by Silverdale Adventure Park, to the west by farmland and an existing dwelling and to the north by the newly formed Stage 1 & 2 East Cost Heights subdivision. Two existing residential properties dominate the majority of the eastern boundary which is situated along the East Coast Road ridgeline. The northern most residential dwelling is included in the proposed wider works as detailed in Section 2.1. It sits at the end of the ridgeline and has East Coast Road running directly along its eastern boundary. The ridgeline controls the slope gradients of the site and it slopes moderately to the west and east at 1(V):3.5(H) and to the north at 1(V):8(H).

Historical aerial photographs[1] show no evidence of significant change in landform across the site and suggest that the property has previously been and is currently open pasture, presumed to be used for agricultural purposes. Minor earthworks have taken place near the northern and southern boundaries due to developments on the neighbouring properties and minor works such as formation of ponds and access tracks.

3 PROPOSED DEVELOPMENT

The current development proposal, as shown on the proposed scheme plans provided by Aspire Consulting Engineers titled 2182 East Coast Road, Silverdale (Stage 3 & 4), 1628 - RC – EW201, EW202 and EW211 to EW219, dated December 2021, is to create approximately 322 residential lots of varying sizes with associated access roads extending from Stages 1 and 2 of the development. Plans illustrate proposed cuts of up to 149,881m^3 with the maximum cut depth of 9.0m occurring in the north-eastern corner of the site. Fills of up to 219,703m^3 with the maximum fill depths of 11.0m occurring through the centre of the site from east to west in the main gully. Generally the lower lying gully areas are proposed to be filled with the upper ridgelines cut down to ease overall gradients.

The proposed contour plan depicts gentler grades across the site post earthworks. Batter slopes with gradients of approximately 1(V):3(H) are proposed along the eastern and western boundaries, off East Coast Road and the 2118 residential property. A 1(V):0.4(H) MSE wall up to 9.5m high, running north to south divides through the centre of the subdivision. The bulk remainder of the site is proposed to have near level lots due to a terraced layout which will be constructed with numerous subdivisional retaining walls.

4 INVESTIGATION SCOPE

4.1 Desktop Study

A desktop study was carried out before commencing fieldwork. This included online research through Auckland Council Geo Maps, Dial Before You Dig, aerial photographs and review of previous investigation and reporting.

A review of historic and recent aerial photographs between 1973 and 2020 indicated the following activity:

- Existence of only the northern most residential dwelling along the eastern boundary in 1973;
- Formation of the southern residential property along the eastern boundary between 1973 and 1996 which also included some earthworks operations and the pushing out of fill in the west to form the lawn;
- Formation and abandonment of a dirt bike track in the northern portion of the site between 2010 and 2019;
- Filling of the two northern ridgeline ponds between 2017 and 2020;
- Formation of a fill batter along the northern boundary as part of the neighbouring earthworks between 2018 and 2020.

4.2 Previous Investigation

CMW has previously completed preliminary investigation and reporting for the subject site and the wider Silverdale South development as part of a Development Concept Plan (DCP) in 2016. The findings for this are outlined in the report titled Preliminary Geotechnical Investigation Report for Proposed Mixed Use Residential and Commercial Development at Silverdale South referenced AKL2016_0206AA Rev.0 dated 4 August 2016.

The fieldwork was conducted in May 2016 and consisted of 6 machine boreholes, 15 test pits and 11 hand auger boreholes. Of these investigations HA06-16, HA07-16, HA09-16, HA10,16, TP11-16 to TP15-16 and MH01-16 to MH03-16 are relevant to the subject site and have been included in the attached site investigation plan and associated cross sections (investigation logs can be found in ***Appendix C***).

[1] Retrolens website, Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0

The findings of these investigations created a ground profile generally consistent with that of this report. Natural soils consisting of stiff to very stiff residual and colluvial/alluvial materials ranging from 1.4m to 4.0m across the site becoming shallower towards the eastern ridgeline. The majority of the alluvial material was mapped and logged along the western boundary, wetlands and within the gullies.

A highly fractured and permeable transition zone between the natural soils and the bedrock generally ranged from 0.5m to 1.0m thick at depths from 1.4m to 4.0m. The Northland Allochthon rock encountered has been logged as siliceous siltstones and slightly sandy siltstones of the Whangai Formation with strengths ranging from extremely weak to weak. The rock mass was highly fractured and jointed.

CMW have also previously completed the site investigation and reporting for the newly formed Silverdale South, Stage 1 & 2 subdivision located directly to the north of the subject site. Along with the preliminary site investigation completed which details ground conditions similar to those observed within this report, CMW also undertook specific design analyses including slope stability analysis and the design of shear keys. Silverdale South, Stage 1 & 2 has since undergone earthworks which CMW have monitored and subsequently signed off under a Geotechnical Completion Report.

4.3 Field Investigation

The field investigation was carried out between 29 June 2020 and 3 July 2020, and again in August 2021 . All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[2] and logged in accordance with NZGS guidance[3]. The scope of fieldwork completed was as follows:

- Undertook a walkover survey of the site to assess the general landform, site conditions and adjacent structures / infrastructure and observations are detailed in Section 2.2 and Section 5.2;
- Three machine boreholes, MH07-20, MH01-21 and MH02-21 were drilled using rotary techniques to a maximum depth of 15.0m to determine the ground model through and below the proposed earthworks profile. A single standpipe piezometer was installed in MH07-20 from 0.0 to 12.5m to monitor groundwater levels. Engineering logs of the boreholes are provided in ***Appendix B***;
- Ten test pits, denoted TP16-20 to TP25-20, were excavated using a 12.5-tonne hydraulic excavator fitted with a 0.6m wide toothed rock bucket to depths of between 3.5m and 5.0m below existing ground levels. All test pits were terminated at target depths which were within Northland Allochthon rock. Engineering logs and photographs of the test pits are presented in ***Appendix B***;
- Twelve hand auger boreholes, denoted HA12-20 to HA21-20, HA01-21 and HA02-21, were drilled using a 50mm diameter auger to target depths of up to 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ vane shear strength testing. Refusal on hard ground, inferred to be Northland Allochthon rock occurred in hand auger boreholes HA12-20 to HA16-20 and HA18-20 to HA20-20, HA01-21 and HA02-21. HA17-20 and HA21-20 reached the target depth of 5.0m. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths are presented in ***Appendix B***;
- Dynamic cone (Scala) penetrometer (DCP) tests were carried out in the base of hand auger boreholes HA12-20 to HA16-20 and HA18-20 to HA20-20, HA01-21 and HA02-21 to depths ranging from 2.1m to 4.2m to provide soil density profiles and confirm ground conditions. Graphical results of the DCP testing are presented on the borehole logs in ***Appendix B***;
- Groundwater monitoring was undertaken on three different occasions during further visits following the initial fieldwork, to monitor the groundwater level in MH07-20. The results of this monitoring is presented in Section 5.4 below.

The approximate locations of the respective investigation sites referred to above are shown on the Site Investigation Plan as ***Drawing 01***. Test locations were specifically picked up by survey, with coordinates in

[2] NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification
[3] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

Mount Eden Circuit 2020 and elevations from LINZ, Auckland Vertical Datum 1946 and provided to us by C&R surveyors limited.

5 GROUND MODEL

5.1 Published Geology

Published geological maps[4][5] for the area depict the regional geology for the area as comprising Hukerenui Mudstone (Mangakahia Complex) of the Northland Allochthon, previously known as Onerahi Chaos as illustrated in ***Figure 2*** below.

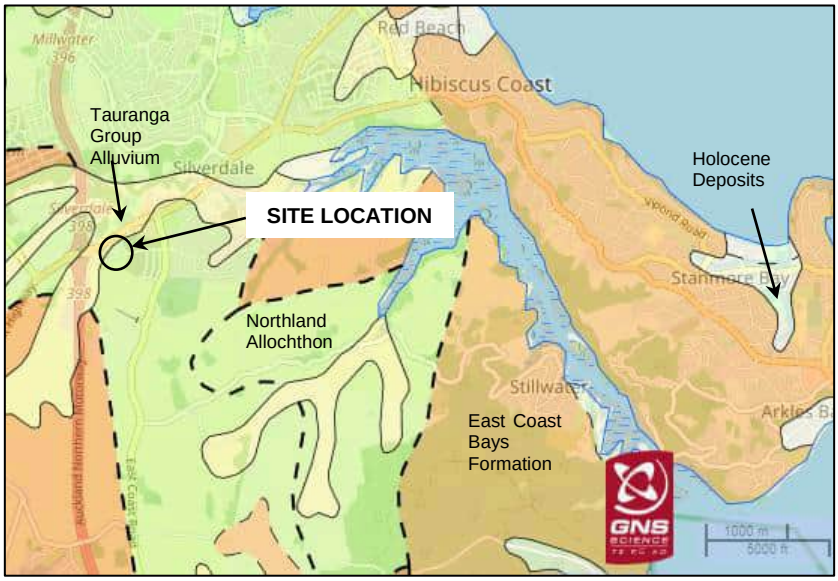

Figure 2: Regional Geology (GNS Science – Geology Web Map 1:250 000)

This strata is part of an allochthonous (meaning removed from its formation location) mass of continental crust that had been peeled from the subduction zone north of New Zealand and emplaced through low angle thrust faulting onto areas of Northland and the Silverdale area.

Due to the nature of the faulting and emplacement, the materials which form the Northland Allochthon are highly fractured, variably weathered and often form a melange of strata including mudstones, siltstones, limestones, ultra-mafic rocks and shales. This geological formation is often unstable even on gentle slopes.

Two lithologies are present within the Northland Allochthon. Whangai Formation is described as cream to grey siliceous and locally calcareous mudstone while Hukerenui Mudstone is described as commonly sheared and deformed mudstone with small serpentine bodies.

Tauranga Group alluvial and colluvial materials generally fill the low-lying areas and gullies. These materials are described as clays and silts.

Groundwater levels are expected to be high during the winter months. The location of historic farm ponds near the head of gullies or on ridgelines with little or no catchment suggests the presence of springs.

Based on the known history of the site and surrounding land levels, some superficial depths of fill could be anticipated as a result of earthwork work operations in neighbouring sites and the filling of historic ponds.

[4] Edbrooke, S. W. (complier) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3.1 sheet +74p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences.

[5] Schofield, J. C. 1989: Sheets Q10 & R10 – Helensville and Whangaparaoa. Geological map of New Zealand 1:50 000. Map (2 sheets) and notes. Wellington, New Zealand. Department of Scientific and Industrial Research.

5.2 Geomorphology

The geomorphology of the site was mapped by examination of aerial photograph stereo pairs[2] and during a site walkover and is shown in the appended Geomorphology Plan (***Figure 02***).

The geomorphology reflects the underlying geology and associated slope processes. The dominant regional structure is evident in the subject and neighbouring sites in the form of features such as gullies and ridgelines.

This geology is typically known for its deformed, crushed and sheared nature and is notorious for instability even at gentle slopes. The combination of the existing elevation of the East Coast Road ridgeline and the shallow Northland Allochthon rock controls the geomorphology of the site.

Roughly three main gullies trending west to north-west dominate the subject site, the orientation of these is likely to be controlled by groundwater flows creating natural drainage systems for the main ridgeline. The prominent headscarps and significantly steeper slope gradients directly off the ridgeline, both within the subject site and the neighbouring properties suggest historic movement, predominantly within the shallow transition zone which would allow the underlying rock to retain its gradient.

The heads of the gully systems form directly within this steeper slope immediately below the existing residential properties along the eastern boundary. Debris lobes, soil creep and mid slope benches are all present at the head of these gullies with subsequently more shallow slope movement observed in the two northern-most gullies where historic ponds had been formed in mid-slope depressions suggesting the groundwater flow rate is greater here.

The remainder of the site progressing down from the ridgelines and gully heads displays geomorphology characteristic of Northland Allochthon geology. Numerous, presumably shallow (given the shallow residual soil profile and onsite observations), isolated debris lobes are displaced within the gully slopes, most likely occurring along low-angle pre-existing failure planes and shear surfaces in the transition zone, between the residual soils and underlying rock masses. Fissures observed in the test pit investigations throughout the site are interpreted to be the result of swelling and shrinkage creating soil creep movement on the slopes. Of particular note is an area of hummocky, inferred colluvial ground (currently covered in thick gorse) in the southern portion of the site, directly below the last ridgeline. This area of material appears to have been gradually displaced downslope but has been locked in place by the intersecting small gullies that outlet in the south western corner.

Five main ridgelines trending west to north-west begin at a steep gradient directly off the East Coast Road ridgeline and then gradually change to moderately graded, broad, hummocky slopes with terracettes on most slope angles. Localized, shallow debris lobes, mid slope benches and hummocky ground is observed within the slopes of these ridgelines and along the banks of the gullies. All but one of the ridgelines taper off into the gentler slopes of the mapped alluvial plain along the western boundary. The one remaining ridgeline begins in the south eastern corner of the site and grades moderately down to the centre of the western boundary and extends into the neighbouring property. Isolated, shallow, hummocky ground and minor headscarps exist along the slopes of this ridgeline, particularly along the western boundary when the grade increases up to the fence line.

Wet and swampy ground is present within the south and north western corners of the site which is common in this geology where the ground shallows out at the toe of slopes and draining groundwater accumulates. Tunnel-gully erosion can be seen within the two northern gully systems, reiterating the presence of colluvium.

5.3 Stratigraphic Units

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area and can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented in the appended Geological Sections on ***Drawing 03 to 06***.

[2] Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0

5.3.1 Topsoil

Topsoil was encountered in all the boreholes and test pits and ranged from 0.1m to 0.4m thick below current ground level. The average thickness is approximately 0.3m and material was typically dry to moist.

5.3.2 Fill (Engineered and Uncontrolled)

Uncontrolled fill was encountered in investigation boreholes HA01-21 and HA02-21 which was likely placed during the construction of the dwelling at 2150 East Coast Road. It's also likely given the earthworks batter that was formed during the development of the neighbouring subdivision and extends into the subject site along the northern boundary, the presence of both engineered fill and discarded uncontrolled fill is possible. It should also be noted that filling of two of the natural farm ponds has been undertaken and uncontrolled fill will be present in these areas. More recently, lower portions of the site have also undergone some filling.

A relict dirt bike track formed and then abandoned between 2010 and 2019 may also have included some fill, and the lower portion of the northern most gully was filled with uncontrolled fill in December 2020.

Further uncertified fill of up to 3.0m has been placed in the wetland area in the north-western corner of the site in late 2020.

5.3.3 Alluvium

Alluvial soils were encountered in HA17-20, HA18-20, TP17-20, TP20-20 and TP24-20 generally located at the toe of the gullies and low-lying wet land areas from depths of 0.1m to 0.4m. The alluvial material was generally firm to stiff, brownish grey mottled orange clays, silty clays and clayey silts with black organic staining and organic inclusions. Moisture condition was generally moist to wet. Vane shear strengths ranged from 45kPa to unable to penetrate (UTP) and averaged around 108kPa. 45kPa is observed to be an outlier due to the test pit location being undertaken within the toe of a gully where wet material due to groundwater was encountered.

5.3.4 Colluvium

Colluvial soils were encountered in HA13-20 to HA16-20, HA19-20, TP16-20 to TP19-20, TP21-20 and TP25-20 from depths of 0.4m to 0.8m. They generally consisted of stiff to very stiff, grey, orange, brown mottled orange clays and silty clays. Vane shear strengths ranged from 90kPa to unable to penetrate (UTP) and averaged 157kPa. Colluvial material was typically moist.

5.3.5 Residual Northland Allochthon

Residual soils of the Northland Allochthon Formation were encountered in HA12-20 to HA21-20, TP16-20 to TP23-20 and MH07-20 from depths of 0.15m to 4.3m. These soils generally consisted of stiff to hard, light grey mottled orange, bluish grey, light orange brown, clays silty clays and clayey silts with minor fine to medium sands. Vane shear strengths ranged from 84kPa to UTP and averaged over 160kPa. The residual soils were generally consistent across the site ranging from moist to wet with trace fissures typical of shrink-swell processes.

5.3.6 Transitional Northland Allochthon

A weathered transitional layer was encountered between the residual/colluvium and rock mass in HA15-20, HA20-20, TP16-20 to TP20-20 and TP22-20 to TP25-20 from depths of 1.5m to 4.2m. This layer generally consisted of hard, bluish grey mottled orange, purple red and grey clays, clayey silts with various amounts of gravel sized completed weathered siltstone/mudstone. This zone was observed to be highly fractured with moisture contents ranging from dry to wet.

5.3.7 Northland Allochthon Rock

Completely weathered to highly weathered Northland Allochthon Rock was encountered in all investigation boreholes and test pits from depth of 1.7m to 4.5m below existing ground level. Rock encountered consisted of extremely weak to weak siltstones and mudstones of both the Whangai Formation and Hukerenui Formation origins. Whangai was observed across the majority of the site while Hukerenui appeared to be more isolated to the north western corner of the site in the low-lying area. The rock mass was generally retrieved as completely weathered siltstone/mudstone or highly fractured gravels.

5.3.8 Summary

The distribution of these units is illustrated on the appended Geological Sections A-A to G-G (***Drawing 03 to 06***) and presented below in Table 1.

Table 1: Summary of Strata Encountered

Unit	Depth to base (m)		Thickness (m)**	
	Min	Max	Min	Max
Topsoil	0.1	0.4	0.1	0.4
*Alluvium	0.6	3.0	0.4	2.8
*Colluvium	0.4	1.8	0.3	1.5
*Residual Northland Allochthon	1.5	4.5	0.2	4.3
*Transitional Northland Allochthon	1.7	4.2	0.2	1.2
Northland Allochthon Rock	-	-	-	-

Notes: *Thickness only recorded where base of strata has been confirmed.

5.4 Groundwater

During the investigation, which was completed in mid-winter conditions (June/July 2020), groundwater was encountered within boreholes at the depths provided in Table 2, which also presents the results of groundwater monitoring undertaken following the investigation:

Table 2: Groundwater Monitoring Data

Borehole	Screen Depth (mbgl)	30 June 2020	
		Depth (mbgl)	Elevation (m RL)
HA12-20	-	2.6	67.89
HA16-20	-	0.0	56.50
HA18-20	-	0.5	34.13
HA20-20	-	0.9	62.71

MH07-20			
Date	Screen Depth (mbgl)	Depth (mbgl)	Elevation (m RL)
21 July 2020	12.5	1.2	66.79
22 January 2021	12.5	1.14	66.85
1 April 2021	12.5	2.23	65.76
Note: mbgl = metres below ground level			

However, given the presence of a variable and clayey soil profile, it is possible that perched groundwater may occur during and following periods of rainfall. It should also be noted that while groundwater was not

encountered across all investigation boreholes or test pits, it is typical in this geology for the groundwater to flow through the more permeable transition zone, which in this site is relatively shallow in depth.

6 GEOHAZARDS ASSESSMENT

6.1 Context

Section 106 of the Resource Management Act[6] (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence).

The following sections of this report provide an assessment of the geohazards relevant to this site and provide the basis for the Natural Hazards Risk Assessment presented in ***Appendix H***.

6.2 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[7] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.2 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (for importance level 2)

f = site response factor subject to subsoil class (refer Section 7.2 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[8] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 3: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	$Magnitude_{eff}$
ACCOP	1/150	0.6	0.09	5.75
ULS	1/500	1.0	0.15	5.75

Note: SLS = serviceability limit state; ULS = ultimate limit state; AEP = annual exceedance probability

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

[6] Resource Management Act (1991), as at 29 October 2019

[7] NZ Geotechnical Society publication "Earthquake geotechnical engineering practice, Module 1: Overview of the standards", (March 2016)

[8] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)

In accordance with NZGS guidance[9] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency / density.

6.3.2 Geological Age

The vast majority, and nearly all, case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[10][11]. Pleistocene aged alluvium (>12,000 years) is also considered to have a very low to low risk of liquefaction[11].

The recent alluvium (river and hill slope), units QIS5 + QIS2, found within the low-lying area of the site are of middle to late Pleistocene geological age and therefore, in terms of geological age, are considered to be low risk of liquefaction.

Across the elevated terraces, soils below the water table comprise Northland Allochthon deposits. These soils are defined as having a dated age of 37.0 million to 98.9 million years old. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance[5] sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

PI < 7: Susceptible to Liquefaction

7 ≤ PI ≥ 12: Potentially Susceptible to Liquefaction

PI ≥ 12: Not Susceptible to Liquefaction

The fines content of the sands beneath the site also has a significant impact on their liquefaction susceptibility.

Although plasticity index testing has not been undertaken, the soils recorded on site were predominantly moderately to highly plastic silty clays, clays and clayey silts and are therefore considered to be at low risk of liquefaction.

6.3.4 Specific Analyses

Specific liquefaction analysis was not undertaken at the subject site due to the clayey soil fabric, geological age, which all present a very low liquefaction risk. Liquefaction has therefore not been considered further.

6.4 Slope Stability

6.4.1 Design Criteria

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment:

[9] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

[10] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[11] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

Table 4: Slope Stability Factor of Safety Criteria	
Condition	**Required Factor of Safety**
Static long term conditions (drained soil conditions, normal groundwater)	1.5
Transient short term conditions (elevated groundwater)	1.3
Ultimate Limit State (ULS) seismic condition	1.2*
Note*: Factor of safety < 1.0 acceptable where displacement-based approach is adopted.	

6.4.2 Shear Strength Parameters

6.4.2.1 Effective Stress Parameters

Drained shear strength parameters for the various geological units that underlie the site were inferred from the field investigation and experience in similar ground conditions within the neighbouring sites and across the Northland and Auckland regions. CMW have undertaken extensive work in the area and on adjacent sites and have gained considerable knowledge in the behaviour of these materials and their properties.

Table 5: Summary of Effective Stress Shear Strength Parameters			
Geological Unit	**Unit Weight (kN/m^3)**	**Effective Stress Shear Strength Parameters**	
		c' (kPa)	**Ø' (deg)**
Colluvium	18	4	26
Alluvium	18	3	26
Residual Northland Allochthon	18	5	26
Transitional Northland Allochthon	18	0	20
Completely Weathered to Highly Weathered Northland Allochthon	23	10	40
Engineered Fill	18	5	30
Note: Where c' = effective cohesion, Ø' = effective friction angle			

6.4.2.2 Total Stress Parameters

The soils that will be exposed in the proposed cut batters / underlie the proposed fill embankments comprise predominantly cohesive silts and clays that will behave in an undrained state during short term seismic loading. Undrained soil shear strengths (Su), used for assessing the stability of slopes during seismic loading, were taken from the hand held shear vane results and are summarised as follows:

Table 6: Summary of Undrained Shear Strength Parameters	
Geological Unit	**Design Su (kPa)**
Colluvium	80
Alluvium	90
Residual Northland Allochthon	100
Transitional Northland Allochthon	200
Engineered Fill	100

6.4.3 Slope Stability Analyses

Slope stability analyses were undertaken using the proprietary software SLIDE 2. Analysis was undertaken using the Morgenstern-Price method of slices under the translational failure mechanism which is the anticipated failure mechanism in this geology. Due to the length of some of the cross sections, initially the Particle Swarm Search with multiple failures was used in order to identity areas with lower factors of safety which could further be targeted for analysis.

Once areas with a low factor of safety (FoS) were identified, these were then targeted using a translational failure path search and results confirmed areas with the highest risk of failure were constant with the mapped colluvial failure lobes, high groundwater and steeper ground within the site.

Stability cases for Sections A-A and B-B were also analysed for a partial remediation case where only the counterfort drainage was assessed. This was completed to determine that the Factors of Safety achieved for the upper lots (directly below the property at 2118 East Coast Rd) were acceptable for a short-term temporary case where the full remediation i.e. palisade wall and/or shear piles weren't constructed until this stage scheme design and building development proposals have been confirmed.

Selected stability printouts are attached in ***Appendix D*** and summarised as follows:

Table 7: Slope Stability Analyses Results

Geological Section	Slope Stability Factor of Safety (Existing)		Slope Stability Factor of Safety (Proposed)			Slope Stability Factor of Safety (Remediated)		
	Prevailing	Transient	Prevailing	Transient	Seismic	Prevailing	Transient	Seismic
A-A	1.3	1.0	1.4	0.8	16.6	1.5	1.5	18.3
A-A	Counterfort drainage only – temporary case					1.4	1.1	16.6
B-B	1.4	1.0	1.2	1.2	8.7	1.7	1.4	8.8
B-B	Counterfort drainage only – temporary case					1.4	1.4	8.5
C-C	1.4	1.5*	1.3	1.2*	13.8	1.6*	1.8*	12.8
D-D	1.2*	0.9*	2.1*	0.9*	4.2	2.0*	1.4*	4.2
E-E	1.5	1.3	1.2	1.1	5.1	2.1	2.1	5.1
F-F	1.4	1.1	1.9	2.0	5.5	2.0	2.0	5.0
G-G	1.2	1.2	3.4	2.6	12.4	-	-	-
H-H	1.5	1.1	1.5	1.3	17.9	1.7	1.7	12.9

Note: *This factor of safety was achieved within the site boundaries however the appended slide section illustrates lower factors of safety occurring in the adjacent / neighbouring properties.

Results within Section B shows the addition of engineered fill within the southern portion of the site should improve the factors of safety for the proposed profile. The high groundwater case still demonstrates a factor of safety of 1.2, however this can be improved during earthworks by the installation of subsoil drainage as outlined in Section 7 below.

The existing profile within Sections C and D demonstrate low factors of safety particularly within the eastern portion of the site, directly adjacent to the 2118 East Coast Road property which is situated off the East Coast Road ridgeline. These factors of safety are consistent with the mapped debris lobes and obvious localised instability that is already evident in this area. The proposed earthworks profile within these two sections is then shown to significantly improve the observed factors of safety, with the filling of the gully creating a buttress for the steep slopes of the East Coast Road ridgeline. Underfill drainage will also aid in reducing pore water pressures created due to the high ground water table recorded. It should be noted as detailed in the appended stability sections that low factors of safety were identified within the steep slopes of the adjacent site (2118 East Coast Road), however they do not extend into the subject site when the proposed earthworks profile is applied.

Geological Sections E to G show generally stable factors of safety within the existing profile during normal groundwater levels, with potential for instability to occur when the groundwater levels are high. The proposed profile with the applied earthworks design scheme demonstrates an improvement in the factors of safety with the installation of a shear key at the base of the filled gully and large cuts in the north-eastern portion of the site to ease the existing gradients. Proposed section E with normal groundwater applied shows a reduced factor of safety due to the extensive cuts proposed within this area, however this can be mitigated by subsoil drainage and the proposed capping layer as outlined in Section 7.5.5 below which is recommended to alleviate erosion within the exposed rock cut.

Results show that the proposed earthworks and new design levels will not worsen the existing slope stability, but generally improve the factors of safety. For areas within the proposed profile where the factors of safety are reduced the implementation of specific remedial earthworks / ground improvement / drainage measures, as described above and outlined in detail in Section 7 below will be required.

6.4.4 Future Stability Analysis

The factors of safety achieved above are deemed acceptable development except for the lots directly below 2118 East Coast Road, which require further stability analysis and detailed design of geotechnical remediation such as palisade walls and/or shear piles to achieve the factors of safety required to meet those set out in the Auckland Council Code of practice for land development and subdivision. This will need to be undertaken in conjunction with scheme design and building design in this area.

6.5 Erosion

There is evidence across the site indicating that the soils are susceptible to erosion where concentrated flows are able to form. This is particularly noted within the incised gullies where tomos have been observed and overland flow paths have created shallow erosion channels.

Along with these geomorphological features, the proposed earthworks cuts are likely to expose erodible rock layers which were once capped and create the potential for consequential piping / tunnelling erosion and slope failure.

Erosion of cut and fill batters during earthworks is considered to be a high-risk natural hazard and easily addressed during construction. Erosion around batters may subsequently contribute to slope instability and falling debris. This hazard can be controlled during the design phase by limiting batters to a maximum of 1(V):3(H) gradients and during earthworks via benches, erosion control blankets, geotextiles and stormwater control. We have also specified that exposed rock areas are undercut and capped with engineered clay fill as detailed further below.

Recommendations for this mitigation and remediation for this is outlined in Section 7.5 below.

6.6 Fill Induced Settlement

Deep fills of the nature proposed on this site may be subject to ongoing settlement for a period following completion of the works. Due to the composition of the underlying soils being very stiff to hard and the relatively shallow overburden soil profile, settlements due to fills are anticipated to be minor in magnitude. Our experience indicates that with appropriate gully preparation and drainage, settlements are typically complete soon after the earthworks are finished.

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for the proposed development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is be agreed with the Geotechnical Engineer during construction.

6.7 Expansive Soils

Seasonal shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have

returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011[12] excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870[13]. for foundation design advice. However the November 2019 update of Acceptable Solution B1/AS1[14] provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

Nevertheless, there is evidence in the NZ geotechnical community indicating that the use of the B1/AS1 method of assessment of expansiveness and therefore its design recommendations are likely to be erroneous. Accordingly, our assessments herein have been made in line with our experience and the AS2870 references. Testing has been undertaken during development of the neighbouring sites indicating that the soils are AS2870 Class M or H1.

6.8 Groundwater Impact Assessment

An assessment has been made of the impact of the proposed works on groundwater conditions in accordance with the requirements of Section E7 of the Auckland Unitary Plan (AuP).[15] The assessment has considered the impacts of the proposals for diversion activities and the results are contained in the table presented in ***Appendix E*** and summarised below.

Following onsite groundwater monitoring, the two main cut areas (along the eastern and western boundaries) were assessed and found to be non-compliant according to the following standards:

1) *E7.6.1.6(2) The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock;*
2) *E7.6.1.6(3) The water take must not occur during construction;*
3) *E7.6.1.10(1d) Diversions for no longer than 10 days;*
4) *E7.6.1.10(3) The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.*

The proposed excavations required indicate cuts of up to 5.0m within the western boundary and up to 10.0 within the north-eastern portion of the site with approximately 6.0m along the boundary.

Subsoil drains will be installed as part of the earthworks which will follow existing alignments of surface water channels. Any groundwater intercepted by these drains will be returned to streams and/or wetlands in the same locations as present and will not be diverted to other catchments. The proposed excavations are therefore not anticipated to alter the receiving flows at the surrounding catchments. The low permeability of the site surface soils should ensure that the groundwater across the boundary is not lowered by 2.0m or more.

The ground conditions comprise a combination of engineered fill and Northland Allochthon rock. Based on experience and published literature, a permeability value of 10^{-7} m/sec is considered to be a reasonable assumption.

Groundwater measurements indicate that the proposed excavations could induce groundwater drawdown of up to 1.6m along the north-eastern boundary. The magnitude of the groundwater drawdown was therefore assessed for a maximum drawdown of 1.6m in accordance with the CIRIA document[16]. Based on this, no influence on the groundwater table is expected at a distance greater than 1.01m away from the excavation. There are no existing structures within this zone of influence so the drawdown effect on neighbouring sites or roads is anticipated to be negligible. Calculations are provided in the appendices.

[12] Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard
[13] Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW
[14] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/AS1, Amendment 19
[15] Auckland Unitary Plan Operative in Part (Updated 12 June 2020)
[16] CIRIA Report 113, Control of groundwater for temporary works, 1986

The groundwater monitoring recorded within the western boundary recorded values below that of the proposed cuts and the proposed excavations within this area are therefore not considered a risk to groundwater drawdown.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 General

We consider that the site will be generally suitable for the proposed development provided the recommendations in the following sections are incorporated into the final development design to mitigate the geotechnical hazards.

7.2 Seismic Site Subsoil Category

Based on the findings of our investigation, including the presence of hard deposits at relatively shallow depths, the seismic site subsoil category defined in Section 3.1.3 of NZS 1170.5 is assessed to be C (shallow soil site).

7.3 Slope Stability Management

Results of the slope stability analyses discussed in Section 6.4 above demonstrate that proposed earthworks landform gradients through the proposed development will not worsen the existing site stability. It will in some areas however improve the existing factors of safety provided the remedial works such as subsoil drainage, palisade walls, shear piles, MSE slope and a shear keys excavated in the completely weathered to highly weathered bedrock is undertaken. The careful design of cut batters will be required to ensure surface erosion within the rock cut is mitigated.

The shear key is critical in ensuring the large volumes of fill upslope of the wetland are appropriately buttressed and drained to avoid any downslope instability.

Specific earthworks design requirements to achieve appropriate slope stability factors of safety are presented on ***Drawing 08*** and outlined in Section 7.5 below.

The proposed earthworks will generally ease gradients and adequate slope stability conditions for the develop are expected to be provided by normal geotechnical remediation techniques during earthworks.

It's understood that earthwork levels across the upper part of the development could possibly change if an agreement is made with the land owner at 2118 East Coast Rd. If the land at 2118 is developed in conjunction with Stage 3 and 4 of the Silverdale south development, then its likely the grades and levels will be reduced which will benefit both properties in terms of global stability. For the purpose of this report and stability management, it is assumed that development will not be done in conjunction with 2118 and therefore remediation such as palisade walls, shear piles and counterfort drainage have been assessed as viable remediation options and provide acceptable slope stability Factors of Safety, both at and beyond the site boundaries. Detailed design of these remediation options will be required at later stage once the final levels have been determined.

7.3.1 Mechanically Stabilised Earth (MSE) Wall

A MSE wall of up to 9.5m high is proposed running north to south more or less through the centre of this stage of the sub-division. Depending on the location onsite, the MSE wall is either founded on natural subsoils (residual soil or unweathered Northland Allochthon rock) or engineered fills placed to infill gullies. As shown on ***Drawing 07***, a 5m wide shear key is required at the base of this MSE wall to improve the slope stability and mitigate the risks related to settlement of the MSE wall. The shear key undercut into unweathered Northland Allochthon rock is required where natural subsoils are encountered. The undercut will be backfilled with engineered fill, and the MSE wall is to be founded on the fill material. The anticipated extents of this shear key is indicated on ***Drawing 07*** but will require onsite verification during construction and may be subject to localised variations.

Detailed design of the MSE wall will need to be undertaken, although the MSE wall has been modelled as part of the of the stability analyses detailed in **Section 6.4.3** above, to confirm that acceptable global stability

Factors of Safety can be achieved and preliminary details of the MSE structure indicate a 1(V):1(H) slope angle with 10m geogrid length. This is preliminary and will require detailed design.

7.3.2 Counterfort Drainage

Completing the stability analysis in the southeastern corner of the development below 2118 East Coast Rd, cross sections A, B and C as shown on ***Drawing 01***, demonstrated Factor of Safety below the what is recommended in the ACCoP, particularly for the high ground water cases. As a result, groundwater is to be controlled by counterfort drainage across the steeper slopes below 2118. The Remediation Plan (***Drawing 07***) shows the indicative location of the proposed counterfort drainage and Counterfort Drain Detail (***Drawing 09***) shows the typical construction of the drains. It's expected that the base of all counterfort drains will be excavated down into the underlying Northland Allochthon mudstone to an anticipated depth between 3.0 - 5.0m. Counterfort drainage across these slopes should be installed as soon as the bulk earthworks within this area is completed and are required to control the temporary stability of the slope particularly during the wet winter months. Drains should be outlet either into the public stormwater system or into an appropriate downslope gully or water course.

7.3.3 Palisade Wall and Shear Piles

Inground palisade walls are proposed along the eastern boundary directly below the neighbouring property at 2118 East Coast Road, as well as a section along the upper southern boundary. Shear piles have also been modelled as part of the stability analyses due to lower Factors of Safety within the steeper lots directly below the proposed palisade wall. The requirement for both the palisade and shear piles is required assuming that 2118 is not developed in conjunction with the Silverdale South development. If both properties are developed together and grades across this upper section of the development are reduced and it's likely that most of the future remediation as depicted on ***Drawing 07***, will not be required. Further assessment and detailed design (if any) will be required once final earthwork levels have been determined. It is possible that these piles could be integrated in to the building development.

Based on the modelling preliminary details of the palisade walls are as follows.

Table 8: Preliminary Palisade Wall Parameters

	Preliminary Pile Depth (m)	Preliminary Shear Capacity (kN)
Palisade Wall (Road Vest and RF to RJ – Southern Boundary)	5.0	100
Palisade Wall (Lots 224, 221, 220, 286 to 288)	5.0	100
Palisade Wall (Lots 225 to 242 and Lot 297 Accessway)	6.0 – 6.5	100

However, as mentioned above detailed design will be required.

7.4 Wetland

It is understood that the wetland within the north-western most corner of the site is to filled. A portion of this wetland has already been filled with up to 3.0m of uncertified fill. Removal of this material and any underlying soft and/or organic soils will need to be removed prior to placement of any further fill and underfill drainage.

7.5 Earthworks

7.5.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431[17] and the requirements of the Auckland Council Code of Practice for Land Development and subdivision under the guidance of a Chartered Professional Geotechnical Engineer.

A Geotechnical Works Specification is provided as ***Appendix F*** and standard detail drawings are provided as ***Drawing 08.*** Between them, these documents provide the requirements for site preparation, fill placement, subsoil drainage, compaction requirements, quality assurance testing and as-built requirements.

Those requirements are summarised below.

7.5.2 Shear Key

A shear key as mentioned in Section 7.3 above and detailed in ***Drawing 08*** has been specified at the toe of the fill batters along the north western and southern boundaries, as well as beneath the toe of the MSE wall where the wall is formed on natural soils. This shear keys should be constructed to be at least 5.0m wide at the base. Excavations to form the shear key are anticipated to be 5.0 to 6.0m deep, extending along the toe of the fills as detailed in the attached drawings. The shear key/s that underlie the MSE wall are expected to be shallower in depth depending on the amount of cut taken off the ridgelines where the MSE wall crosses over. Where cuts along the MSE wall alignment have already encountered unweathered rock, a shear key depth of 1.0m is required, but the depth will increase where residual soils are encountered.

For all shear keys, the base is to be keyed at least 1.0m into the underlying rock with a series of benches and drainage and drainage outlets which are to be maintained throughout the design life of the shear key. A level of redesign is to be expected during the construction of a shear key where ground and or groundwaters conditions vary from what is anticipated.

The construction of shear keys can involve significant risk. The following construction sequencing has been provided for the purpose of reducing the risk of slope instability during construction. This sequencing is considered as good practice in the industry given our understanding of the site topography and underlying geology. If unexpected ground conditions are encountered during shear key construction, the contractor must notify the Geotechnical Engineer as soon as practical so the Engineer can assess stability risk. During shear key construction it is recommended that the following be adhered to by the contractor, although the methodology adapted by the contractor will need to take into account their equipment and other constraints. CMW remains available to assist in developing the construction methodology with the contractor and project team, considering the main construction risk of batter collapse.

- The shear key should be constructed with benches along the cut face. The individual bench height should not exceed 4m, while each bench width should be cut a minimum of two metres back into the soil profile;
- The angle of any battered cut face must not exceed 1H:1V;
- The length of open shear key excavation at any one time should not exceed 40m. Before the contractor is able to excavate a further section, at least ¾ of the height of the open shear key must be backfilled with engineered fill and appropriate drainage;
- Shear keys should not be left open for long periods and should not be constructed or left open during periods of wet weather. Works must be planned around fine weather windows with an open section of shear key left for no longer than 48hrs without being backfilled;
- The contractor should expect a steady ingress of groundwater into shear keys during construction and should allow for temporary dewatering.
- Consideration should be given to loads above open shear key excavations by controlling stockpiling and plant movements and by removing excess cut prior to open excavations.

[17] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

Shear key drainage outlets are to be placed at a maximum spacing of 50m and are to be confirmed by a Geotechnical Engineer onsite before installation.

Any deviations from the methodologies outlined above are at the contractor's risk, unless a prior agreement between the Geotechnical Engineer and/or Project Group has been made.

7.5.3 Excavatability

Given the highly fractured / completely weathered nature of the rock that will be encountered within a large amount of the proposed earthworks cuts, it is expected that excavation of these materials will be readily achieved with normal earthworks plant, such as scrapers and bulldozers with scoops. Where the deep cuts are proposed in to the rock, excavators may be required if more competent material is encountered.

7.5.4 Stockpiles

Careful consideration must be given to the location of temporary topsoil / unsuitables stockpiles to ensure that they are not located immediately above steep or unstable slopes or immediately above proposed stormwater pond excavations.

The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

7.5.5 Underfill Drainage

Underfill drains will need to be installed beneath new fills within low lying tributaries and gully inverts. Effective drainage is a key factor required for maintaining slope stability and reducing the geotechnical hazards across the site.

We have provided approximate positions of the underfill drainage network required for the subdivision works based on existing contour data. Details are in the Geotechnical Works Specification (***Appendix F***) and in the Underfill Drain Typical Detail (***Drawing 08***).

Subsoil drainage is likely to be required during the construction and is generally specified when and where is required. Some allowance should be made for additional drainage during the earthworks phase of the development.

7.5.6 Compaction

We have considered three likely fill material scenarios in the preparation of our compaction specification contained in ***Appendix F***:

Earthfill must be placed, spread and compacted in controlled 250mm to 300mm thick (loose) lifts under the direction of the Geotechnical Engineer. The fill may comprise either granular or cohesive material subject to being free of any organic material and having no particles greater than 150mm diameter.

Most of the proposed cut material, including the natural and existing fill materials should be suitable for reuse as Engineer Certified Fill. Soil textures and moisture contents will however vary widely and careful management, conditioning and compaction control will be required.

All earthfill must be placed to ensure adequate knitting of successive fill lifts by ripping any fill surfaces that have become dry prior to placing the following fill lift.

7.5.7 Capping Layer

The highly fractured rockmass that will be exposed at finished levels across cut depths greater than approximately 3.0m is susceptible to rapid weathering and infiltration of surface water that could compromise downslope stability conditions.

Over-excavation of these deposits to a depth of 1m and capping with engineered filling is a prudent remediation measure. Essentially all of the residual weathered deposits encountered in our investigations across the cut areas would be suitable for use as the engineered capping fill for this purpose. The anticipated extents of the cuts requiring capping have been highlighted on drawing 7.

7.5.8 Temporary Sediment Retention Ponds

Temporary sediment retention ponds may be required to store stormwater for significant periods (several months to years) and therefore their construction should be subject to design and observation input from the geotechnical engineer. As a minimum, the following input is recommended from the project geotechnical engineer:

- Advise on pond locations with respect to land stability and seepage potential;
- Structural design of pond fill embankments including key and compaction specification;
- Observe embankment subgrade conditions and advise on undercut requirements;
- Earthfill QA / QC testing of all embankment materials to ensure compliance with specification.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

7.5.9 Temporary Cuts

During the development of earthworks temporary cuts bay be required. With all over steepened temporary excavations there is a risk of batter collapse. The contractor needs to consider the extent of the excavation that is to be left unsupported for any length of time to mitigate the risk. This will vary with ground conditions and weather. Where cut faces exceed 1.5m, benching and appropriate batter angles are required. Temporary cuts that are susceptible to surface what flows will require diversions or bunds to prevent erosion.

7.5.10 Quality Control

The stripping of existing topsoil, cutting of pre-existing fill materials and undercutting of organic soils, where required from across the site as well as the gully areas must be subject to observation by the project geotechnical engineer to ensure that all unsuitable materials have been removed.

The source and / or type of material used for engineered fill will dictate the type of quality control testing undertaken.

For granular (sand and gravel) fill materials, testing following compaction should be principally in terms of the maximum dry density within the appropriate water content range, which may be calibrated with a dynamic cone (Scala) penetrometer test that is then used as the primary testing measure. Where the source or quality of fill changes, re-calibration will be required.

Where silts and clays are used as filling, alternative test criteria using vane shear strength and air voids should be used. The recommended specification for the proposed development is presented in Table below:

Table 9: Summary of Earthfill Testing Requirements

Fill Type	Test Method	Frequency*	Compliance Criteria
Granular	Maximum Dry Density Scala Penetrometer	New material type 1 x 1m test / 1000m^3	95% MDD 4 blows per 100mm
Cohesive	Vane Shear Strength Air voids	5 tests / 1000m^3 1 test / 1000m^3	Min. average 140kPa over 10 tests, min. single value 110kPa Max. average 10% over 10 tests, max. single value 12%

Note*: testing frequency may vary at the discretion of the geotechnical engineer, which may include small and / or deep isolated fill areas.

The source of the fill should be discussed with and approved by the project geotechnical engineer to verify its appropriateness and quality control testing requirements.

7.6 Civil Works

7.6.1 Subgrade CBR

The subdivision roading is shown as being constructed in a combination of both cut and fill areas, although given the requirement to over-excavate exposed rock deposits, the vast majority will be formed in engineered fills. Typical CBR values of between 5% and 6% should be available in fills. In areas of cut natural ground, CBR values as low as 2% or 3% are likely.

As described for the fills, subgrade improvement with lime (if desired) is expected to provide better results than the use of cement due to the clayey nature of the soils.

7.6.2 Service Trenches

All of the materials to be exposed during the excavation of service trenches should be readily removed using an excavator.

Trench collapse is expected to pose problems in areas wherever the weathered transition zone soils are exposed in excavations / excavations extend below the water table in some locations at 1.0m depth and here, trench support is likely to be required. Temporary dewatering, in the form of regularly spaced sump pumps or well point dewatering spears may also be required.

Services trenches excavated along contour in areas of steep ground may need to be backfilled with engineered filling and if in natural ground, may require a drain coil in the base of the trench connected to the stormwater system. Identification of critical service lines must be made once drawings are available.

At the completion of the development, Specific Design Zones for services will be applied in the Geotechnical Completion Report to protect future foundations from settlement from poorly compacted trench backfill and to prevent new loads crushing service pipes. This is a restriction on building foundations within the 45 degree zone of influence from pipe inverts as depicted in Auckland Council's drawing SW22 from their Code of Practice for Land Development and Subdivision.

7.6.3 Retaining Walls

Design parameters for permanent and temporary retaining walls are summarised in Table 10 below.

Table 10: Summary of Geotechnical Design Parameters

Geological Unit	Unit Weight γ (kN/m^3)	Su (kPa)	c' (kPa)	φ' (deg)	E' (MPa)
Engineered Fill	18	100	5	30	30
Residual Soils	18	80	5	26	20
Transitional Northland Allochthon	18	20	0	20	40

Note: γ – soil unit weight; Su – undrained shear strength; c' – cohesion; φ' - angle of internal soil friction; E' – long term Young's modulus,

At the completion of the development, **Specific Design Zones (retaining)** are expected to be applied in the Geotechnical Completion Report to protect retaining walls from future overloading at the crest or undermining at the toe that could lead to instability. These zones typically extend 1.5x distance of the wall height and where they are present above a wall, require deepening of foundations unless the wall has been designed for future foundation loads. Where they are present below a wall, careful consideration needs to be given to location, depth and timing of any future excavations.

Appropriate allowance in the design should be made for any applicable surcharges or slopes above or below the walls, including those in the Auckland Council Practice Note AC2231.

All retaining walls must be backfilled with free draining aggregate, protected from clogging due to fines migration from the soil by a suitable geotextile filter fabric, with perforated subsoil drainage pipe at the toe, out-letting to a suitable point.

With all over steepened temporary batters there is a risk of batter collapse until the wall is fully constructed. The contractor needs to consider the extent of batter left unsupported for any length of time to mitigate this risk. This will vary with ground conditions and weather. Where battering is undertaken more than a few days in advance of wall construction the batter faces must be covered with polythene to prevent them drying out and cracking, especially where expansive clay soils are present. Similarly, during periods of wet weather the batter face should be protected with polythene, and surface water directed away from the crest and toe of the batter.

It is noted that some ground movement will occur behind temporary or permanent retaining walls. By definition, movement of the wall must occur to fully mobilise the active and passive earth pressure coefficients provided in Table * above. The extent of this movement is dependent on the height of retaining, type of wall selected and construction methodology. This must be considered during the design and construction of the retaining walls to ensure adjacent facilities are not adversely affected.

The locations, heights and detailed designs of these will should be reviewed by the Geotechnical Engineer.

7.6.4 Stormwater Soakage

All of the soils at this site are clayey in nature and have very low coefficients of permeability. Accordingly, rain gardens / attenuation ponds are not expected to provide any significant ground soakage function.

Where the less weathered rockmass are exposed in the deeper cuts near design subgrade level, significantly higher permeabilities will be available. However, the addition of concentrated water into these deposits is highly undesirable from a slope stability perspective and is not recommended.

The use of rain gardens for storage capacity and water quality improvement is understood not to be a requirement for this development. If rain gardens are to be used, designs must be reviewed by the geotechnical engineer to ensure that the details are appropriate for each location.

8 FOUNDATIONS

At the completion of the works, a Geotechnical Completion Report (GCR) will be prepared. The GCR will advise on anticipated foundation design parameters and any restrictions that require further engineering investigation and/ or design on individual lots to address any remaining natural hazards as described in Section 71(3) of the Building Act, i.e. erosion, falling debris, subsidence, slippage, and inundation. The certification for residential lots is based on compliance with the “good ground” definition of NZS 3604 at finished ground levels.

Restrictions that are expected to be applied in the GCR to protect the future buildings from natural hazards associated with steep slopes, retaining walls, MSE walls, palisade walls and drainage are outlined in the respective sections in this report.

On this site our provisional expectation is that provided earthworks are completed in accordance with the standards and recommendations described herein, the following will apply:

- A preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 2.5m in plan.

  There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing.

- On this basis of our visual tactile assessment and expansive soil testing from Stages 1 and 2 of the development, we also expect the AS2870 Site Class for Stages 3 and 4 of the development to be either M (moderate) with an anticipated characteristic surface movement up to 40mm or H1 (high) with an anticipated characteristic surface movement up to 60mm. Foundation design may be selected in

accordance with NZS 3604 / appropriate solutions for this Class from AS2870 or may be undertaken by specific engineering design.

- As required by section B1/VM4[18] of the New Zealand Building Code Handbook, a strength reduction factor of 0.5 and 0.8 must be applied to all recommended geotechnical ultimate soil capacities in conjunction with their use in factored design load cases for static and earthquake overload conditions respectively.

9 SAFETY IN DESIGN

The design landform requires site excavations that includes geotechnical works such as undercuts, temporary excavations, steep fill batters, shear key excavations, deep and shallow subsoil drains as specified in this Geotechnical report and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

Our SiD risk assessment is presented in Appendix G. This risk assessment must be communicated with all affected parties involved with the project and dealt with through specific on-site risk assessment plans.

10 FURTHER WORK

This report has been undertaken to assess the proposed development plans provided. Should development proposals change, further site investigation, analyses and reporting will be required.

During construction of the proposed earthworks and civil works, appropriate site inspections such as site stripping, earth fill compaction testing, installation of subsoil drainage, shear key excavations, construction of MSE wall, palisade wall, retaining walls and backfilling of service trenches will need to be undertaken by a qualified Geotechnical Engineered who is familiar with the contents of this report.

As detailed within ***Section 7.3.1*** and ***Section 7.3.3*** above, detailed design of the MSE wall/s, palisade wall/s, retaining walls and shear piles is required.

[18] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/VM4, Amendment 19

USE OF THIS REPORT

Site subsurface conditions cause more construction problems than any other factor and therefore are generally the largest technical risk to a project. These notes have been prepared to help you understand the limitations of your geotechnical report.

Your geotechnical report is based on project specific criteria

Your geotechnical report has been developed on the basis of our understanding of your project specific requirements and applies only to the site area investigated. Project requirements could include the general nature of the project; its size and configuration; the location of any structures on or around the site; and the presence of underground utilities. If there are any subsequent changes to your project you should seek geotechnical advice as to how such changes affect your report's recommendations. Your geotechnical report should not be applied to a different project given the inherent differences between projects and sites.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface investigation, the conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation of factual data

Site investigations identify actual subsurface conditions at points where samples are taken. Additional geotechnical information (e.g. literature and external data source review, laboratory testing on samples, etc) are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can exactly predict what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

Your report's recommendations require confirmation during construction

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site. A geotechnical designer, who is fully familiar with the background information, is able to assess whether the report's recommendations are valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. Read all geotechnical documents closely and do not hesitate to ask any questions you may have. To help avoid misinterpretations, retain the assistance of geotechnical professionals familiar with the contents of the geotechnical report to work with other project design professionals who need to take account of the contents of the report. Have the report implications explained to design professionals who need to take account of them, and then have the design plans and specifications produced reviewed by a competent Geotechnical Engineer.

Drawings

Drawing 01:	Site Investigation Plan
Drawing 02:	Geomorphology Plan
Drawing 03 to 06:	Geological Section A-A to G-G
Drawing 07:	Remediation Plan
Drawing 08:	Shear Key and Drainage Detail
Drawing 09:	Counterfort Drain Detail

LEGEND:

- HA16-20 HAND AUGER (HA) LOCATION (2020)
- MH07-20 MACHINE BOREHOLE LOCATION (2020)
- TP17-20 TEST PIT (TP) LOCATION (2020)
- HA06-16 HAND AUGER (HA) LOCATION (2016)
- MH02-16 MACHINE BOREHOLE LOCATION (2016)
- TP14-16 TEST PIT (TP) LOCATION (2016)
- HA01-21 HAND AUGER (HA) LOCATION (2021)
- MH01-21 MACHINE BOREHOLE LOCATION (2021)
- SITE BOUNDARY

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

1:2000 0 20 40 60 80 100 m

CMW Geosciences

CLIENT: BUILD RICH		DRAWN: HV	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: SP	DRAWING: 01
		REVISION: 1	SCALE: 1:2000
TITLE: SITE INVESTIGATION PLAN		DATE: 29/09/2021	SHEET: A3

P:\AKL\2020\AKL2020-0125 SILVERDALE SOUTH - STAGES 3 & 4\DRAWINGS\AKL2020-0125 SITE INVESTIGATION PLAN REVA.DWG

LEGEND:

- SITE BOUNDARY
- R — Ridge Spur
- B — Mid-slope Bench
- Head Scarp / Slope break
- Soil Creep
- Reeds / Swampy ground
- Debris lobe
- Hummocky ground
- (P) Pond
- Historic pond that has been filled in
- Water course

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

0 20 40 60 80 100 m
1:2000

CMW Geosciences

CLIENT: BUILD RICH		DRAWN: WPJ	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: JW	DRAWING: 02
		REVISION: A	SCALE: 1:2000
TITLE: GEOMORPHOLOGY PLAN		DATE: 07/07/2020	SHEET: A3

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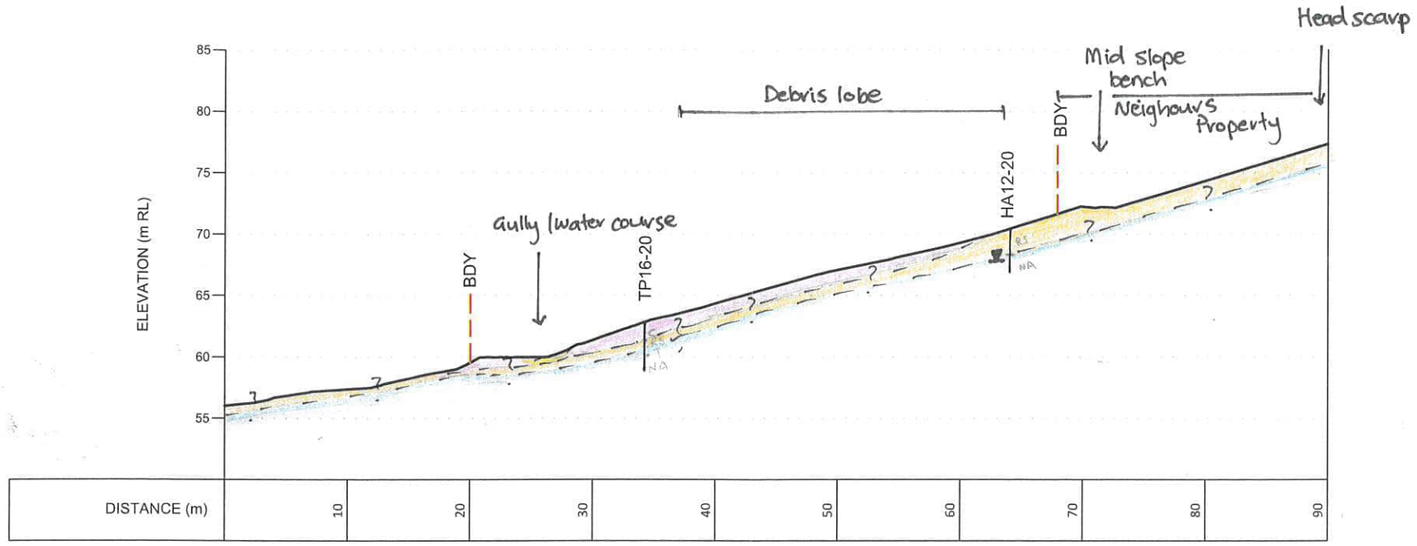

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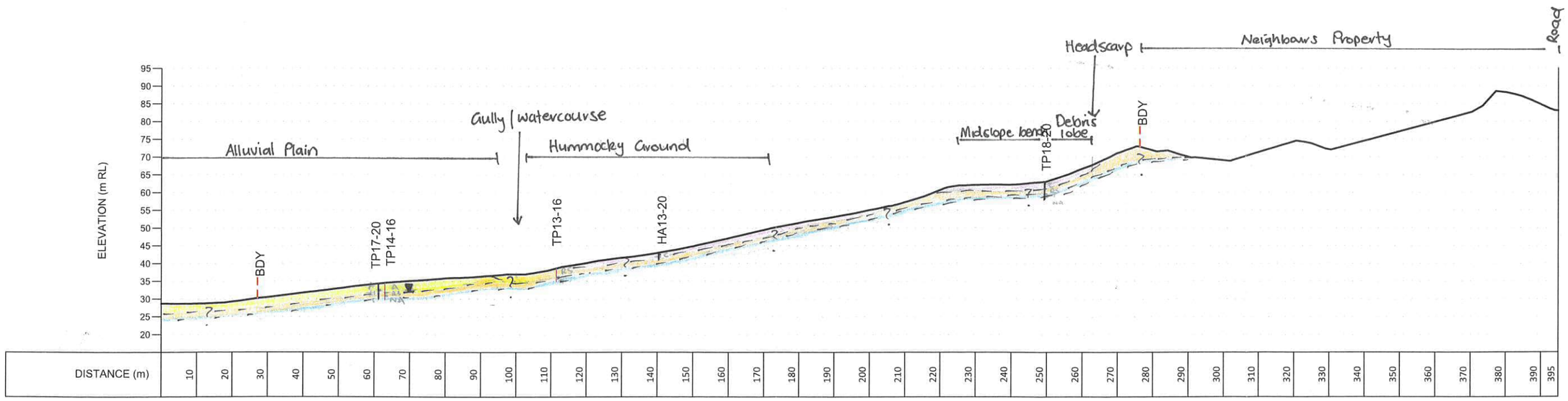

SECTION B
SCALE 1:1250

LEGEND:

EXISTING GROUND PROFILE

COLLUVIUM

ALLUVIUM

RESIDUAL NA

TRANSITIONAL NA

CW to HW NA

GROUND WATER

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

CMW Geosciences

CLIENT: BUILD RICH		DRAWN: WPJ	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: JW	DRAWING: 03
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TITLE: SECTION A & B		DATE: 10/07/2020	SHEET: A3

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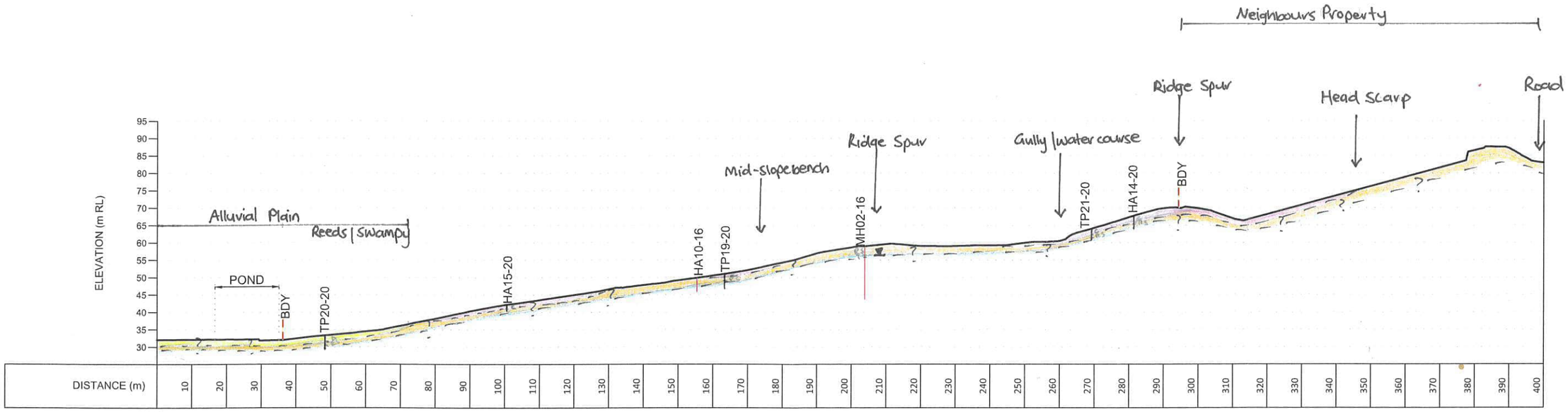

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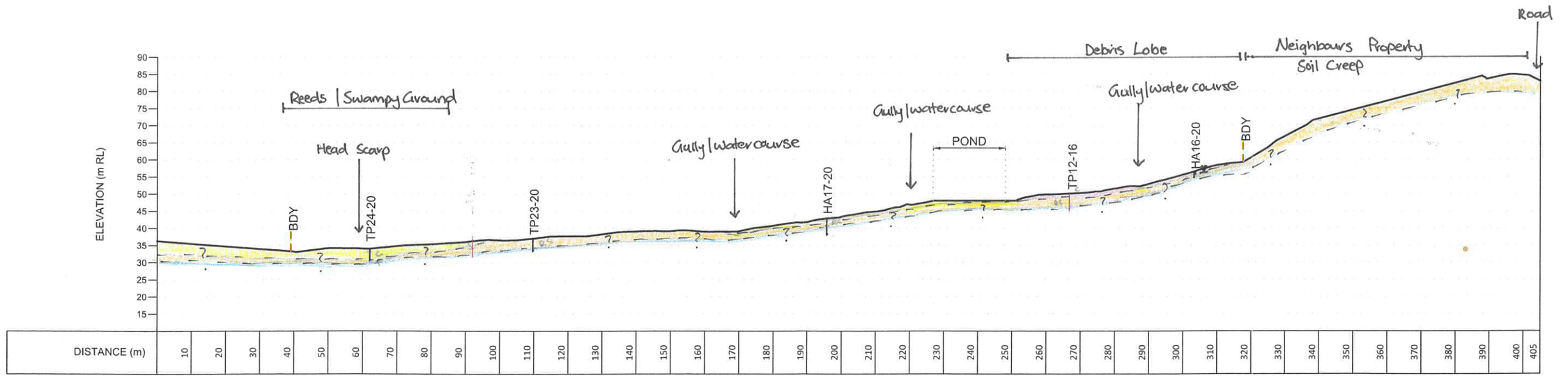

SECTION D
SCALE 1:1250

LEGEND:

EXISTING GROUND PROFILE

COLLUVIUM

ALLUVIUM

RESIDUAL NA

TRANSITIONAL NA

CW to HW NA

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

GROUND WATER

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH		DRAWN: WPJ	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: JW	DRAWING: 04
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TITLE: SECTION C & D		DATE: 10/07/2020	SHEET: A3

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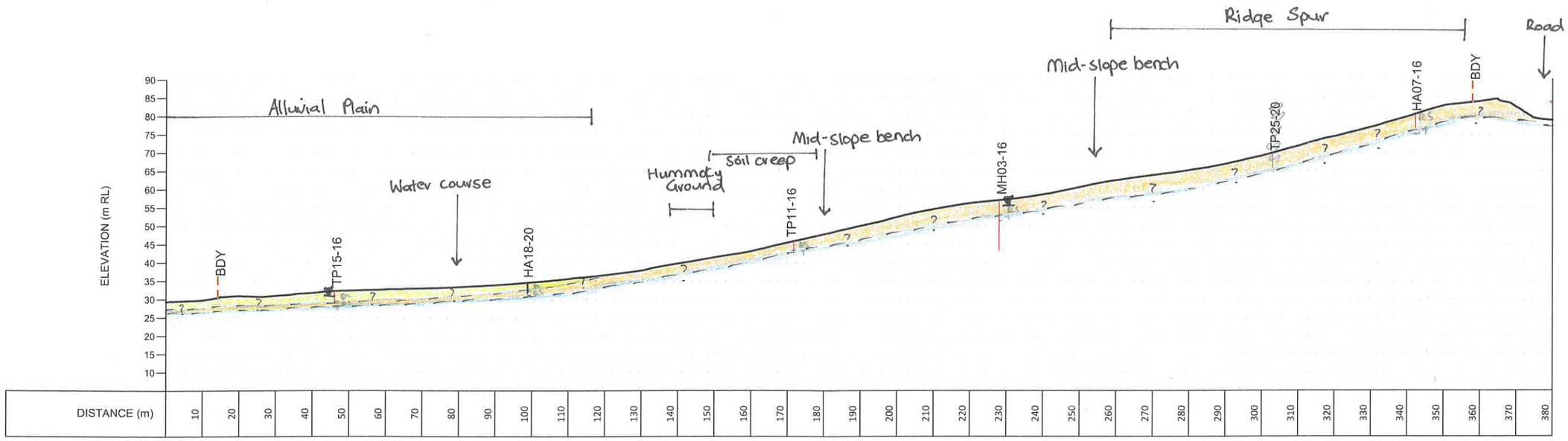
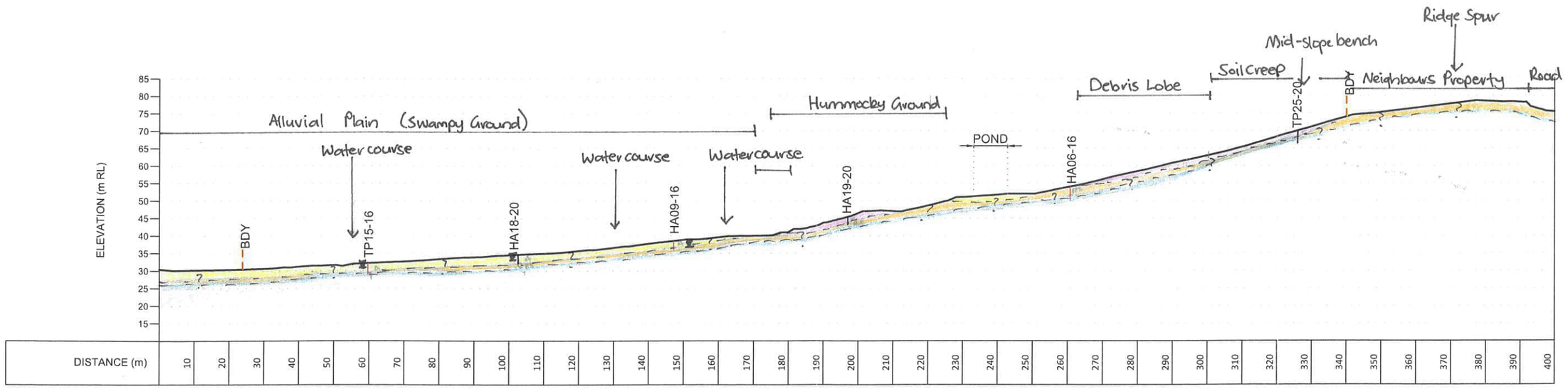


SECTION E

SCALE 1:1250



SECTION F

SCALE 1:1250

LEGEND:

EXISTING GROUND PROFILE

COLLUVIUM

ALLUVIUM

RESIDUAL NA

TRANSITIONAL NA

CW to HW NA

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

GROUND WATER

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH		DRAWN: WPJ	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: JW	DRAWING: 05
		REVISION: A	SCALE: 1:1250
TITLE: SECTION E & F		DATE: 10/07/2020	SHEET: A3

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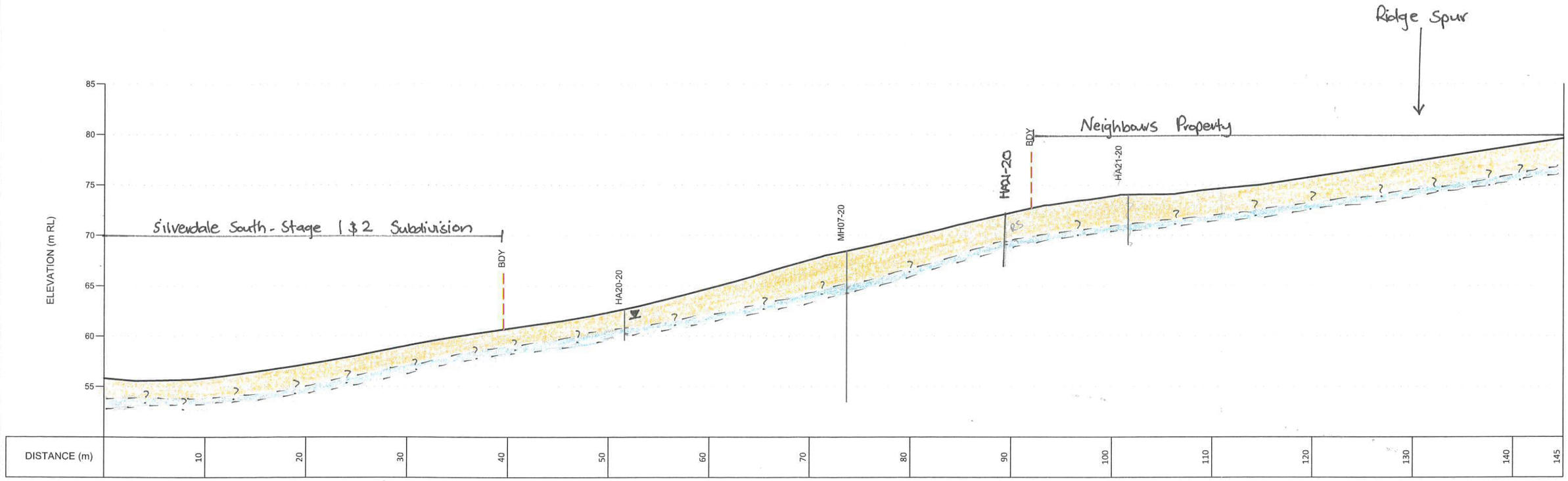

SECTION G

SCALE 1:400

LEGEND:

EXISTING GROUND PROFILE

RESIDUAL NA

TRANSITIONAL NA

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

CW to HW NA

GROUND WATER

1:400 0 4 8 12 16 20 m

CMW Geosciences

CLIENT: BUILD RICH		DRAWN: WPJ	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: JW	DRAWING: 06
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TITLE: SECTION G		DATE: 10/07/2020	SHEET: A3

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LEGEND:

- ANTICIPATED ROCK CUT AREA DRAINAGE
- UNDER FILL DRAINAGE
- SITE BOUNDARY
- UNDERCUT OF LOW STRENGTH SOILS
- SHEAR KEY-MINIMUM WIDTH OF BASE 5m - MAXIMUM DEPTH 6M BELOW EXISTING GROUND LEVEL
- FUTURE REMEDIATION - INGROUND SHEAR PILES
- FUTURE REMEDIATION - PALISADE WALL
- COUNTERFORT DRAINAGE

NOTES:

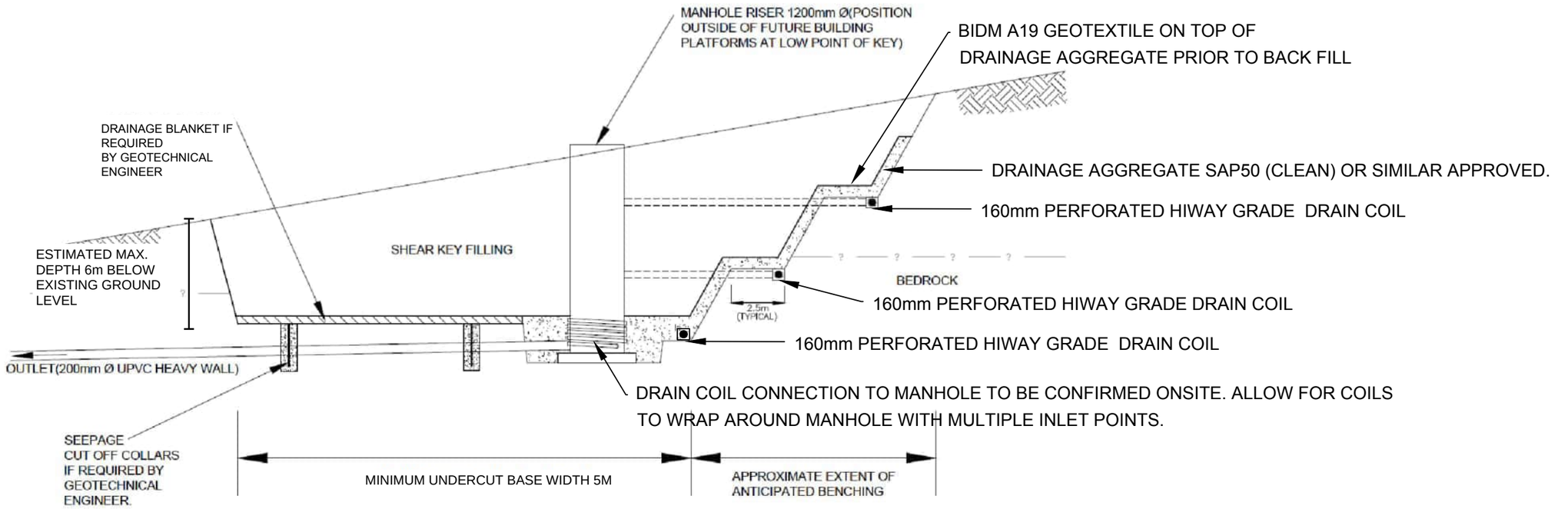
1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

1:2000 0 20 40 60 80 100 m

CMW Geosciences

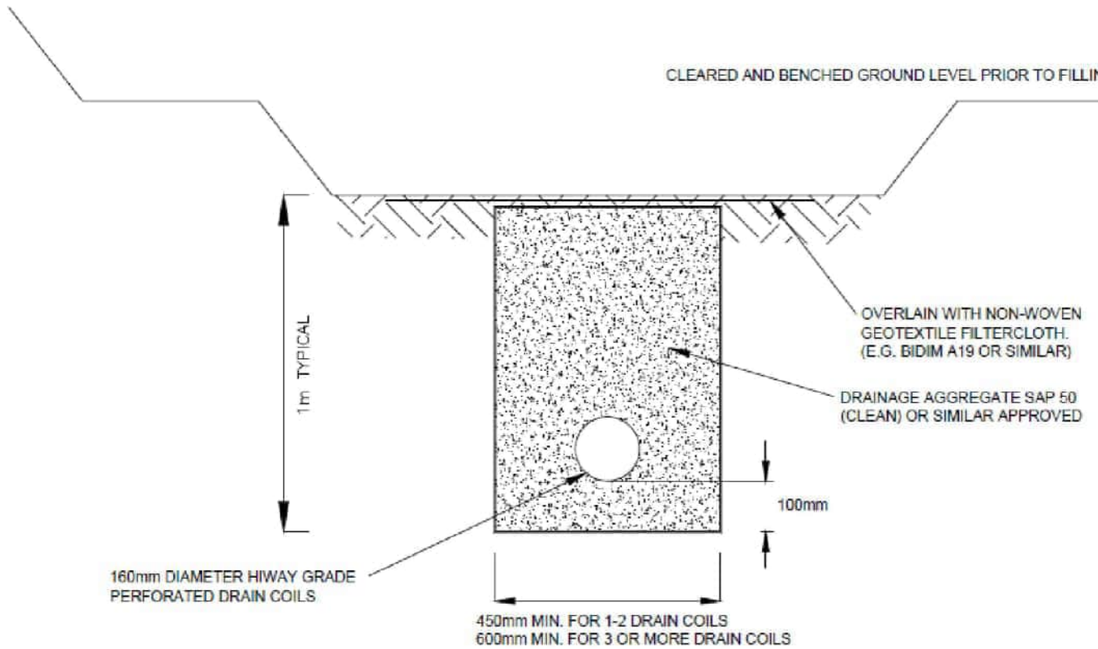
CLIENT: BUILD RICH		DRAWN: HV	PROJECT No: AKL2020-0125
PROJECT: STAGE 3 & 4, SILVERDALE SOUTH		CHECKED: SP	DRAWING: 07
		REVISION: 1	SCALE: 1:2000
TITLE: REMEDIATION PLAN		DATE: 29/09/2021	SHEET: A3

P:\AKL\2020\AKL2020-0125 SILVERDALE SOUTH - STAGES 3 & 4\DRAWINGS\AKL2020-0125 SITE INVESTIGATION PLAN REVA.DWG



TYPICAL DETAIL #2: SHEAR KEY CROSS SECTION

NOT TO SCALE



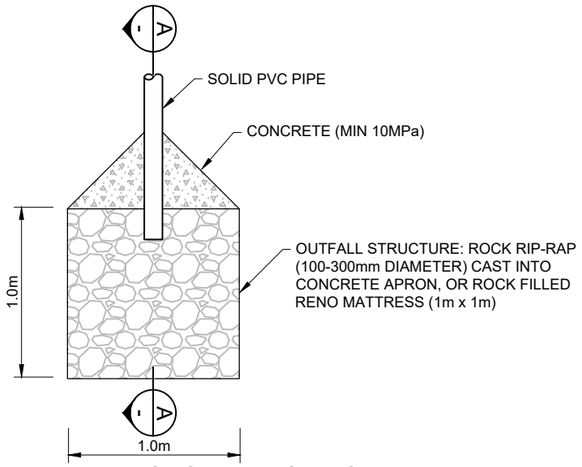
TYPICAL DETAIL #5: UNDERFILL DRAIN

BASE PLAN REFERENCE:

CMW Geosciences (NZ) Ltd
Chapman Morton Woodward

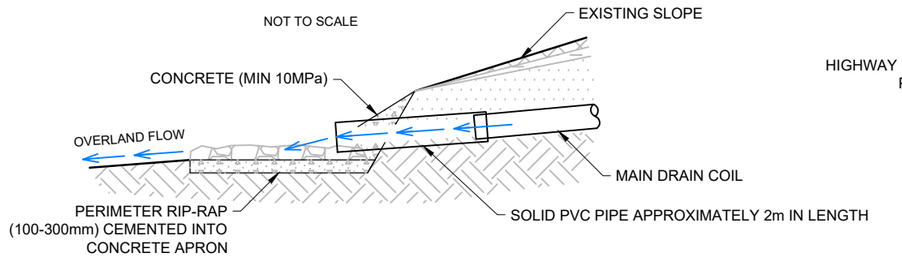
CLIENT: BUILD RICH		DRAWN: SP	PROJECT: AKL2020-0125
PROJECT: SILVERDALE SOUTH - STAGE 3 & 4		CHECKED: RK	FIGURE: Drawing: 08
		REVISION: 0	SCALE: NTS
TITLE: SHEAR KEY AND UNDERFILL DRAINAGE DETAIL		DATE: 29/04/2021	SHEET: A3

X:\04 SOFTWARE\CAD_CMW STANDARD DETAILS\SHEAR KEY.DWG

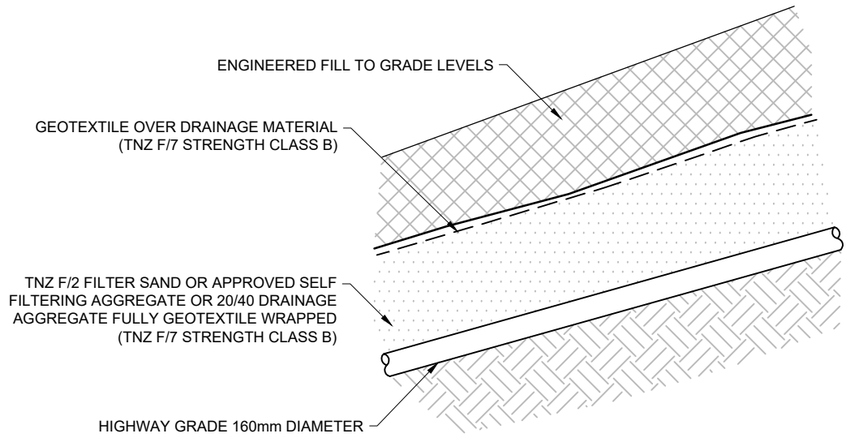


DETAIL A - PLAN A OF OUTFALL STRUCTURE

NOT TO SCALE

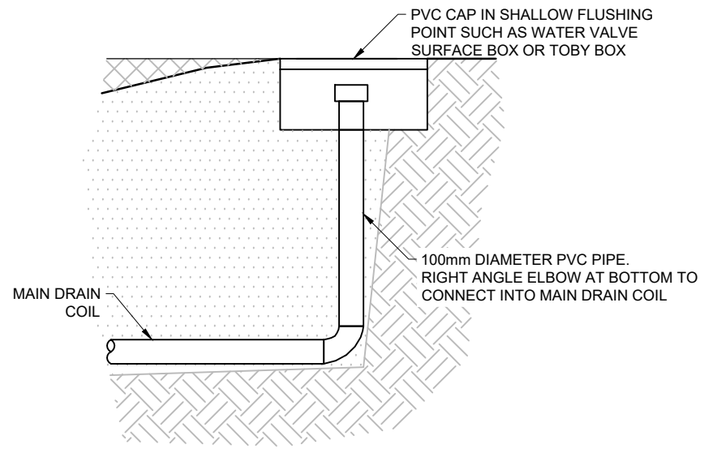


DETAIL B - OUTFALL STRUCTURE CROSS SECTION



DETAIL C - COUNTERFORT DRAIN

NOT TO SCALE

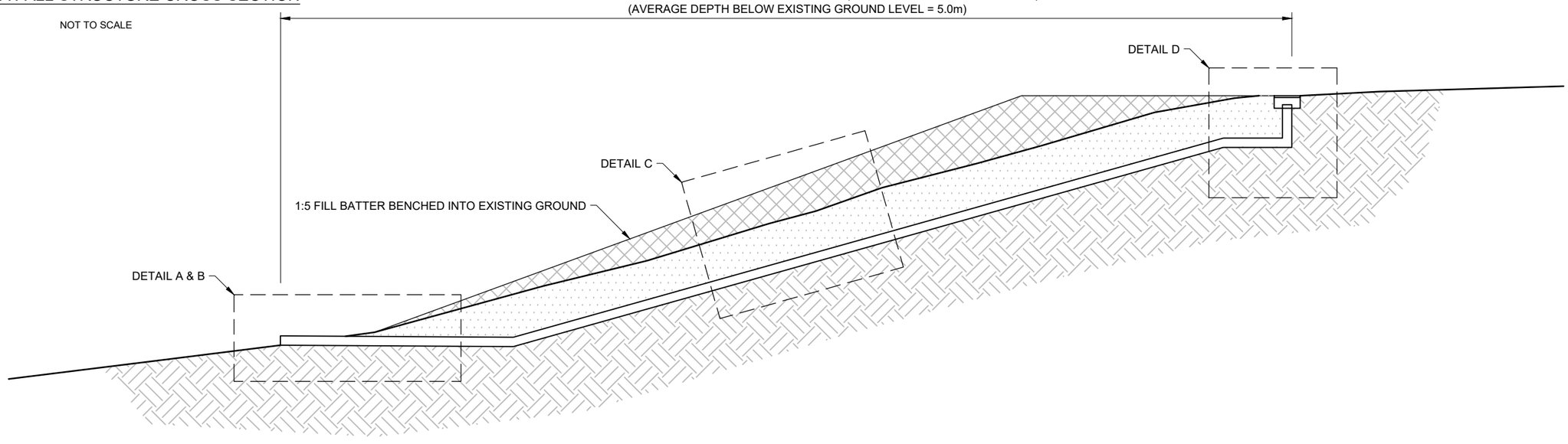


DETAIL D - FLUSHING PORT

NOT TO SCALE

APPROXIMATE EXTENT OF COUNTERFORT DRAIN = (VARIES - REFER TO DRAWING 07)
(AVERAGE DEPTH BELOW EXISTING GROUND LEVEL = 5.0m)

NOT TO SCALE



DETAIL E - COUNTERFORT DRAIN TYPICAL LONG SECTION

SCALE 1:50

ISSUED FOR TENDER
NOT TO BE USED FOR CONSTRUCTION

NOTE: ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE

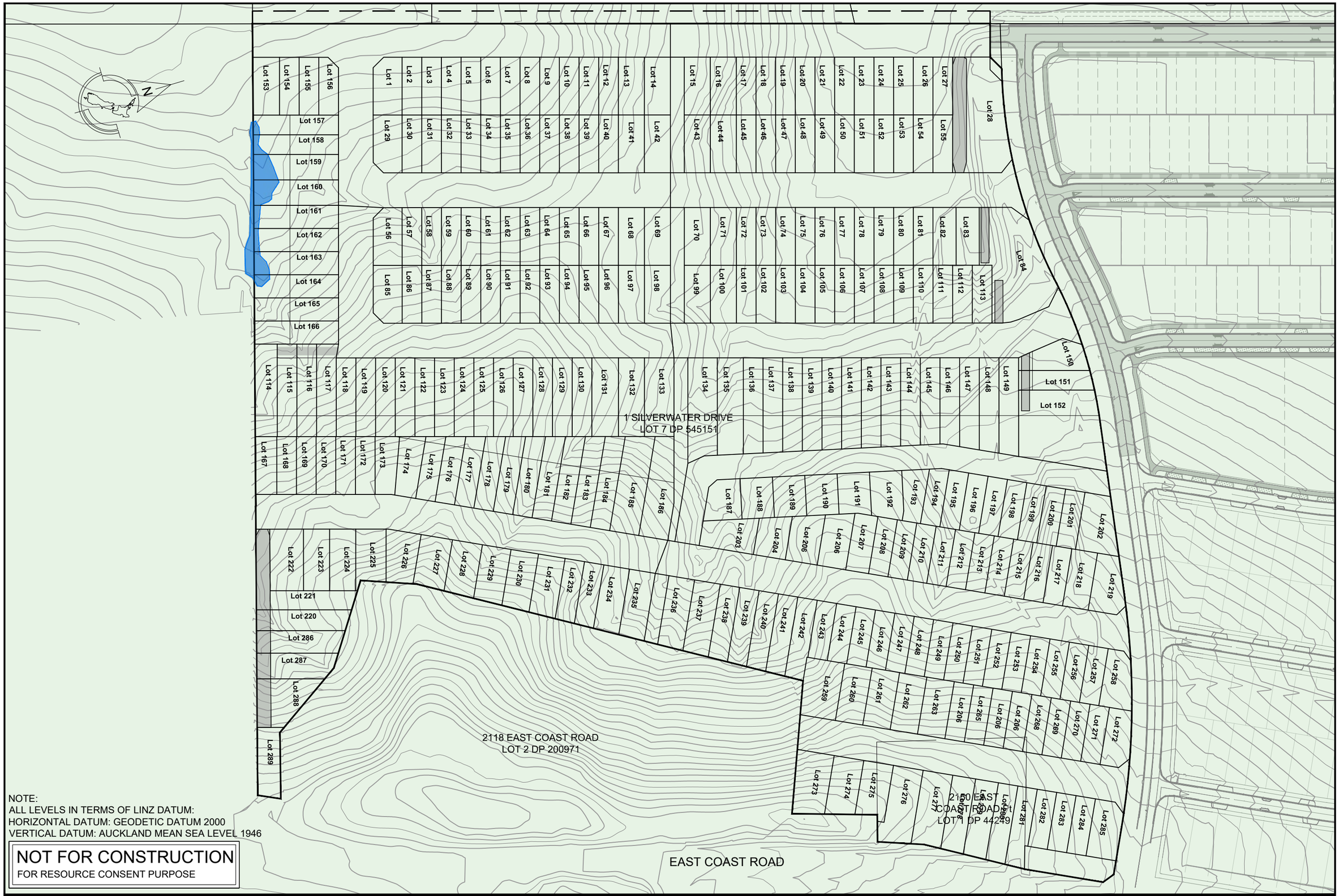
REV	DATE	DESCRIPTION	BY
A		ISSUED FOR COMMENT	
0		ISSUED FOR CONSTRUCTION	

CMW Geosciences

CLIENT: **BUILD RICH**	DRAWN:	PROJECT: AKL2020-0125
PROJECT: **STAGE 3 & 4, SILVERDALE SOUTH**	CHECKED: JW	DRAWING: 09
	REVISION: 0	SCALE: NTS
TITLE: **COUNTERFORT DRAIN DETAIL**	DATE: 10/07/2020	SHEET: A3 L

X:\01 PROJECTS\HAM\HAM2016\HAM2016_0001 TO 0050\HAM2016_0022 RANGITAHI PENINSULA\07 DRAWINGS\WORKING\COUNTERFORT DRAIN DETAIL TEMPLATE R2 02102019.DWG

Appendix A: Aspire Consulting Engineers Development Plans



NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

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					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

CLIENT
BUILD RICH LIMITED

Conditions of Use:
These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.

SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
EXISTING SITE PLAN

DRAWING NUMBER
1628 - RC - PG103

DATE
DEC 2021

REVISION
-

ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspeng.co.nz

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3	NAME	DATE
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					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

CLIENT
BUILD RICH LIMITED

Conditions of Use:
These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.

SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED DEVELOPMENT OVERVIEW PLAN

DRAWING NUMBER
1628 - RC - PG104

DATE
DEC 2021

REVISION
-

ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspeng.co.nz

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3	NAME	DATE
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					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

CLIENT
BUILD RICH LIMITED

Conditions of Use:
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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

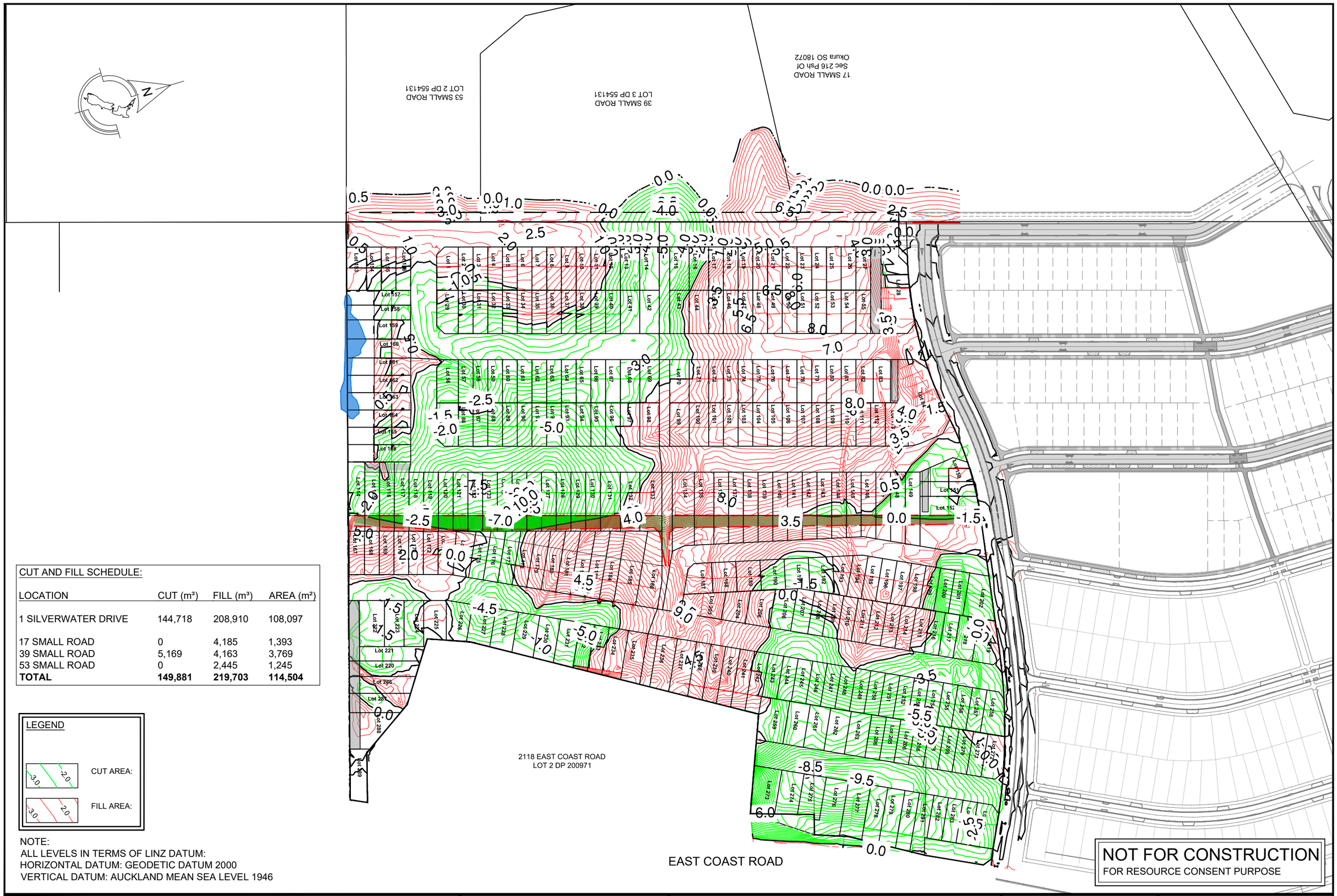
DRAWING TITLE
PROPOSED OVERALL CONTOUR PLAN

DRAWING NUMBER
1628 - RC - EW201

DATE
DEC 2021

REVISION
-

ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspeng.co.nz



CUT AND FILL SCHEDULE:

LOCATION	CUT (m³)	FILL (m³)	AREA (m²)
1 SILVERWATER DRIVE	144,718	208,910	108,097
17 SMALL ROAD	0	4,185	1,393
39 SMALL ROAD	5,169	4,163	3,769
53 SMALL ROAD	0	2,445	1,245
TOTAL	**149,881**	**219,703**	**114,504**

LEGEND

CUT AREA:

FILL AREA:

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:2000 AT A3	NAME	DATE
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					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

CLIENT
BUILD RICH LIMITED

Conditions of Use:
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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED OVERALL CUT AND FILL CONTOUR PLAN

DRAWING NUMBER
1628 - RC - EW202

DATE
DEC 2021

REVISION
-

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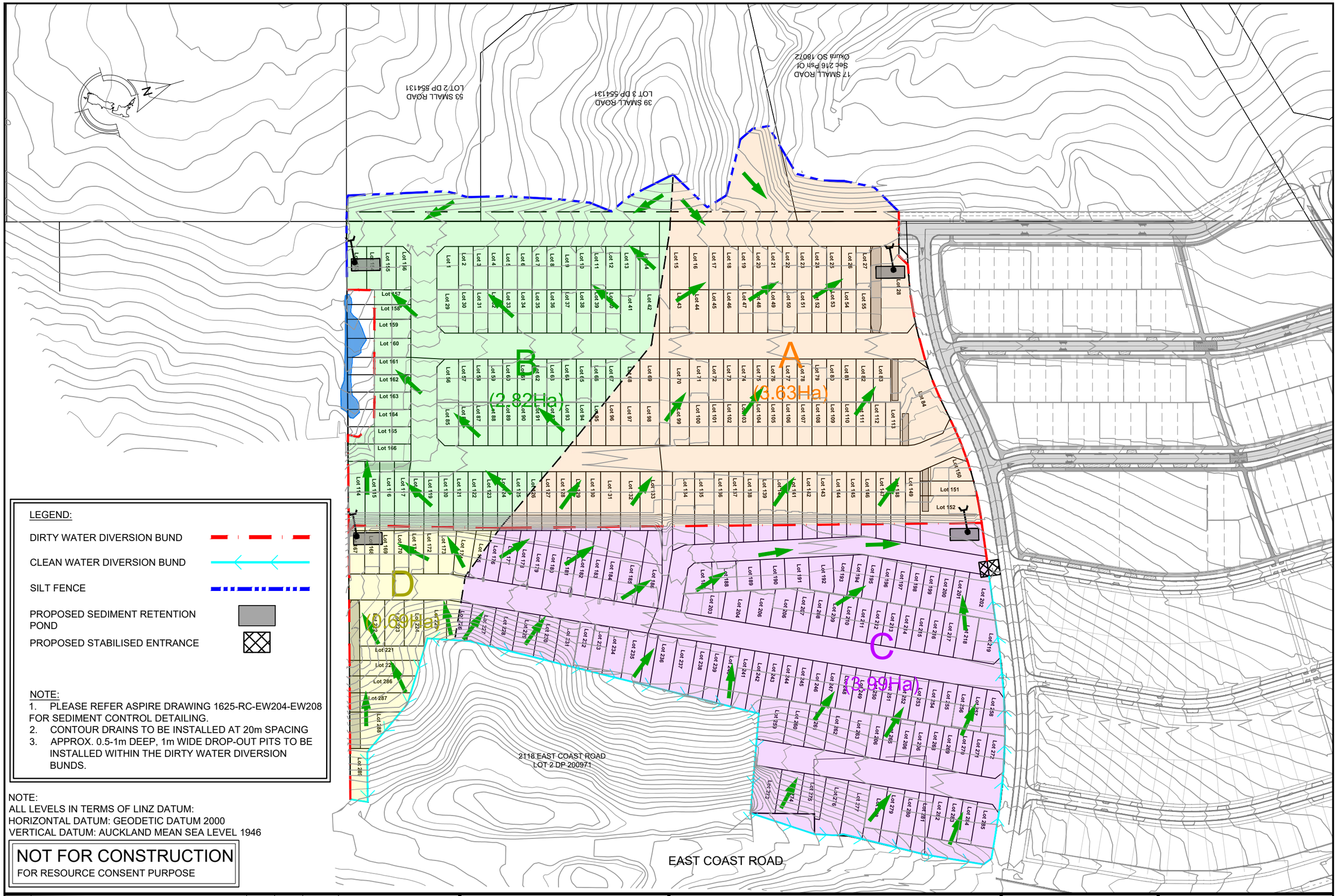

LEGEND:

- DIRTY WATER DIVERSION BUND
- CLEAN WATER DIVERSION BUND
- SILT FENCE
- PROPOSED SEDIMENT RETENTION POND
- PROPOSED STABILISED ENTRANCE

NOTE:

1. PLEASE REFER ASPIRE DRAWING 1625-RC-EW204-EW208 FOR SEDIMENT CONTROL DETAILING.
2. CONTOUR DRAINS TO BE INSTALLED AT 20m SPACING
3. APPROX. 0.5-1m DEEP, 1m WIDE DROP-OUT PITS TO BE INSTALLED WITHIN THE DIRTY WATER DIVERSION BUNDS.

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:2000 AT A3

	NAME	DATE
DESIGN	JH	12.21
DRAWN	JH	12.21
DRAWING CHECK	PF	12.21
DESIGN CHECK	PF	12.21
APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EROSION AND SEDIMENT CONTROL PLAN

DRAWING NUMBER
1628 - RC - EW203

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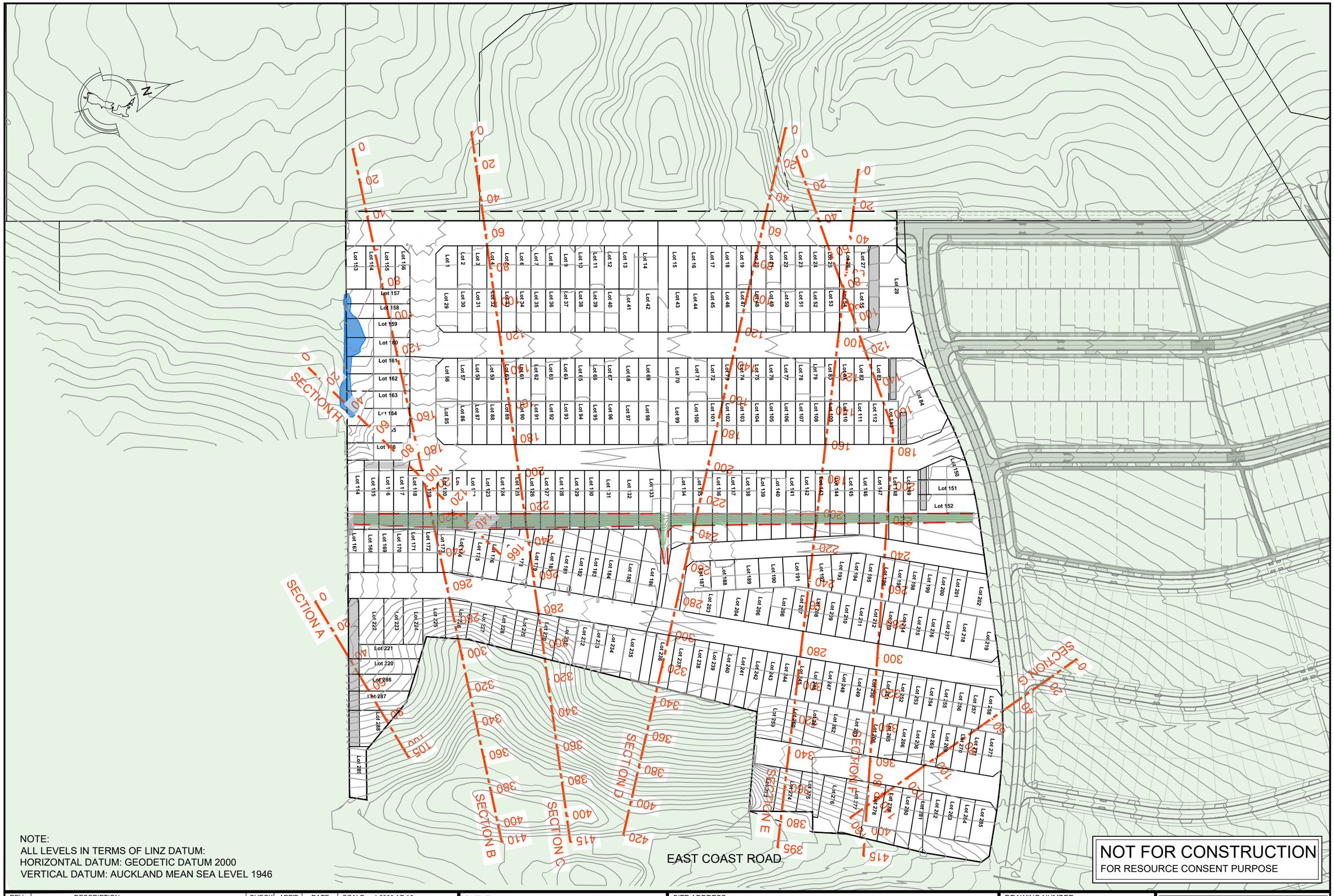

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:2000 AT A3	NAME	DATE
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					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTIONS PLAN

DRAWING NUMBER
1628 - RC - EW211

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DEC 2021

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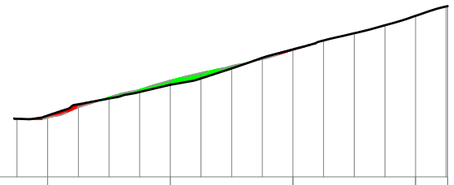
CUT

FILL

VERT EXAG 1:1
Datum 50.000



DESIGN LEVELS		59.99	64.99	70.77	76.24	77.83
EXISTING LEVELS		59.64	65.72	70.65	76.24	77.83
DEPTH		0.35	-0.73	0.13	0.00	0.00
CHAINAGE	0	20	40	60	80	100	105

EARTHWORKS SECTION A

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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1000 AT A3	NAME	DATE
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION A

DRAWING NUMBER
1628 - RC - EW212

DATE
DEC 2021

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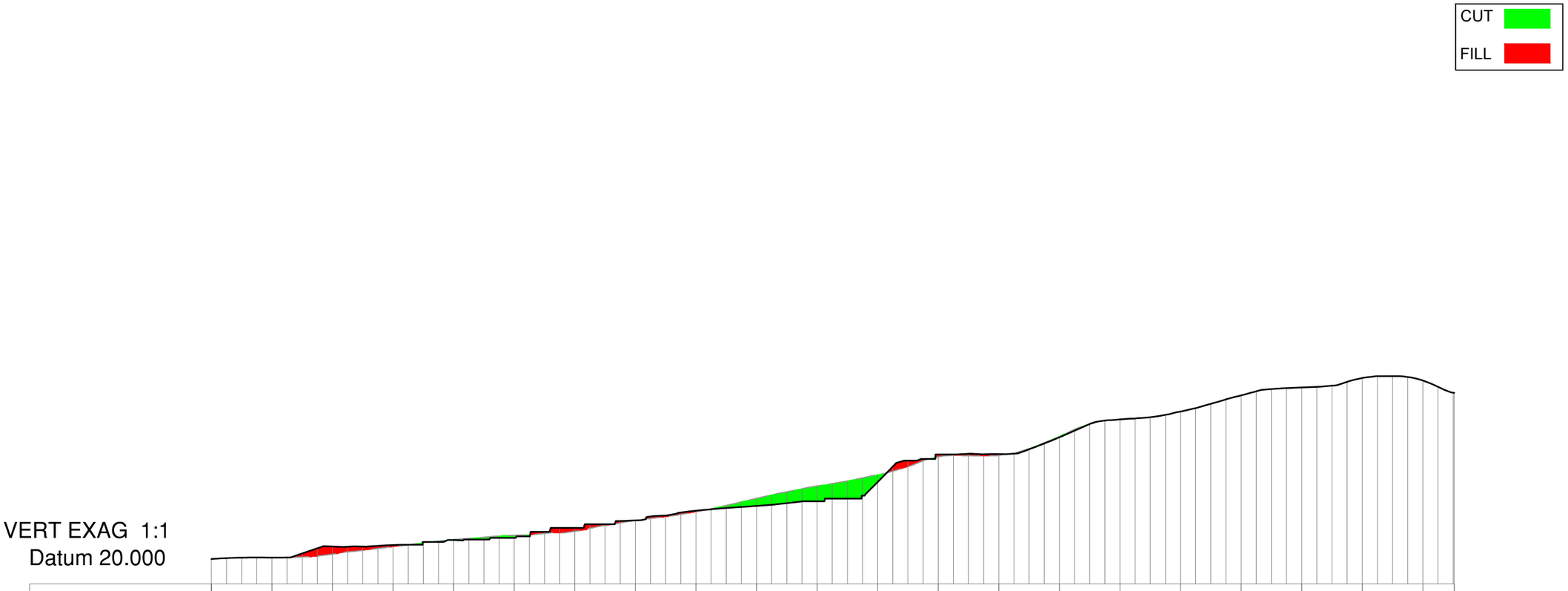

DESIGN LEVELS	28.21	28.67	32.32	32.81	34.46	35.15	38.45	40.92	44.13	45.71	47.21	53.58	62.68	62.82	68.35	74.25	76.83	82.16	84.76	87.91	87.05	83.00
EXISTING LEVELS	28.21	28.67	29.78	32.25	34.62	36.02	37.31	40.94	43.78	48.20	52.28	55.99	61.86	62.40	68.51	74.25	76.83	82.16	84.76	87.91	87.05	83.00
DEPTH	0.00	0.00	2.54	0.55	-0.16	-0.87	1.14	-0.01	0.35	-2.49	-5.07	-2.41	0.82	0.42	-0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	410

EARTHWORKS SECTION B

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3	NAME	DATE
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION B

DRAWING NUMBER
1628 - RC - EW213

DATE
DEC 2021

REVISION
-

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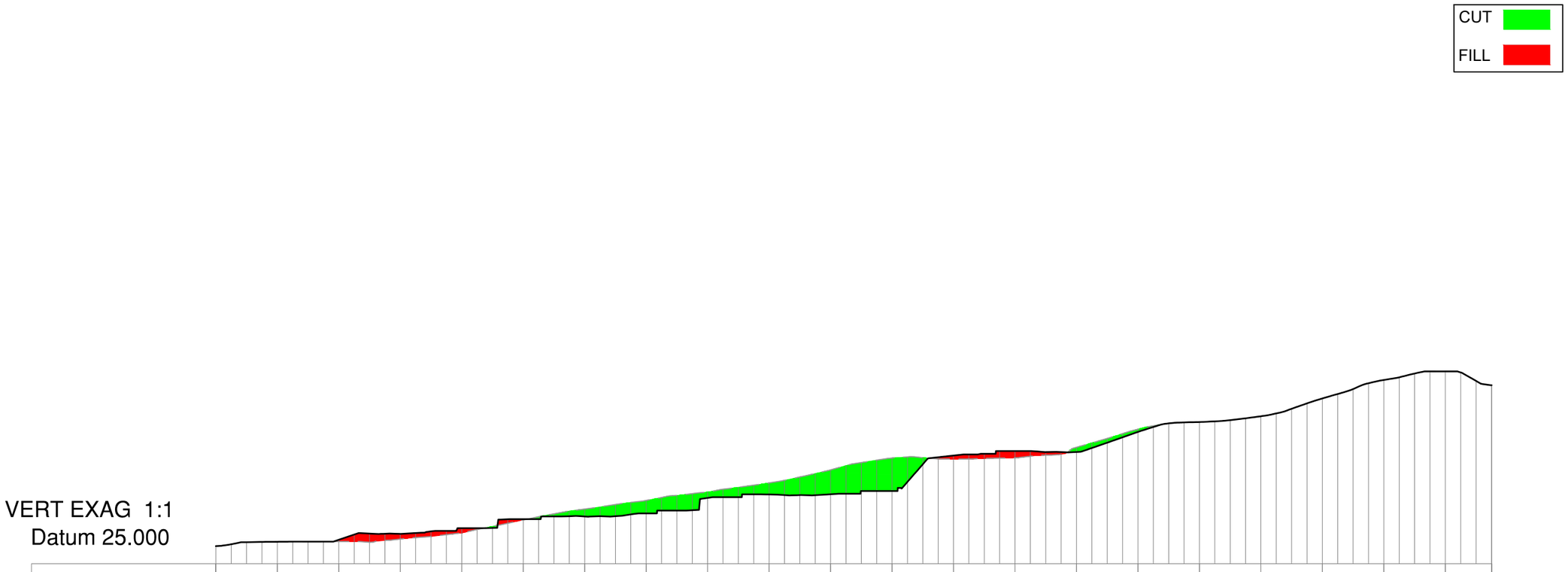

VERT EXAG 1:1
Datum 25.000

DESIGN LEVELS	30.70	32.13	32.79	34.70	36.56	39.48	40.36	41.37	46.40	47.50	47.57	48.63	60.14	61.61	61.30	67.83	71.03	72.92	78.70	84.71	87.50	83.00
EXISTING LEVELS	30.70	32.13	32.20	33.00	35.02	39.21	42.76	45.57	48.33	51.25	55.49	59.35	59.02	59.39	62.82	68.72	71.03	72.92	78.70	84.71	87.50	83.00
DEPTH	0.00	0.00	0.59	1.70	1.54	0.27	-2.40	-4.20	-1.93	-3.75	-7.92	-10.72	1.12	2.22	-1.52	-0.89	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	415

EARTHWORKS SECTION C

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:1500 AT A3

	NAME	DATE
DESIGN	JH	12.21
DRAWN	JH	12.21
DRAWING CHECK	PF	12.21
DESIGN CHECK	PF	12.21
APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION C

DRAWING NUMBER
1628 - RC - EW214

DATE
DEC 2021

REVISION
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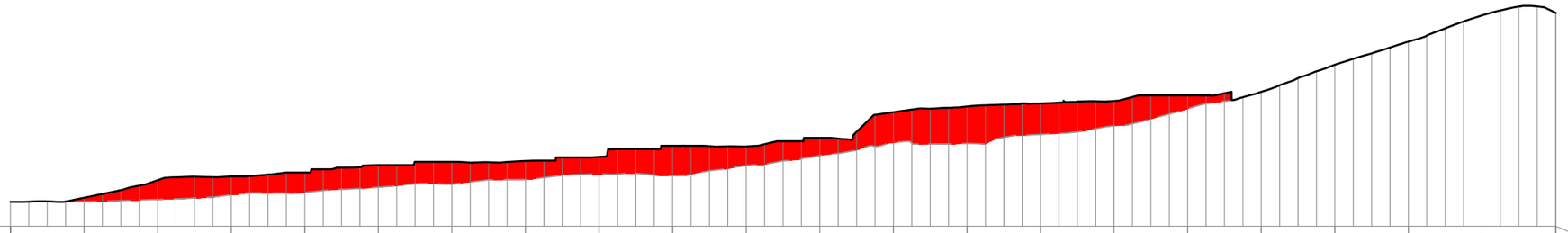
CUT

FILL



VERT EXAG 1:1
Datum 25.000

DESIGN LEVELS	31.63	32.74	37.51	38.56	39.60	41.64	42.53	42.76	43.85	46.89	46.68	49.02	56.00	57.54	58.39	59.05	60.55	61.53	68.88	75.16	82.29	83.00	82.96
EXISTING LEVELS	31.63	31.69	32.29	33.54	34.21	35.61	36.44	37.71	39.22	38.83	41.48	44.20	47.73	47.48	49.96	52.27	56.97	61.53	68.88	75.16	82.29	83.00	82.96
DEPTH	0.00	1.05	5.22	5.01	5.39	6.03	6.08	5.05	4.63	8.06	5.20	4.82	8.27	10.06	8.43	6.78	3.58	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	420

EARTHWORKS SECTION D

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3	NAME	DATE
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION D

DRAWING NUMBER
1628 - RC - EW215

DATE
DEC 2021

REVISION
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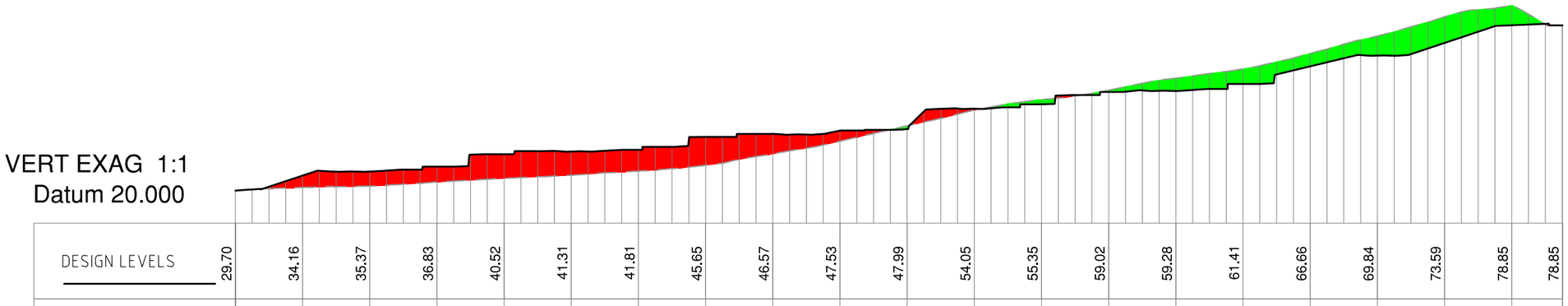
CUT

FILL



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Datum 20.000

DESIGN LEVELS	29.70	34.16	35.37	36.83	40.52	41.31	41.81	45.65	46.57	47.53	47.99	54.05	55.35	59.02	59.28	61.41	66.66	69.84	73.59	78.85	78.85
EXISTING LEVELS	29.70	30.64	31.04	32.25	33.35	34.26	35.52	37.24	40.63	44.38	48.97	53.63	56.78	59.56	63.13	65.90	70.49	75.66	81.41	84.65	78.85
DEPTH	0.00	3.52	4.33	4.58	7.18	7.06	6.30	8.42	5.94	3.15	-0.97	0.43	-1.42	-0.54	-3.85	-4.49	-3.83	-5.82	-7.82	-5.80	0.00
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	395

EARTHWORKS SECTION E

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:1500 AT A3

	NAME	DATE
DESIGN	JH	12.21
DRAWN	JH	12.21
DRAWING CHECK	PF	12.21
DESIGN CHECK	PF	12.21
APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION E

DRAWING NUMBER
1628 - RC - EW216

DATE
DEC 2021

REVISION
-

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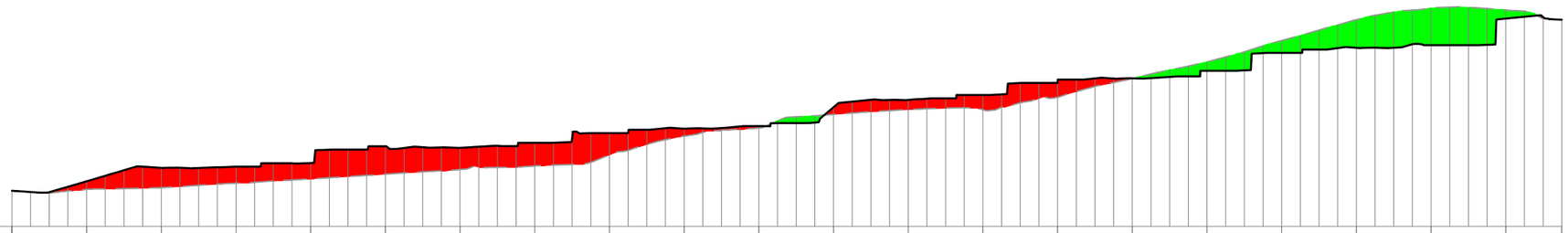
CUT

FILL



VERT EXAG 1:1
Datum 20.000

DESIGN LEVELS	29.52	32.05	35.65	35.97	36.93	41.42	41.01	42.35	44.94	46.13	46.83	51.85	53.82	55.14	58.74	59.61	61.62	66.40	67.77	68.48	75.59	75.31
EXISTING LEVELS	29.52	29.85	30.35	31.53	32.69	33.95	35.20	36.14	39.10	44.13	46.29	49.94	51.24	51.20	54.50	59.55	64.01	69.72	75.28	78.36	77.88	75.31
DEPTH	0.00	2.20	5.30	4.44	4.24	7.48	5.81	6.21	5.84	2.00	0.53	1.91	2.58	3.94	4.24	0.06	-2.39	-3.32	-7.51	-9.88	-2.29	0.00
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	415

EARTHWORKS SECTION F

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3	NAME	DATE
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION F

DRAWING NUMBER
1628 - RC - EW217

DATE
DEC 2021

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CUT

FILL

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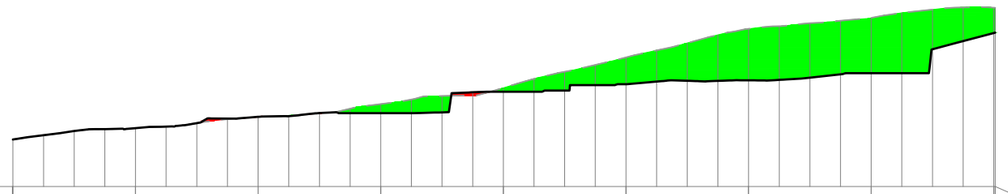
Datum 50.000



DESIGN LEVELS	57.67	59.53	61.37	61.97	65.46	66.70	67.32	68.48	75.04	75.10
EXISTING LEVELS	57.67	59.53	61.37	63.46	66.09	71.05	75.72	77.50	79.17	79.15
DEPTH	0.00	0.00	0.00	-1.49	-0.63	-4.35	-8.40	-9.02	-4.13	-4.06
CHAINAGE	0	20	40	60	80	100	120	140	160	160

EARTHWORKS SECTION G

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1000 AT A3	NAME	DATE
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION G

DRAWING NUMBER
1628 - RC - EW218

DATE
DEC 2021

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CUT

FILL

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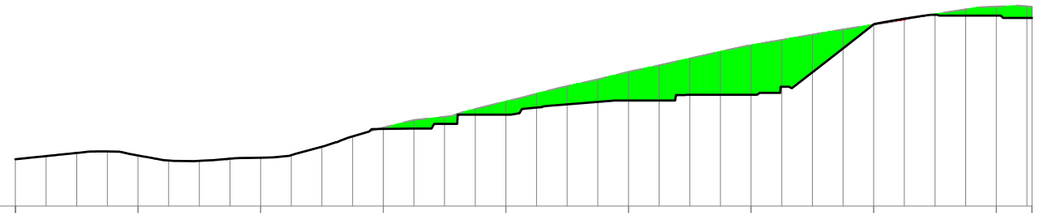
Datum 30.000



DESIGN LEVELS	37.64	38.25	37.89	42.58	44.90	47.21	48.15	59.63	61.05	60.68
EXISTING LEVELS	37.64	38.25	37.89	42.81	47.09	51.91	56.27	59.60	62.55	62.52
DEPTH	0.00	0.00	0.00	-0.23	-2.19	-4.70	-8.12	0.03	-1.50	-1.84
CHAINAGE	0	20	40	60	80	100	120	140	160	166

EARTHWORKS SECTION H

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1000 AT A3	NAME	DATE
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

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SITE ADDRESS
2182 EAST COAST ROAD
SILVERDALE (STAGE 3 & 4)

DRAWING TITLE
PROPOSED EARTHWORKS SECTION H

DRAWING NUMBER
1628 - RC - EW219

DATE
DEC 2021

REVISION
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Appendix B: Hand Auger Borehole, Test Pit and Machine Borehole Logs 2020 and 2021

HAND AUGER BOREHOLE LOG - HA12-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: TK Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391568.9mE; 827626.4mN Projection: Mount Eden Circuit 2000
Elevation: 70.49m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			70.5			TOPSOIL	W		
			70.3			CH: Silty CLAY with trace fine to medium sand: grey mottled orange, high plasticity. (Northland Allochthon)	M to W	VSt	
	0.4	Peak = 137kPa Residual = 67kPa							
	0.8	Peak = 123kPa Residual = 59kPa		1					
	1.2	Peak = 84kPa Residual = 48kPa						St	
	1.6	Peak = 103kPa Residual = 50kPa						VSt	
	2.0	Peak = 131kPa Residual = 45kPa		2		*... at 2.00m, ...becoming grey mottled orange.*			
			68.3			Completely weathered, dark grey, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)			
30-06-2020 09:06-2020	2.4	Peak = UTP							
	2.8	Peak = UTP						H	
				3					
	3.2	Peak = UTP							
	3.6	Peak = UTP				Borehole terminated at 3.6 m			20
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1195 DCP No: 04
Remarks: Groundwater encountered at 2.8m and rose to 2.6m at the end of drilling.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA13-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 391419.1mE; 827671.5mN Projection: Mount Eden Circuit 2000
Elevation: 43.00m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			43.0			TOPSOIL			
			42.8			CL: CLAY minor silt: light grey mottled yellowish orange, low plasticity. (Colluvium)			
	0.4	Peak = 165kPa Residual = 102kPa							
	0.8	Peak = 174kPa Residual = 84kPa					D	VSt	
				1					
			41.9			CL: CLAY: orange mottled light grey, low plasticity. (Colluvium)			
	1.2	Peak = 210kPa+							
			41.5			CL: CLAY: bluish grey, low plasticity. (RS Northland Allochthon)			
	1.6	Peak = 210kPa+							
						Borehole terminated at 1.7 m			6, 8, 18, 20
				2					
				3					
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1589 DCP No: 02
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA14-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: TK Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391538.8mE; 827716.4mN Projection: Mount Eden Circuit 2000
Elevation: 67.72m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			67.7			TOPSOIL	W		
			67.6			CH: Silty CLAY with trace fine to medium sand: mottled brown, orange and grey, high plasticity. (Alluvium)			
	0.4	Peak = > 196kPa							
	0.8	Peak = 115kPa Residual = 42kPa		1				VSt	
	1.2	Peak = > 196kPa							
			66.4			CL: Silty CLAY with trace fine to medium sand: brown mottled grey and orange, low plasticity. (Northland Allochthon)			
	1.6	Peak = UTP	66.1			Completely weathered, dark grey mottled greyish brown, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)			
	2.0	Peak = UTP		2			M		
	2.4	Peak = UTP							
	2.8	Peak = UTP						H	
				3					
	3.2	Peak = UTP							
	3.6	Peak = UTP							
							D to…		
	4.0	Peak = UTP		4		Borehole terminated at 4.0 m			10
									20
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1195 DCP No: 04
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA15-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 391375.4mE; 827774.9mN Projection: Mount Eden Circuit 2000
Elevation: 42.18m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			42.2			TOPSOIL			
			42.0			CL: CLAY with some silt: orange brown mottled grey, low plasticity. (Colluvium)			
	0.4	Peak = 150kPa Residual = 102kPa							
	0.8	Peak = 165kPa Residual = 105kPa					D	VSt	
				1					
			41.1			CL: CLAY with trace silt: light grey mottled orange, low plasticity. (Colluvium)			
	1.2	Peak = 189kPa Residual = 102kPa							
			40.9			CL: CLAY minor silt: light grey mottled yellowish orange, low plasticity. (RS Northland Allochthon)			
			40.7			Completely weathered MUDSTONE, dark grey mottled orange. Extremely weak. Weathered to silty CLAY, low plasticity. (Transitional Northland Allochthon)		H	
	1.6	Peak = UTP							
						Borehole terminated at 1.7 m			4
									8
									6
				2					15
									20
				3					
				4					
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1589 DCP No: 02
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA16-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: TK Checked by: JW Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 391579.4mE; 827791.1mN Projection: Mount Eden Circuit 2000
Elevation: 56.50m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
29-06-2020			56.5			TOPSOIL			
			56.4			CH: Silty CLAY with trace fine to medium sand: mottled brown, orange, grey, high plasticity. (Colluvium)	W to S		
	0.4	Peak = 126kPa Residual = 25kPa	56.1			CH: Silty CLAY with trace fine to medium sand: light grey mottled orange, high plasticity. (Northland Allochthon)			
	0.8	Peak = 137kPa Residual = 11kPa		1				VSt	
	1.2	Peak = 168kPa Residual = 20kPa					W		
	1.6	Peak = > 196kPa							
			54.7			Completely weathered, dark grey mottled orange, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)		H	
	2.0	Peak = UTP		2		Borehole terminated at 2.0 m			20
				3					
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1195 DCP No: 04
Remarks: Groundwater encountered at the surface.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA17-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: TK Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391490.2mE; 827838.1mN Projection: Mount Eden Circuit 2000
Elevation: 42.82m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			42.8			TOPSOIL			
			42.6			CH: Silty CLAY: mottled brown, orange, grey, high plasticity. (Alluvium)			
	0.4	Peak = 95kPa Residual = 53kPa						St	
			42.2			CH: Silty CLAY with trace fine to medium sand: light grey mottled orange, high plasticity. (Northland Allochthon)			
	0.8	Peak = 109kPa Residual = 39kPa		1					
	1.2	Peak = 151kPa Residual = 81kPa					W	VSt	
	1.6	Peak = > 196kPa				... at 1.80m, ...becoming grey mottled orange.			
	2.0	Peak = UTP		2					
			40.5			Completely weathered, dark grey mottled grey, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)			
	2.4	Peak = UTP							
	2.8	Peak = > 196kPa		3					
	3.2	Peak = UTP							
	3.6	Peak = UTP					M	H	
	4.0	Peak = UTP		4					
	4.4	Peak = UTP							
	4.8	Peak = UTP							
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No:
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA18-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391438.2mE; 827964.7mN Projection: Mount Eden Circuit 2000
Elevation: 34.63m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
02-07-2020			34.6			TOPSOIL			
28-06-2020	0.4	Peak = 129kPa Residual = 57kPa	34.2			CH: CLAY minor silt: brownish grey, high plasticity. (Alluvium)	M		
	0.8	Peak = 174kPa Residual = 60kPa		1					
			33.5			CH: CLAY with trace silt: brownish grey streaked orange, high plasticity. (Alluvium)		VSt	
	1.2	Peak = 174kPa Residual = 114kPa							
	1.6	Peak = 192kPa Residual = 120kPa							
	2.0	Peak = 105kPa Residual = 63kPa		2					
			32.5			CH: Silty CLAY: light grey, high plasticity. (RS Northland Allochthon)	W		
	2.4	Peak = 120kPa Residual = 78kPa							
	2.8	Peak = 174kPa Residual = 90kPa		3				St	
	3.2	Peak = 99kPa Residual = 48kPa							
						Borehole terminated at 3.3 m			1, 2, 3, 7, 20
				4					
				5					

Termination Reason: Unable to Retain Sample
Shear Vane No: 1589 DCP No: 02
Remarks: Groundwater encountered at 0.8m and rose to 0.5m at the end of drilling.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA19-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391523.7mE; 827962.9mN Projection: Mount Eden Circuit 2000
Elevation: 45.39m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			45.4			TOPSOIL			
			45.3			CL: CLAY minor silt: greyish brown mottled orange, low plasticity. (Colluvium)			
	0.4	Peak = 150kPa Residual = 114kPa							
	0.8	Peak = 159kPa Residual = 105kPa		1			D	VSt	
	1.2	Peak = UTP							
			44.0			CL: Silty CLAY: brownish orange mottled light grey, low plasticity. (Colluvium)			
	1.6	Peak = UTP				*... from 1.60m to 1.80m, ...limonite streaks.*			
			43.6			CL: Clay minor silt: light grey mottled orange, low plasticity. (RS Northland Allochthon)			
	2.0	Peak = UTP		2				VSt to H	
						Borehole terminated at 2.1 m			
				3					
				4					
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5, 10, 15, 10, 20

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1589 DCP No: 04
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA20-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391645.4mE; 827957.7mN Projection: Mount Eden Circuit 2000
Elevation: 63.61m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			63.6			TOPSOIL			
			63.4			CH: CLAY: grey, green mottled orange, high plasticity. (RS Northland Allochthon)			
	0.4	Peak = 105kPa Residual = 57kPa					M to W		
02-07-2020	0.8	Peak = 165kPa Residual = 111kPa	62.7	1		CH: CLAY: bluish grey mottled grey, high plasticity. (RS Northland Allochthon)			
	1.2	Peak = 159kPa Residual = 102kPa							
30-06-2020	1.6	Peak = 180kPa Residual = 114kPa				*... from 1.70m to 1.90m, ...limonite staining.*	D to M	VSt	
			61.7	2		CL: CLAY: bluish grey mottled greyish yellow, low plasticity. Completely weathered mudstone inclusions (10mm). (Transitional Northland Allochthon)			
	2.0	Peak = 156kPa Residual = 99kPa							
	2.4	Peak = 120kPa Residual = 57kPa							
			61.1			CL: CLAY: bluish grey mottled orange, low plasticity. (Transitional Northland Allochthon)	D		
				3					
						Borehole terminated at 3.1 m			13
									20
				4					
				5					

Termination Reason: Refusal on hard ground.
Shear Vane No: 1589 DCP No: 02
Remarks: Initial groundwater @ 1.9m. Groundwater dipped on 2/07/2020 0.9m below ground level.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA21-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01 Logged by: TK Checked by: JW Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 391721.1mE; 827930.3mN Projection: Mount Eden Circuit 2000
Elevation: 72.79m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			72.8			TOPSOIL			
			72.6			CH: Silty CLAY with trace fine to medium sand: grey mottled orange and brown, high plasticity. (Northland Allochthon)			
	0.4	Peak = 182kPa Residual = 57kPa							
						... at 0.50m, ...becoming light grey mottled orange.			
	0.8	Peak = > 196kPa						VSt	
				1			W		
	1.2	Peak = > 196kPa							
	1.6	Peak = > 196kPa							
						... at 1.80m, ...minor fine to medium sand.		VSt to H	
	2.0	Peak = > 196kPa		2					
	2.4	Peak = UTP					D to M		
	2.8	Peak = UTP				... at 2.70m, ...becoming grey mottled light grey and orange.			
			69.9			Completely weathered, dark grey, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine gravel sized mudstone clasts, low plasticity. (Northland Allochthon)	D		
				3					
	3.2	Peak = UTP							
	3.6	Peak = > 196kPa						H	
							M		
	4.0	Peak = UTP		4					
	4.4	Peak = UTP							
	4.8	Peak = UTP							
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No:
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA01-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 05/08/2021
Borehole Location: Refer to site plan

PRELIMINARY

CMW Geosciences

Logged by: CK Checked by: Scale: 1:25 Sheet 1 of 1

Position: 1749431.0mE; 5945080.2mN Projection: NZTM
Elevation: 76.10m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			76.1			OL: TOPSOIL: brown. Low plasticity, with rootlets.			
			76.0			(TS)			
						CH: Silty CLAY with some sand and gravel: orange brown streaked light grey and dark grey. High plasticity, sand is fine grained, gravel is fine and subangular to angular. (Uncontrolled Fill)			
	0.4	Peak = 180kPa Residual = 61kPa							
	0.8	Peak = UTP							
			75.1	1		ML: Clayey sandy SILT with some gravel: orange brown streaked light grey, dark grey and pink. Low plasticity, sand is fine, gravel is fine, subangular to angular and poorly graded. (Uncontrolled Fill)			
	1.2	Peak = UTP					D		
	1.6	Peak = >207kPa	74.5			CH: Silty CLAY with some sand: light grey streaked orange. High plasticity, sand is fine grained. (Alluvium)		VSt	
	2.0	Peak = >207kPa		2					
	2.4	Peak = UTP							
	2.8	Peak = UTP	73.3			ML: Sandy SILT with minor clay: light grey streaked orange. Low plasticity, sand is fine grained and poorly graded. (Alluvium)			
				3			D to M		
			73.0			SP: Silty SAND: light grey streaked brown and orange. Loosely packed, sand is fine grained and poorly graded. (Alluvium)		LP	
	3.2	Peak = UTP							20
						Borehole terminated at 3.2 m			
				4					
				5					

Termination Reason: Refusal on hard ground. DCP refusal at 3.3m.
Shear Vane No: 2904 DCP No: 05
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA02-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 05/08/2021
Borehole Location: Refer to site plan

PRELIMINARY

CMW Geosciences

Logged by: CK Checked by: Scale: 1:25 Sheet 1 of 1

Position: 1749406.8mE; 5945039.4mN Projection: NZTM
Elevation: 78.30m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			78.3			OL: TOPSOIL: brown. Low plasticity, with rootlets.			
			78.2			(TS)			
						CH: Silty CLAY with some sand: orange brown streaked light grey. High plasticity, sand is fine grained. (Alluvium)			
	0.4	Peak = UTP							
						... at 0.50m, ... becoming light grey streaked orange brown		VSt	
	0.8	Peak = >207kPa	77.5			ML: Clayey SILT with some sand: light grey streaked orange brown. Low plasticity, sand is fine grained. (Alluvium)	D		
				1					
	1.2	Peak = UTP	77.1			SP: Silty SAND: light grey streaked orange. Sand is fine grained, poorly graded. (Alluvium)		MD	10, 14, 10, 15
			76.7			SP: SAND: light grey. Sand is fine grained, poorly graded. (Alluvium)			8
						Borehole terminated at 1.7 m			20
				2					
				3					
				4					
				5					

Termination Reason: Refusal on hard ground. DCP refusal at 1.7m.
Shear Vane No: 2904 DCP No: 05
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA03-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021
Borehole Location: Refer to site plan Logged by: CK Checked by: SP Scale: 1:25 Sheet 1 of 1

Position: 1749082.1mE; 5945084.7mN Projection: NZTM
Elevation: 37.30m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			37.3			OL: TOPSOIL: Clayey SILT, brown.			
			37.1			ML: Clayey SILT: orange brown. Low plasticity. (Residual Soil)			
	0.4	Peak = >232kPa+							
			36.7			CH: Silty CLAY: orange brown mottled brown. High plasticity. (Residual Soil)		VSt	
	0.8	Peak = 195kPa Residual = 61kPa		1		*... from 1.00m to 1.30m, becoming light greyish orange*	D to M		
	1.2	Peak = UTP				*... from 1.30m to 1.70m, becoming light grey streaked orange*			
	1.6	Peak = UTP						H	
			35.6			ML: SILT with some sand and fine to coarse gravel sized siltstone fragments: light grey streaked orange. Low plasticity. Sand: fine grained. Siltstone: completely weathered, subangular. (Residual Soil)			
	2.0	Peak = UTP		2		Borehole terminated at 2.0 m			8, 16, 20
				3					
				4					
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5, 10, 15

Termination Reason: Refusal on hard ground. DCP refusal at 2.2m.
Shear Vane No: 2904 DCP No: 19
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA04-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021
Borehole Location: Refer to site plan Logged by: CK Checked by: SP Scale: 1:25 Sheet 1 of 1

Position: 1749077.7mE; 5945074.5mN Projection: NZTM
Elevation: 40.40m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			40.4			OL: TOPSOIL: SILT, brown.			
			40.3			CH: Silty CLAY: orange brown streaked light grey. High plasticity. (Residual Soil)			
	0.4	Peak = UTP					D	H	
	0.8	Peak = UTP		1					
			39.3			ML: Clayey SILT with minor fine to coarse gravel sized siltstone fragments: light grey streaked orange. Low plasticity. Siltstone: completely weathered, subangular. (Residual Soil)			
	1.2	Peak = UTP							
			39.0			ML: SILT with some sand and minor fine to coarse gravel sized siltstone fragments: light grey streaked orange. Low plasticity. Sand: fine grained. Siltstone: completely weathered, subangular. (Residual Soil)	D to M		
	1.6	Peak = UTP				Borehole terminated at 1.6 m			12
				2					20
				3					
				4					
				5					

Termination Reason: Refusal on hard ground. DCP refusal at 1.7m.
Shear Vane No: 2904 DCP No: 19
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA05-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021
Borehole Location: Refer to site plan Logged by: CK Checked by: SP Scale: 1:25 Sheet 1 of 1

Position: 1749068.2mE; 5945054.0mN Projection: NZTM
Elevation: 46.80m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			46.8			OL: TOPSOIL: SILT, brown.			
			46.7			ML: Clayey SILT with some sand: orange brown streaked light grey. Low plasticity. Sand: fine grained. (Residual Soil)			
	0.4	Peak = UTP							
			46.3			ML: SILT with some sand and fine to coarse gravel sized siltstone fragments: orange brown streaked light grey. Low plasticity. Sand: fine grained. Siltstone: completely weathered, subangular. (Residual Soil)	D	H	
	0.8	Peak = UTP							
			45.8	1		ML: Sandy SILT with some fine to coarse gravel sized siltstone fragments: whitish grey streaked orange. Low plasticity. Sand: fine grained, poorly graded. Siltstone: completely weathered, subangular. (Residual Soil)			
	1.2	Peak = UTP				Borehole terminated at 1.2 m			14
									16
									20
				2					
				3					
				4					
				5					

Termination Reason: Refusal on hard ground. DCP refusal at 1.4m.
Shear Vane No: 2904 DCP No: 19
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA06-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021
Borehole Location: Refer to site plan Logged by: CK Checked by: SP Scale: 1:25 Sheet 1 of 1

Position: 1749053.2mE; 5945000.3mN Projection: NZTM
Elevation: 38.50m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			38.5			OL: TOPSOIL: SILT, brown.			
			38.4			ML: Clayey SILT with some sand and fine to coarse gravel sized siltstone fragments: orange brown streaked light grey. Low plasticity. Sand: fine grained. Siltstone: completely weathered, subangular. (Residual Soil)	D	H	
						Borehole terminated at 0.6 m			14, 18, 20

Termination Reason: Refusal on hard ground. DCP refusal at 0.8m.
Shear Vane No: DCP No: 19
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA07-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021
Borehole Location: Refer to site plan Logged by: CK Checked by: SP Scale: 1:25 Sheet 1 of 1

Position: 1749046.1mE; 5944973.8mN Projection: NZTM
Elevation: 34.30m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			34.3			OL: TOPSOIL: SILT, brown.			
			34.2			ML: Clayey SILT with some sand and fine to coarse gravel sized siltstone fragments: orange brown streaked light grey. Low plasticity. Sand: fine grained. Siltstone: completely weathered, subangular. (Residual Soil)	D	H	
	0.4	Peak = UTP							
						Borehole terminated at 0.5 m			12
									20
				1					
				2					
				3					
				4					
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5, 10, 15

Termination Reason: Refusal on hard ground. DCP refusal at 0.6m.
Shear Vane No: 2904 DCP No: 19
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP16-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391530.5mE; 827633.8mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 62.87m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
			62.9			TOPSOIL				
			62.7			CL: Silty CLAY: greyish brown mottled orange, low plasticity. (Colluvium)				
	0.5	Peak = 120kPa Residual = 96kPa					D			
	1.0	Peak = 126kPa Residual = 93kPa		1				VSt		
			61.6			CL: CLAY minor silt: bluish grey, low plasticity. (RS Northland Allochthon)				
	1.5	Peak = 165kPa Residual = 90kPa					M			
			61.0			Completely weathered SILTSTONE, bluish grey, extremely weak. Weathered to silty CLAY, low plasticity. (Transitional Northland Allochthon)				
	2.0	Peak = 210+ kPa		2						
	2.5	Peak = UTP				*... from 2.50m to 2.70m, ...limonite nodules.*				
			60.2			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. Blocky structure. (Northland Allochthon)				
	3.0	Peak = UTP		3			D	VSt to H		
	3.5	Peak = UTP								
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP16-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: 391530.493 & 827633.783	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 62.869	Termination Depth: 4.0m	Contractor: Abernethy Projects

TP16 -20 – TEST PIT EXCAVATION

TEST PIT LOG - TP17-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391337.9mE; 827688.1mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 34.30m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
			34.3			TOPSOIL				
			34.0			MH: Clayey SILT: blackish brown, organic stained. High plasticity. (Alluvium)	M to W	F		
	0.5	Peak = 45kPa Residual = 24kPa								
			33.6			CH: CLAY minor silt: brownish orange mottled brownish grey, high plasticity. (Colluvium)				
	1.0	Peak = 108kPa Residual = 84kPa		1			M			
	1.5	Peak = 105kPa Residual = 72kPa						VSt		
			32.6			MH: Clayey SILT with some fine grained sand: brownish grey, high plasticity. (RS Northland Allochthon)				
	2.0	Peak = 90kPa Residual = 54kPa		2			M to W	St		
	2.5	Peak = UTP								
			31.5			Completely weathered SILTSTONE, bluish grey. Extremely weak. Weathered to CLAY, low plasticity. Blocky structure. (Transitional Northland Allochthon)				
	3.0	Peak = UTP		3				VSt to H		
	3.5	Peak = UTP	30.8			Highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (RS Northland Allochthon)	D			
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP17-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391337.865 N:827688.104	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 34.300	Termination Depth: 4.0m	Contractor: Abernethy Projects

TP17-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP18-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391508.5mE; 827693.4mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 62.98m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
			63.0			TOPSOIL				
			62.7			CL: Silty CLAY: orange mottled light grey, low plasticity. (Colluvium)				
	0.5	Peak = 210+ kPa								
	1.0	Peak = 210+ kPa		1			M			
	1.5	Peak = UTP								
			61.2			CL: CLAY: yellowish orange, low plasticity. (RS Northland Allochthon)				
	2.0	Peak = 210+ kPa		2				VSt to H		
	2.5	Peak = UTP								
	3.0	Peak = UTP		3						
			59.8			CL: CLAY with minor silt: bluish grey, low plasticity, with completely weathered SILTSTONE inclusions (10mm). (Transitional Northland Allochthon)	D			
	3.5	Peak = UTP								
	4.0	Peak = UTP		4						
			58.8			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. (Northland Allochthon)		H		
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP18-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E;391508.483 N:827693.363	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 62.985	Termination Depth: 4.2m	Contractor: Abernethy Projects

TP18-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP19-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 02/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391431.9mE; 827752.7mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 51.00m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			51.0			TOPSOIL				
			50.8			CH: CLAY minor silt: orange brown, high plasticity. (Colluvium)	M			
	0.5	Peak = 135kPa Residual = 102kPa						VSt		
			50.4			CH: Silty CLAY with trace fine grained sand: bluish grey, high plasticity, with completely weathered SILTSTONE inclusions. (RS Northland Allochthon)				
	1.0	Peak = 90kPa Residual = 54kPa		1						
						... from 1.30m to 1.40m, ...limonite streaks.		St		
	1.5	Peak = UTP	49.5			Completely weathered SILTSTONE, bluish grey. Extremely weak. Weathered to silty CLAY, low plasticity. (Transitional Northland Allochthon)				
	2.0	Peak = UTP		2						
	2.5	Peak = UTP								
			48.4			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)	D	VSt to H		
	3.0	Peak = UTP		3						
	3.5	Peak = UTP								
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15 20

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP19-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391431.916 N:827752.722	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 50.997	Termination Depth: 4.0m	Contractor: Abernethy Projects

TP19-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP20-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391315.6mE; 827770.6mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 33.30m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			33.3			TOPSOIL			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
			33.1			CH: Silty CLAY: brown grey streaked orange, high plasticity. (Alluvium)				
						... at 0.30m, ...limonite streaks.				
	0.5	Peak = 114kPa Residual = 63kPa					M			
	1.0	Peak = 105kPa Residual = 51kPa		1						
	1.5	Peak = 150kPa Residual = 87kPa								
			31.7			CH: Silty CLAY: bluish grey, high plasticity. (RS Northland Allochthon)				
	2.0	Peak = 210+ kPa		2						
	2.5	Peak = 114kPa Residual = 63kPa					M to W	VSt		
	3.0	Peak = 135kPa Residual = 84kPa	30.3	3		MH: Clayey SILT with fine to medium sized SILTSTONE clasts (5mm-10mm): bluish grey, high plasticity. (Transitional Northland Allochthon)				
	3.5	Peak = UTP								
	4.0	Peak = UTP	29.3	4		Completely weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. (Northland Allochthon)	D			
				5		Test pit terminated at 4.90 m				

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: Hole beginning to collapse @ 3.0m, benched out to re mediate. Stopped shear vanes due to collapse/instability.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP20-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391315.594 N:827770.572	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 33.296	Termination Depth: 4.9m	Contractor: Abernethy Projects

TP20-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP21-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 02/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391564.6mE; 827754.8mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 1.0m
Elevation:Elevation: 63.99m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			64.0			TOPSOIL				
			63.7			CL: Silty CLAY: orange brown, low plasticity (slump debris). (Colluvium)				
	0.5	Peak = 90kPa Residual = 84kPa						St		
	1.0	Peak = 105kPa Residual = 84kPa		1			M			
	1.5	Peak = UTP	62.5			CL: CLAY minor silt: greyish brown mottled orange, low plasticity. (RS Northland Allochthon)				
	2.0	Peak = UTP		2				VSt to H		
			61.7			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. Blocky structure. (Northland Allochthon)				
	2.5	Peak = UTP					D			
	3.0	Peak = UTP		3						
	3.5	Peak = UTP				Test pit terminated at 3.50 m				
				4						
				5						

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15 20

Termination Reason: Unable to continue due to instability and collapse.
Shear Vane No: 1589 DCP No:

Remarks: Hole collapsed to 2.0m. Rock encountered @ 2.3m. No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP21-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391564.650 N:827754.754	Dimensions: 3.0m x 1.0m	Plant: 12.5 Tonne
Checked by:	Elevation: 63.993	Termination Depth: 3.5m	Contractor: Abernethy Projects

TP21-20– TEST PIT EXCAVATION

TEST PIT LOG - TP22-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391366.9mE; 827827.0mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 42.91m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			42.9			TOPSOIL				
			42.7			CL: Silty CLAY: orange mottled yellowish grey, low plasticity. (RS Northland Allochthon)				
	0.5	Peak = 210+ kPa								
	1.0	Peak = UTP		1						
	1.5	Peak = UTP						VSt		
	2.0	Peak = UTP		2			D			
	2.5	Peak = UTP	40.4			CL: CLAY: greyish yellow mottled orange, low plasticity. (RS Northland Allochthon) *... at 2.60m, ...limonite staining and limonite nodules.*				
	3.0	Peak = UTP		3						
			39.7			Completely weathered SILTSTONE, greyish blue. Extremely weak. Weathered to silty CLAY, low plasticity. Blocky structure, crumbling when disturbed. (Transitional Northland Allochthon)				
	3.5	Peak = UTP						H		
			39.1			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)				
	4.0	Peak = UTP		4						
						Test pit terminated at 4.20 m				
				5						

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP22-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391366.925 N:827826.960	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 42.909	Termination Depth: 3.5m	Contractor: Abernethy Projects

TP22-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP23-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391431.0mE; 827887.5mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 36.96m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			37.0			TOPSOIL				
			36.8			CH: CLAY minor silt: orange brown mottled light grey, high plasticity. (RS Northland Allochthon)				
	0.5	Peak = 120kPa Residual = 75kPa								
	1.0	Peak = 165kPa Residual = 84kPa		1						
			35.7			CH: Silty sandy CLAY: greyish brown with orange streaks, high plasticity. (RS Northland Allochthon)				
	1.5	Peak = 180kPa Residual = 93kPa					M			
	2.0	Peak = 162kPa Residual = 87kPa		2				VSt		
	2.5	Peak = UTP								
			34.2			Completely weathered SILTSTONE with trace sand, bluish grey (Powdery, some completely weathered rock inclusions). (Transitional Northland Allochthon)				
	3.0	Peak = 210+ kPa		3						
	3.5	Peak = 210+ kPa	33.5			Completely weathered to highly weathered SILTSTONE, dark bluish grey. Extremely weak to very weak, powdery. (Northland Allochthon)	D			
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP23-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391430.952 N:827887.467	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 36.955	Termination Depth: 4.0m	Contractor: Abernethy Projects

TP23-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP24-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391371.2mE; 827915.7mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 34.19m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			34.2			TOPSOIL				
			34.0			CL: CLAY minor silt: orange brown mottled brown grey, low plasticity. (Colluvium)				
	0.5	Peak = UTP								
	1.0	Peak = UTP		1						
			32.9			CL: Silty CLAY: brownish grey with orange streaks, low plasticity. (Colluvium)				
	1.5	Peak = UTP								
	2.0	Peak = UTP		2			D	VSt to H		
	2.5	Peak = UTP								
	3.0	Peak = UTP	31.2	3		CL: CLAY: purple red, low plasticity, becoming completely weathered SILTSTONE extremely weak. (Transitional Northland Allochthon)				
	3.5	Peak = UTP	30.7			Highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)				
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15 20

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP24-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391371.237 N:827915.718	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 34.194	Termination Depth: 3.5m	Contractor: Abernethy Projects

TP24-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP25-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020
Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1
Position: 391645.1mE; 827879.0mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation:Elevation: 70.08m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			70.1			TOPSOIL				
			69.9			CH: CLAY: orange brown mottled grey, high plasticity. (Colluvium)				
	0.5	Peak = 165kPa Residual = 87kPa					M			
	1.0	Peak = 174kPa Residual = 99kPa		1						
	1.5	Peak = 210+ kPa	68.6			Completely weathered SILTSTONE, greyish blue. Extremely weak. Weathered to silty CLAY, low plasticity. (Transitional Northland Allochthon)				
	2.0	Peak = 210+ kPa	68.1	2		Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)		VSt		
	2.5	Peak = UTP					D			
	3.0	Peak = UTP		3						
	3.5	Peak = UTP								
	4.0	Peak = UTP		4						
						Test pit terminated at 4.10 m				
				5						

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15 20

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP25-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020

Logged by: MMC	Position: E:391645.093 N:827879.000	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 70.085	Termination Depth: 4.0m	Contractor: Abernethy Projects

TP25-20 – TEST PIT EXCAVATION

BOREHOLE LOG - MH07-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 03/07/2020
Borehole Location: Refer to Drawing 01 Logged by: FZ Checked by: JW Scale: 1:50 Sheet 1 of 2

CMW Geosciences

Position: 391667.9mE; 827941.9mN Projection: Mount Eden Circuit 2000 Angle from horizontal: 90°
Elevation: 67.99m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
				68.0			TOPSOIL						
				67.8			CH: Silty CLAY: light orange brown, high plasticity. (Northland Allochthon)	D to M		100	TT / HQ3		
					1		... at 0.80m, ...becoming light orange brown streaked orange and light grey.						
							... from 1.10m to 1.40m, ...with some fine sand.	M					
		1.5 1.5	Peak = 120kPa Residual = 30kPa SPT = (1,3,6) N* = 9						VSt	67	SPT		
					2		... at 2.20m, ...trace limonite staining.	M to W		100	TT / HQ3		
				65.2			CH: Silty CLAY with medium to coarse gravel sized completely weathered mudstone clasts: light bluish grey, high plasticity. (Northland Allochthon)						
		3.0 3.0	Peak = 48kPa Residual = 7kPa SPT = (4,4,6) N* = 10		3				F	33	SPT		
								W		100	TT / HQ3		
					4				H				
		4.5 4.5	SPT = (14,22,18) N* = 40 Peak = UTP	63.5			MUDSTONE: light bluish grey with light brownish grey mottles. Completely weathered to silty CLAY with medium to coarse gravel sized mudstone inclusions. Highly fractured. (Northland Allochthon)			44	SPT		4.5-6.4m:7,B,ST,R,OP,IF,(CL),
					5					48	TT / HQ3		
		6.0	SPT = (12,13,15) N* = 28		6					44	SPT		
							... at 6.50m, ...poor recovery due to highly fractured rock.						6.4-9.0m:8,B,ST,R,OP,IF,(CL),
					7			W to S		38	TT / HQ3		
		7.5	SPT = (5,5,10) N* = 15							56	SPT		
					8					43	TT / HQ3		
		9.0	SPT = (5,9,13) N* = 22		9					78	SPT		
													9.4-10.5m:3,B,ST,R,IF,(CL),
										35	TT / HQ3		
					10								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Single piezometer installed from 0.0m to 12.0m. Hole collapse from 12.0m to 15.0m prior to piezo installation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - MH07-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 03/07/2020
Borehole Location: Refer to Drawing 01 Logged by: FZ Checked by: JW Scale: 1:50 Sheet 2 of 2

CMW Geosciences

Position: 391667.9mE; 827941.9mN Projection: Mount Eden Circuit 2000 Angle from horizontal: 90°
Elevation: 67.99m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
		10.5	SPT = (5,8,14) N* = 22		11		*... from 10.40m to 10.50m, ...becoming angular medium gravel sized mudstone clasts.*			78	SPT		10.5-12.0m:8,B,ST,R,OP,IF, (CL),
										52	TT / HQ3		
		12.0	SPT = (15,29,25/22mm (Run over)) N* = 50 +	56.0	12		MUDSTONE: light bluish grey. Mudstone weathered to silty CLAY with medium to coarse gravel sized clasts. Highly fractured. (Northland Allochthon)			78	SPT		
					13					43	TT / HQ3		12.4-13.5m:5,B,ST,R,OP,IF, (CL),
		13.5	SPT = (12,34,16/20mm) N* = 50+							63	SPT		
				54.0	14		MUDSTONE: light bluish grey. Highly fractured with highly weathered angular medium gravel sized mudstone clasts. (Northland Allochthon)			51	TT / HQ3		14.0-15.0m:4,B,ST,R,OP,IF, (CL),
		15.0	SPT = (,20,30/60mm) N* = 50+		15		Borehole terminated at 15.0 m			97	SPT		
					16								
					17								
					18								
					19								
					20								

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:

Remarks: Single piezometer installed from 0.0m to 12.0m. Hole collapse from 12.0m to 15.0m prior to piezo installation.

BOREHOLE CORE PHOTOGRAPHS: MH07-20

Client: Build Rich Limited

Project: Silverdale South Stage 3 & 4
Location: Refer to Drawing 01
Project No: AKL2020-0125
Date: 03/07/2020

Logged by: FYZ	Position: E.1749410.0m N.5945111.0m	Hole Diameter: 95mm	Plant: Excavator Rig
Checked by:	Elevation: RL 67.70m	Angle from Horizontal: 90°	Contractor: McMillan Drilling

MH07-20: 0.00m to 2.80m

MH07-20: 2.80m to 9.00m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH07-20

Client: Build Rich Limited

Project: Silverdale South Stage 3 & 4
Location: Refer to Drawing 01
Project No: AKL2020-0125
Date: 03/07/2020

Logged by: FYZ	Position: E.1749410.0m N.5945111.0m	Hole Diameter: 95mm	Plant: Excavator Rig
Checked by:	Elevation: RL 67.70m	Angle from Horizontal: 90°	Contractor: McMillan Drilling

MH07-20: 9.00m to 15.00m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE LOG - MH01-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 06/08/2021
Borehole Location: Refer to site plan

PRELIMINARY

CMW Geosciences

Logged by: LSW Checked by: Scale: 1:50 Sheet 1 of 1

Position: 1749109.0mE; 5945143.0mN Projection: NZTM
Elevation: 30.80m Datum: AUCKHT1946

Survey Source: Hand Held GPS

Depth	Type & Results	RL (m)	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	RQD	Drilling Method/ Support
		30.8		OL: TOPSOIL: Brown.					
		30.7		CH: Silty CLAY: Brown. High plasticity. (Alluvium)		F to St	97		TT / HQ3
				... from 0.50m to 0.80m, becoming light brown mottled grey and brown.					
			1	*... from 0.80m to 1.30m, becoming brown.*					
		29.5		CH: Silty CLAY: Light greyish brown mottled brown. High plasticity. (Alluvium)					
1.5	Peak = 87kPa Residual = 39kPa								
1.5	SPT = (0,5,6) N* = 11								SPT
2.0	Peak = 122kPa Residual = 29kPa		2		W		76		TT / HQ3
3.0	SPT = (3,3,4) N* = 7		3			St			SPT
		26.9	4	ML: Sandy SILT with some clay: Light bluish grey. Low plasticity. Sand is fine to medium grained. (Alluvium)			64		TT / HQ3
		26.3		Completely weathered, bluish grey SANDSTONE. Extremely weak: Weathered to sandy SILT. Low plasticity. Sand is fine to medium grained. (Northland Allochthon)					
5.0	SPT = (8,15,10) N* = 25		5						SPT
		25.3		Completely weathered to highly weathered, greenish grey SILTSTONE. Extremely weak: (Northland Allochthon)			95	100	TT / HQ3
		24.8	6	Highly weathered, grey mottled light grey SANDSTONE. Extremely weak to very weak: Sand is fine to medium grained. (Northland Allochthon)					
6.5	SPT = (14,17,19) N* = 36								SPT
			7				100	100	TT / HQ3
8.0	SPT = (12,14,11) N* = 25		8						SPT
		22.4		Moderately weathered, bluish grey mottled dark grey and reddish brown SILTSTONE. Extremely weak to very weak: (Northland Allochthon)			100	91	TT / HQ3
9.5	SPT = (8,12,16) N* = 28		9						SPT
				Borehole terminated at 9.50 m					
			10						

Termination Reason: Target Depth Reached
Shear Vane No: 1824 DCP No:
Remarks:

BOREHOLE LOG - MH02-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 05/08/2021
Borehole Location: Refer to site plan

PRELIMINARY

CMW Geosciences

Logged by: LSW Checked by: Scale: 1:50 Sheet 1 of 1

Position: 1749102.0mE; 5945118.0mN Projection: NZTM
Elevation: 30.40m Datum: AUCKHT1946

Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Weathering	Recovery	RQD	Estimated Strength	Defect Spacing (mm)	Drilling Method/ Support	Structure & Other Observations
				30.4			OL: TOPSOIL: Brown.									
				30.2			CH: Silty CLAY: Brown. High plasticity. (Alluvium)									
				29.4	1		CH: Silty CLAY: Dark grey. High plasticity. (Alluvium)		F to St		75				TT / HQ3	
				29.2			CL: Silty CLAY with some fine to medium sand: Brown. Low plasticity. (Alluvium)									
				28.6			SC: Clayey SAND: Greyish brown. Low plasticity. Sand is fine to coarse grained. (Alluvium)		LP							
		2.0	SPT = (1,1,0) N* = 1		2		*... from 2.00m to 2.50m, contains some organics and wood fragments up to 15mm in size.*								SPT	
				27.8			CH: Silty CLAY: Light greenish grey. High plasticity. Contains some organic fragments up to 10mm in size and some inclusions of very stiff clayey SILT. (Alluvium)	W to S			81				TT / HQ3	
		3.5	SPT = (2,2,2) N* = 4		3										SPT	
					4				St		67				TT / HQ3	
		5.0	SPT = (2,2,4) N* = 6		5										SPT	
				25.0			Completely weathered, greenish grey mottled grey SILTSTONE. Extremely weak: (Northland Allochthon)				100	100			TT / HQ3	
				24.5	6		Completely weathered to highly weathered, light greenish grey mottled dark grey SILTSTONE. Extremely weak to very weak : (Northland Allochthon)									
		6.5	SPT = (6,10,9) N* = 19												SPT	
					7		*... at 7.20m, becoming reddish brown mottled dark grey.*				100	100			TT / HQ3	
							... at 7.60m, becoming greenish grey mottled dark grey and reddish brown.									
		8.0	SPT = (14,16,24) N* = 40		8										SPT	
					9						100	100			TT / HQ3	
		9.5	SPT = (11,12,22) N* = 34												SPT	
							Borehole terminated at 9.50 m									
					10											

Termination Reason: Target Depth Reached
Shear Vane No: DCP No:
Remarks:

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE CORE PHOTOGRAPHS: MH01-21

Client: Build Rich Limited
Project: Silverdale South Stage 3+4
Location: Silverdale
Project No: AKL2020-0125
Date: 6 August 2021

Logged by: LSW	Position: 1749109mE, 5945143mN	Hole Diameter: 63mm	Plant: Tractor-Mounted Drill Rig
Checked by:	Elevation: 30.8m	Angle from Horizontal: 90°	Contractor: ProDrill

MH01-21: 0.00m to 3.45m

MH01-21: 3.45m to 7.75m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH01-21

Client: Build Rich Limited
Project: Silverdale South Stage 3+4
Location: Silverdale
Project No: AKL2020-0125
Date: 6 August 2021

Logged by: LSW	Position: 1749109mE, 5945143mN	Hole Diameter: 63mm	Plant: Tractor-Mounted Drill Rig
Checked by:	Elevation: 30.8m	Angle from Horizontal: 90°	Contractor: ProDrill

MH01-21: 7.75m to 9.50m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH02-21

Client: Build Rich Limited

Project: Silverdale South Stage 3+4

Location: Silverdale

Project No: AKL2020-0125

Date: 5 August 2021

Logged by: LSW	Position: 1749102mE, 5945118mN	Hole Diameter: 63mm	Plant: Tractor-Mounted Drill Rig
Checked by:	Elevation: 30.3m	Angle from Horizontal: 90°	Contractor: ProDrill

MH02-21: 0.00m to 4.40m

MH02-21: 4.40m to 8.00m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH02-21

Client: Build Rich Limited
Project: Silverdale South Stage 3+4
Location: Silverdale
Project No: AKL2020-0125
Date: 5 August 2021

Logged by: LSW	Position: 1749102mE, 5945118mN	Hole Diameter: 63mm	Plant: Tractor-Mounted Drill Rig
Checked by:	Elevation: 30.3m	Angle from Horizontal: 90°	Contractor: ProDrill

MH02-21: 8.00m to 9.50m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

Appendix C: Hand Auger Borehole, Test Pit and Machine Borehole Logs 2016

MACHINE BOREHOLE - BH01-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 06/05/2016
Borehole Location: See Site Plan

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Chapman Morton Woodward

1:50 Sheet 1 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
Northland Allochthon			0		OL: TOPSOIL											
					CL: CLAY: orange and brown. Very stiff to hard, dry to moist, low plasticity.		Vst to H		100			V-UTP				
					...becoming with fine to medium, angular, dark orange and light brown gravel.				80							
			1		*...becoming light golden orange with dark orange, grey and brown sub-horizontal, thinly laminated, wavy bands.*				100			V-UTP				
					...fine to medium gravel begins again.				0			V-UTP	(18,42,8/15mm) N* = R			
			2		CL: Silty CLAY with minor completely weathered SILTSTONE clasts: light grey with limonite staining. Hard, dry to moist, low plasticity.	D to M	H		20							
					Moderately weathered, light grey, with sub-vertical to sub-vertical orange banding SILTSTONE. Very weak.				100							
			3		*...fractured to fine gravel, hard, CLAY with limonite on faces.*											
					CH: Silty CLAY with some fine to medium siltstone gravel: light grey. Very stiff, moist, high plasticity.	M	VSt		100	100			(10,22,28/135mm) Nc = R			
			4													
					Highly weathered, light grey SILTSTONE. Extremely weak to very weak.				100	60			(24,50/140 mm) Nc = R		RC	5.5-5.9m:1 Crushed zone, 0°, crushed to fine to course gravel.
			5													
			6										(50,) Nc = R			6.7-7.5m:1 Crushed zone, 0°, crushed to very stiff to hard clay.
			7						100	100						7.6m:1 Joint, 0°, moderately wide, dark grey clay infill.
			8										(50,) Nc = R			
			9						100	100						
			10		Continued on next sheet								(50/130mm) Nc = R			

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 4.8m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

MACHINE BOREHOLE - BH01-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 06/05/2016
Borehole Location: See Site Plan

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Chapman Morton Woodward

1:50 Sheet 2 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
			11		*...becoming completely weathered to highly weathered. Weathered to very stiff, light grey Silty CLAY with fine to course gravel SILTSTONE clasts.*				100	90			(32,50,) Nc = R			10.2-10.3m:1 Crushed zone, 45°, crushed to dark grey medium gravel. 10.7m:1 Joint, 10°, dark grey clay infill.
			12						70	90						12.1-12.2m:2 Crushed zones, 25°, crushed to medium gravel. 12.3m:1 Joint, 25°, undulating rough, infill washed away.
			13						100	100			(50/140mm) Nc = R			
			14						100	50			(50/95mm) Nc = R			14.6-4.6m:1 Crushed Zone, 10°, crushed to fine gravel. 15.0-15.5m:6 Joints, 40°, very closely spaced, undulating rough.
			15		Borehole terminated at 15.5 m								(50/85mm) Nc = R			
			16													
			17													
			18													
			19													
			20													

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 4.8m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

MACHINE BOREHOLE - BH02-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 05/05/2016
Borehole Location: See Site Plan

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Chapman Morton Woodward

1:50 Sheet 1 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Recovery	RQD	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Drilling Method/ Support	Comments/Defect Description
Top soil		OL: TOPSOIL								
Northland Allochthon		CH: CLAY: orange with minor sub-horizontal thinly laminated wave brown banding. Very stiff to hard, moist, high plasticity. Minor rootlets.	M		80		V-UTP			
		...becoming light brown.			100					
		...sub-vertical shrink swell fissures with rootlets and orange staining on fissure faces.								
	1	*...becoming with sub-horizontal thinly laminated wavy orange and light grey banding. Minor very closely spaced cracking along banding becoming closely spaced at 0.9m.*		Vst to H	100		V-UTP			
		...becoming hard and friable, dry to moist, low plasticity. Sub-horizontal thinly laminated micro fractures with limonite and dark grey staining on faces. Fractures to fine to medium gravel sized clasts. Rootlets becoming rare.	D to M		0		V-UTP	(8,12,18) N* = 30		
	2	CL: Silty CLAY with traces of highly weathered, extremely weak fine to medium gravel siltstone clasts.: light grey and orange limonite staining. Hard, dry to moist, low plasticity.			100	100				2.2m:1 Joint, 45°, planar rough, limonite and rootlets on face.
		...fractures end.								2.6m:1 Joint, 45°, stepped smooth, limonite infill.
		Completely weathered to highly weathered, light grey SILTSTONE. Extremely weak to weak. Thinly laminated micro fractures throughout.:								
	3	*...becoming blueish dark grey.*			100	100				
								(10,17,25) Nc = 42		3.4m:1 Joint, 45°, planar rough, firm grey CLAY infill.
	4	Highly weathered to moderately weathered, grey SANDSTONE. Very weak to weak. Minor thinly laminated, closely spaced micro fractures. Bedding contact is stepped at with 45°. :			100	100				
										4.5m:1 Joint, 5°, planar rough, very narrow, firm grey CLAY infill.
	5	Alternating highly weathered, grey SILTSTONE, very weak to weak, and highly weathered, grey SANDSTONE, very weak to weak. Bedding is moderately thick to moderately thin. Bedding boundaries are steeply inclined with 2mm thick hard grey CLAY infill.:			100	100			RC	
								(16,23,27/ 140mm) Nc = R		
					100	100				5.6m:1 Joint, 45°, undulating rough, moderately narrow, stiff grey CLAY infill.
	6	*...SANDSTONE ends.*								
		...becoming with thinly laminated dark grey sub-horizontal to steeply inclined banding.						(13,20,30) Nc = 50		
	7	*...thinly laminated micro fractures begin.*			100	100				7.2m:1 Drilling induced, 45°, planar slickensided, no infill.
								(13,25,25/ 100mm) Nc = R		
	8				100	100				
	9							(23,25,25/ 120mm) Nc = R		
	10	Continued on next sheet								

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 2.6m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

MACHINE BOREHOLE - BH02-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 05/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 2 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Depth (m)	Material Description	Recovery	RQD	SPT N-Value	Comments/Defect Description
11		100	100	(24,44,6/15mm) Nc = R	10.6m:1 Drilling induced, 45°, undulating rough, no infill.
12		100	100		11.1m:1 Joint, 45°, stepped rough, moderately wide, stiff dark grey CLAY infill.
13		100	92	(24,50,) Nc = R	11.2m:1 Drilling induced, 10°, stepped smooth, no infill.
14		100	100	(31,45,5/10mm) Nc = R	12.2m:1 Crushed zone, 0°, moderately narrow, crushed to fine to medium gravel.
15	...thin sub-horizontal band of stiff dark grey CLAY.				13.7m:2 Joints, 30° intersecting at 120°, stepped slickensided, no infill.
	Borehole terminated at 15.5 m			(17,27,23/110mm) Nc = R	
16					
17					
18					
19					
20					

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 2.6m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

MACHINE BOREHOLE - BH03-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 04/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 1 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil Type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Weathering (RS, CW, HW, MW, SW, DW)	Recovery	RQD	Estimated Strength (EW, VW, W, MS, S, VS, ES)	Vane Shear Strength (kPa) Peak (Residual)	SPT N-Value	Defect Spacing (mm) (<20, 20-60, 60-200, 200-600, 600-2000, >2000)	Drilling Method/ Support	Comments/Defect Description
Topsoil					OL: TOPSOIL											
Northland Allochthon			1		CH: CLAY: orange with minor sub-horizontal, thinly laminated brown banding. Very stiff to hard, moist, high plasticity. Minor rootlets throughout. *...banding ends. Vertical fissures with minor organic staining and rootlets running along fissure faces.* *...banding begins again. Fissures end.* *...fissures begin again. Banding ends.* *...becoming grey with orange mottle. Fissures end. Rootlets remain.*	M	Vst to H		80 100 100 100			V-UTP 89(41) V-UTP	(3,3,6) N* = 9			
			2		*...band of heavy limonite staining.* *...2 10mm thick sub-horizontal heavy limonite stained bands.* *...becoming dark grey with darker grey mottle and occasional limonite mottle.*				100							
			3									V-UTP	(6,8,10) N* = 18			
			4		CL: Silty CLAY with minor fine to medium siltstone gravel: grey with dark grey clasts. Hard, dry to moist, low plasticity. *...extremely closely spaced, laminated, sub-horizontal, wavy dark grey bans*	D to M	H		100							
			5		*...30mm thick crushed zone, crushed to angular siltstone clasts.*				50			V-UTP	(8,10,13) N* = 23		RC	
			6		Alternating completely weathered, dark grey SILTSTONE, extremely weak with darker grey micro-fractures throughout and highly weathered, light grey SILTSTONE, extremely weak to very weak with occasional micro-fracture.				100	100						
			7						100	100			(10,14,36/ 140mm) Nc = R			7.3m:1 Joint, 85°, undulating smooth, dark grey clay infill. 7.6m:1 Crushed zone, 5°, moderately thin, crushed to fine angular gravel.
			8						100	100						
			9						100	100			(19,32,18/ 90mm) Nc = R			9.1m:1 Drilling induced, 20°, stepped rough, no infill.
			10		Alternating highly weathered, grey SILTSTONE, extremely weak to weak and moderately weathered,				100	100						9.5-9.6m:1 Crushed zone, 45°, crushed to medium, angular, weak to very weak gravel in a grey, stiff clay.
					(16,25,25/ 140mm) Nc = R											
					Continued on next sheet											

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 1.4m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

MACHINE BOREHOLE - BH03-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project: AKL2016_0209
Date: 04/05/2016
Borehole Location: See Site Plan

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1:50 Sheet 2 of 2

Logged by: JMJ Position: Elevation:
Checked by: JMJ Survey Source: Estimated onsite Datum: Angle from horizontal: 90°

Depth (m)	Material Description	Recovery	RQD	SPT N-Value	Comments/Defect Description
11	grey SILTSTONE, very weak to weak. Thin to moderately thin bedding.	50	100	(11,16,32) Nc = 48	
	...band of slightly weathered, grey SANDSTONE, moderately strong. Minor sub-vertical, laminated quartz veins.	90	50		11.5-11.5m:1 Drilling induced, 5°.
12	*...1 sub-horizontal quartz vein with stepped rough boundaries.*				
13		100	100	(10,19,21) Nc = 40	
14	Borehole terminated at 14.0 m			(10,23,27/ 115mm) Nc = R	13.7-13.7m:1 Crushed zone, 45°, crushed to fine gravel.
15					
16					
17					
18					
19					
20					

Termination reason: Target Depth Reached

Remarks: Standing groundwater measured at 1.4m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

TEST PIT - TP11-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 20°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Top soil			0		OL: TOPSOIL	D			
Northland Allochthon					CH: Silty CLAY: Light orange with limonite staining. Very stiff, moist, high plasticity. Vertical and horizontal fissures from shrink/swell. Rootlets and limonite staining is fissures.		MS	V-107(52)	
					...fissures end.				
			1				MS	V-110(34)	
					...becoming creamy white with limonite staining.				
						M	MS	V-83(34)	
			2				IS	V-62(41)	
					...band of heavy limonite staining above boundary.				
					CH: Silty CLAY with some highly weathered fine to medium siltstone gravel: dark grey and light grey. Stiff to very stiff, moist, high plasticity.				
			3		Completely weathered to highly weathered, dark grey SILTSTONE. Extremely weak to very weak. Fractures to stepped smooth polished surfaces.				
					Test Pit excavated to 3.1 m				
			4						
			5						
			6						
			7						
			8						

Termination reason: Target depth reached

Remarks: Standing groundwater not encountered

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

TEST PIT - TP12-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Chapman Morton Woodward

Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 320°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil			0		OL: Topsoil	D			
Northland Allochthon					CL: Silty CLAY: dark orange with limonite staining and grey mottle. Stiff to very stiff, dry to moist, low plasticity. Vertical and horizontal fissures from shrink/swell. Limonite and rootlets on fissures.		S	V-89(21)	
			1				MS	V-62(28)	
					CH: Silty CLAY: light grey with orange mottle and limonite staining increasing with depth. Very stiff, dry to moist, high plasticity.				
			2				MS	V-103(44)	
					...limonite staining becoming major.			V-UTP	
					CL: Silty CLAY with trace extremely weathered fine to medium siltstone gravel: light grey/off white with orange mottle. Hard, dry to moist, low plasticity.	D to M			
			3						
					...orange end. Becoming blueish light grey. Becoming with some gravel.				
			4						
					...becoming blueish dark grey.				
			5		Extremely weathered to highly weathered, dark grey with black banding SILTSTONE. Extremely weak. Clasts of weak siltstone. Fractures to smooth stepped polished surfaces.				
					Test Pit excavated to 5.2 m				
			6						
			7						
			8						

Termination reason: Target depth reached
Remarks: Standing groundwater not encountered

TEST PIT - TP13-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

CMW Geosciences (NZ) Ltd
Chapman Morton Woodward

Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 40°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Top soil			0		OL: TOPSOIL	D			
Northland Allochthon			1		CH: Silty CLAY: light grey and orange. Stiff to very stiff, dry to moist, high plasticity. Horizontal and vertical fissures from shrink/swell. Rootlets and very minor limonite and organic staining in fissures. *...fissured end. Becoming more orange.* *...becoming light grey and creamy white with orange mottle. Rootlets end.*	M	MS MS MS	V-165(48) V-76(21) V-83(34)	
			2		CH: Silty CLAY with trace fine to medium completely weathered siltstone gravel. : light blueish grey. Very stiff to hard, moist, high plasticity. Heavy limonite staining in top 200mm.		MS	V-165(55)	
			3		Completely weathered, dark grey SILTSTONE. Extremely weak. *... becoming dark grey and blocky in structure. Fractures on right angles to smooth stepped surfaces.* *...thin lenses of slightly sandier SILTSTONE. Becoming moderately weathered and weak. Fractures decreasing.*				
			4		Moderately weathered, light blueish grey SILTSTONE. Very weak to weak. Fractures to angular fine to medium gravel sized clasts. Test Pit excavated to 3.8 m				
			5						
			6						
			7						
			8						

Termination reason: Target depth reached

Remarks: Standing groundwater not encountered.

TEST PIT - TP14-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

CMW Geosciences (NZ) Ltd
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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil			0		OL: TOPSOIL	D			
Tauranga Group			1		CH: Silty CLAY: light grey with orange mottle. Stiff to very stiff, dry to moist, high plasticity. Minor rootlets.	D to M	MS	V-138(58)	
							MS	V-179(50)	
					ML: SILT with trace fine sand: white. Hard, dry to moist, low plasticity. Pumiceous. Abrupt top boundary. Dipping at 10° at bearing 180°			V-UTP	
	▼		2		CH: Silty CLAY: light grey with light brown organic staining. Firm, moist to wet, high plasticity.	M to W	IS	V-41(21)	
Northland Allochthon			3						
			4		CH: Silty CLAY with minor fine to medium completely weathered siltstone gravel: light blueish grey. Very stiff to hard, moist, high plasticity.	M			
					...becoming darker blueish grey.				
			5		Test Pit excavated to 5.0 m				
			6						
			7						
			8						

Termination reason: Target depth reached
Remarks: Groundwater seepage encountered at 2.0m

TEST PIT - TP15-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No.: AKL2016_0209
Date: 10/05/2016

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Test Pit Location: See Site Plan | Plant Used: Hyundai 20T | 1:50 | Sheet 1 of 1

Logged by: JMJ | Position: | Elevation: | Pit Dimensions: 4.0m by 1.2m
Checked by: JMJ | Survey Source: Estimated onsite | Datum: | Orientation: 20°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil					OL: TOPSOIL	M			
Tauranga Group			1		ML: Clayey SILT: light grey and light brown. Soft to firm, moist to wet, high plasticity. Exhibiting dilatant behaviour. Rootlets throughout.	M…	MS	V-34(11)	
					...becoming with minor orange mottle. Becoming wet. Groundwater seepage. Side of pit failing in rectangular slabs.		MS	V-34(14)	
							S	V-83(14)	
			2			W	MS	V-55(25)	
							MS	V-55(28)	
Northland Allochthon			3		CH: Silty CLAY trace fine to medium highly weathered siltstone gravel: light grey with dark grey and black banding. Firm to stiff, moist to wet, high plasticity.	D to M			
					Highly weathered, light grey SILTSTONE. Extremely to very weak. Fractures to irregular stepped faces.				
			4		Test Pit excavated to 3.5 m				
			5						
			6						
			7						
			8						

Termination reason: Unable to penetrate further
Remarks: Seeping groundwater encountered at 0.5m

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA06-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

CMW Geosciences (NZ) Ltd
Chapman Morton Woodward

1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ

Position:
Survey Source: Estimated onsite

Elevation:
Datum:

Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Northland Allochthon			0		OL: Topsoil.					
					CH: CLAY: orange, mixed light grey. Hard, dry, high plasticity.	D		V-193+		
								V-162(66)		
			1		CL: Silty CLAY: orange, mixed, light grey. Very stiff, moist, low plasticity.	M		V-107(45)		
					CH: CLAY: orange, mixed light grey. Very stiff, moist, high plasticity. With sheared texture.					
					CL: Silty CLAY: grey, streaked orange. Hard, dry, low plasticity. With some limonite stained relict defects.	D		V-193+		
			2		MH: Clayey SILT: light grey, streaked orange, Hard, dry, high plasticity. With crushed and sheared texture.			V-UTP		
					CH: CLAY, with some fine to medium sand and seams of saturated orange clay: light grey streaked orange. Stiff, wet, high plasticity. Sand consists of residually weathered, hard siltstone, with crushed and sheared texture.	W		V-72(21)		
					ML: SILT, with trace fine sand and clay: grey. Hard, dry, low plasticity. With chaotic fracturing (residually weathered very fine sandstone).	D		V-UTP V-UTP		
			3							
			4		Borehole terminated at 4.0m					
			5							

Termination reason: Unable to penetrate further

Remarks: Standing groundwater not encountered at end of borehole

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA07-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

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1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ
Position:
Survey Source: Estimated onsite
Elevation:
Datum:
Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Northland Allochthon			0		OL: Topsoil.					
					CL: Silty CLAY: light brownish orange. Very stiff, dry, low plasticity.	D		V-197+		
					...becoming moist			V-197+		
			1		...becoming light grey and orange	M		V-197+		
					...becoming dry to moist and hard			V-UTP		
					...with some limonite staining	D to M				
			2		...becoming moist			V-UTP		
					...becoming light grey, with up to medium gravel sized angular clasts of extremely weathered siltstone			V-UTP		
					...becoming light grey mottled orange and dry with friable blocky texture and some extremely weathered siltstone clasts			V-UTP		
			3			M				
					...becoming greenish grey and hard, with some brownish red mottles, with sheared texture			V-UTP		
								V-UTP		
			4		Borehole terminated at 4.0m			V-UTP		
								V-UTP		
			5							

Termination reason: Unable to penetrate further

Remarks: Standing groundwater not encountered at end of borehole

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA09-16

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

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1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ

Position:
Survey Source: Estimated onsite

Elevation:
Datum:

Hole Diameter: 50mm
Angle from horizontal: 90°

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Alluvium			0		OL: Topsoil.					
					...with clay inclusions					
					MH: Clayey SILT mixed with topsoil: orange, mixed brown and black. Stiff, moist, low plasticity.		MS	V-49(14)		
					OH: Organic CLAY: dark brownish black. Stiff, moist, high plasticity.		MS	V-76(31)		
					...slight groundwater seepage					
			1			M	S	V-87(21)		
					ML: SILT mixed with CH: CLAY. SILT is orange and low plasticity, CLAY is light grey and high plasticity. Both are stiff and moist.		MS	V-75(27)		
					CL: Sandy CLAY: brown. Very stiff, moist, low plasticity.					
	▼		2		*...with some hard orange silty clay inclusions and trace organic mottles*		MS	V-99(44)		
Northland Allochthon					CL: Silty CLAY: greenish grey. Hard, dry, low plasticity. With sheared texture.	D		V-UTP		
					Borehole terminated at 2.8m			V-UTP		
			3							
			4							
			5							

Termination reason: Unable to penetrate further

Remarks: Groundwater at 2.0 meters at end of borehole

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA10-15

Client: KVest Investments
Project: Silverdale South
Site Address: Silverdale
Project No: AKL2016_0209
Date: 12/05/2016
Borehole Location: See Site Plan

CMW Geosciences (NZ) Ltd
Chapman Morton Woodward

1:25 Sheet 1 of 1

Logged by: MP
Checked by: JMJ
Position:
Survey Source: Estimated onsite
Elevation:
Datum:
Hole Diameter: 50mm
Angle from horizontal: 90°

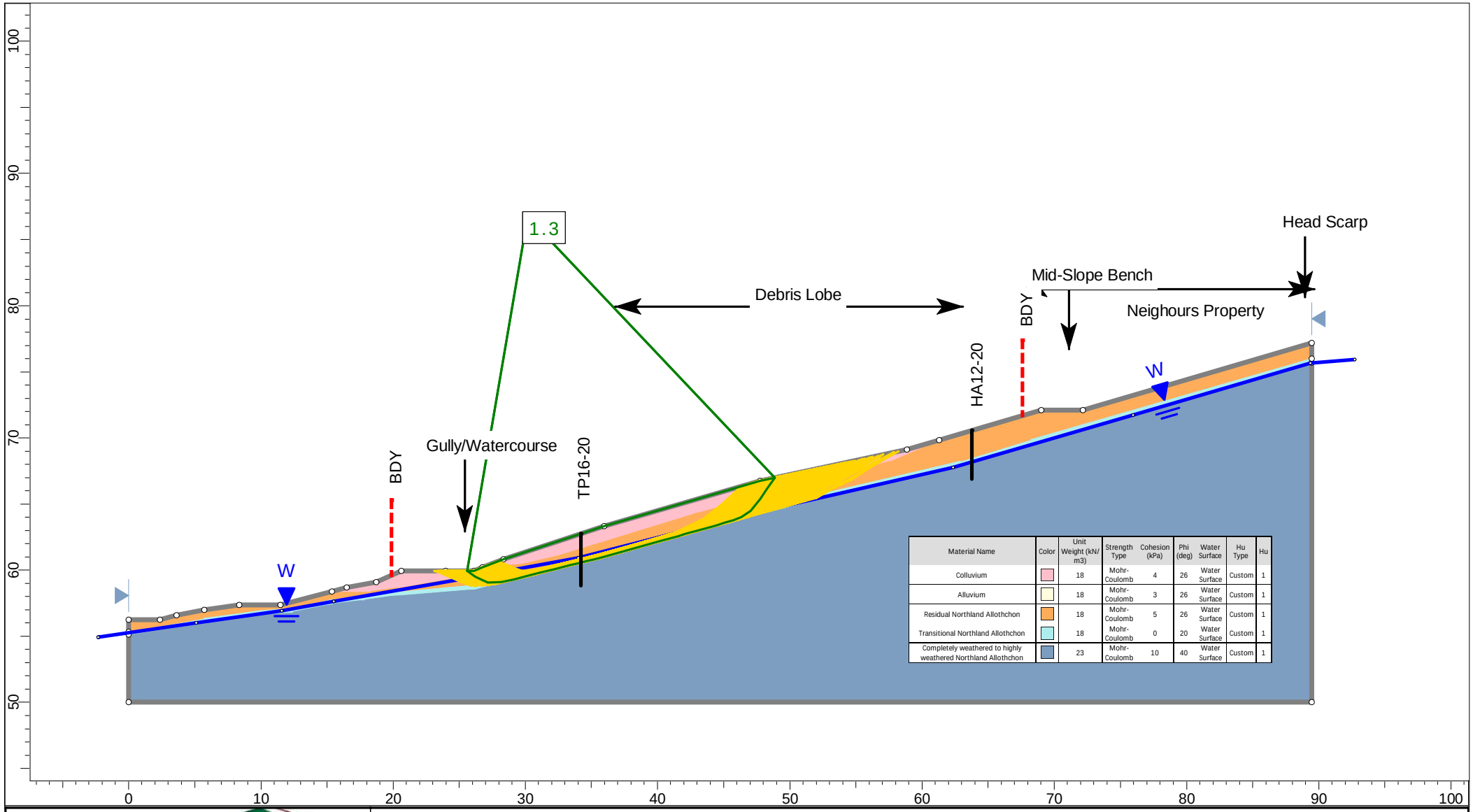
Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Northland Allochthon					OL: Topsoil.					
					CH: CLAY: reddish orange. Very stiff, moist, high plasticity.					
					...becoming light greyish orange		S	V-162(39)		
							MS	V-142(39)		
			1		CL: Silty CLAY: light grey, streaked orange. Very stiff, moist, high plasticity. With pockets of clayey silt.	M				
					CH: CLAY, with minor silt: reddish brown, mixed light grey and orange. Hard, moist, high plasticity.		MS	V-186(66)		
								V-193+		
			2		MH: Clayey SILT: reddish brown. Hard, dry, low plasticity. With sheared and crushed texture.	D		V-UTP		
								V-UTP		
					CH: CLAY: dark reddish grey. Hard, moist, high plasticity. With sheared texture.	M		V-UTP		
			3		ML: SILT: light grey. Hard, dry, low plasticity.	D		V-UTP		
					CH: CLAY, with some silt: dark grey, mottled red. Hard, moist, high plasticity. With sheared texture.					
					CH: CLAY, with trace fine to medium sand: dark red. Hard, moist, high plasticity. Sand consists of completely weathered, extremely weak siltstone.	M		V-UTP		
			4		CL: Silty CLAY: greenish grey, mixed dark red. Hard, dry, low plasticity. With some pockets of SILT and with sheared and crushed textures.	D		V-UTP		
					Borehole terminated at 4.2m					
			5							

Termination reason: Unable to penetrate further

Remarks: Standing groundwater not present at end of borehole

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

Appendix D: Stability Analysis



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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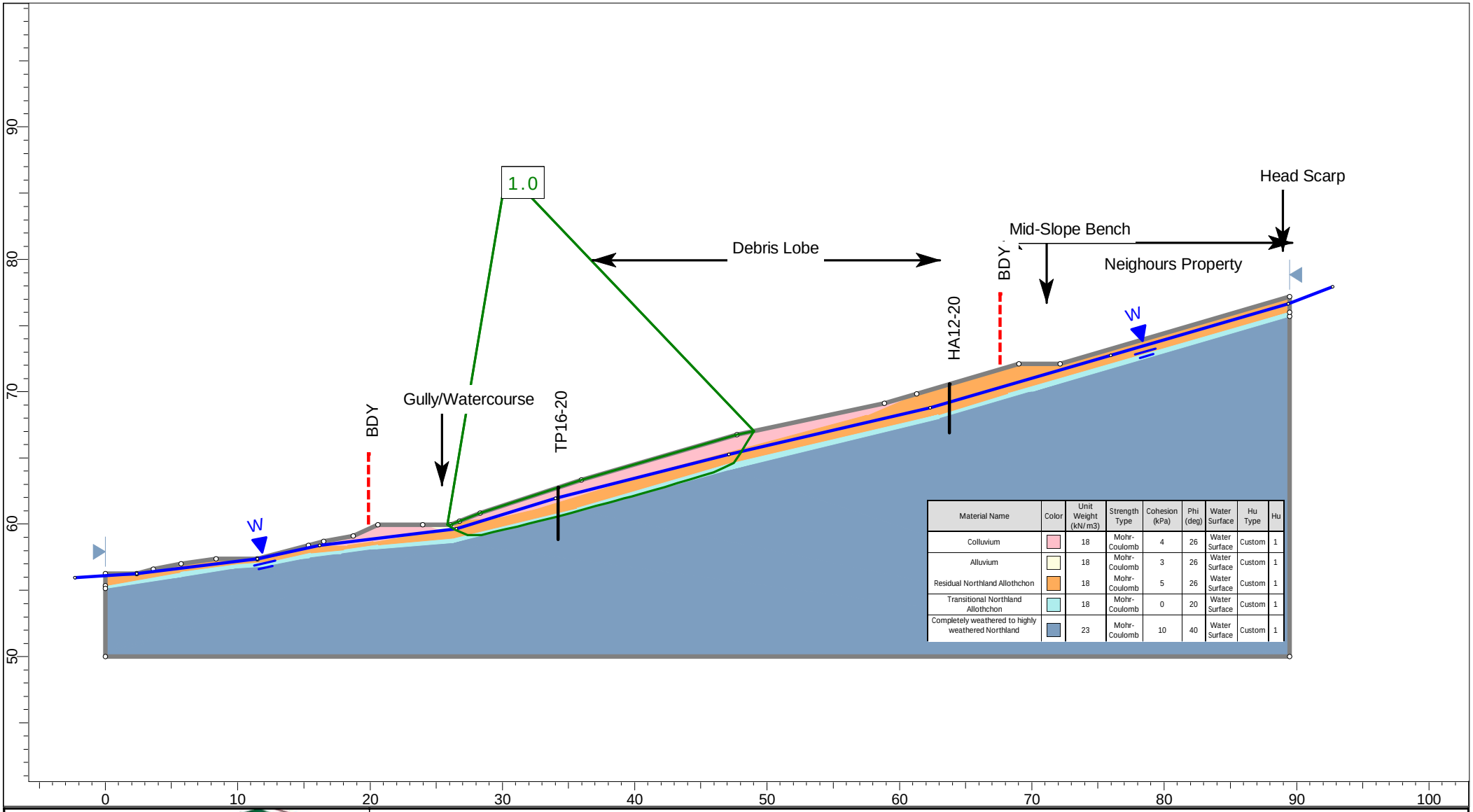
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section A - Existing Profile, Normal Groundwater		
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company* Build Rich
			File Name AKL2020-0125 Section A 23082021 SP.slmd

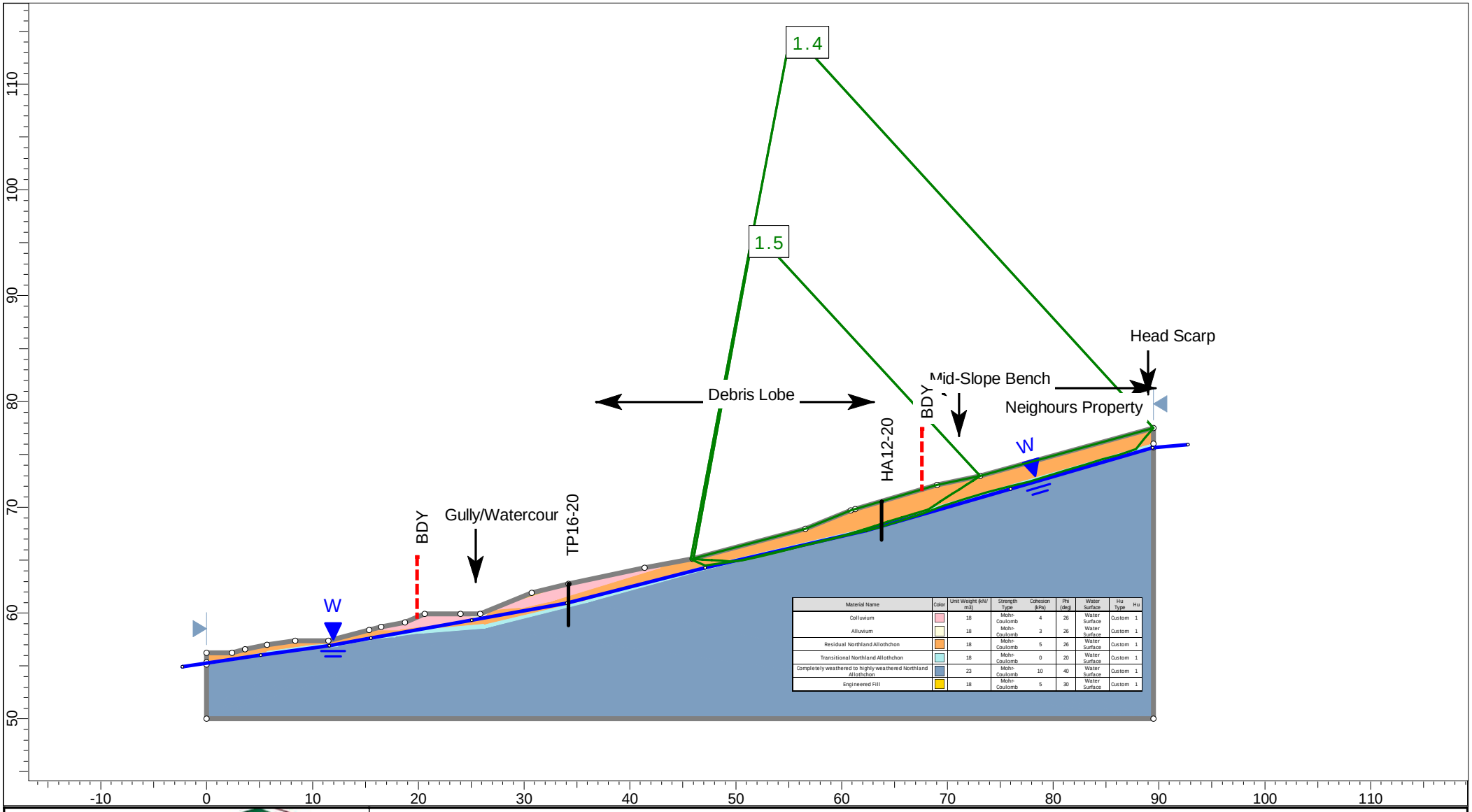


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section A - Existing Profile, High Groundwater		
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company* Build Rich
			File Name AKL2020-0125 Section A 23082021 SP.slmd



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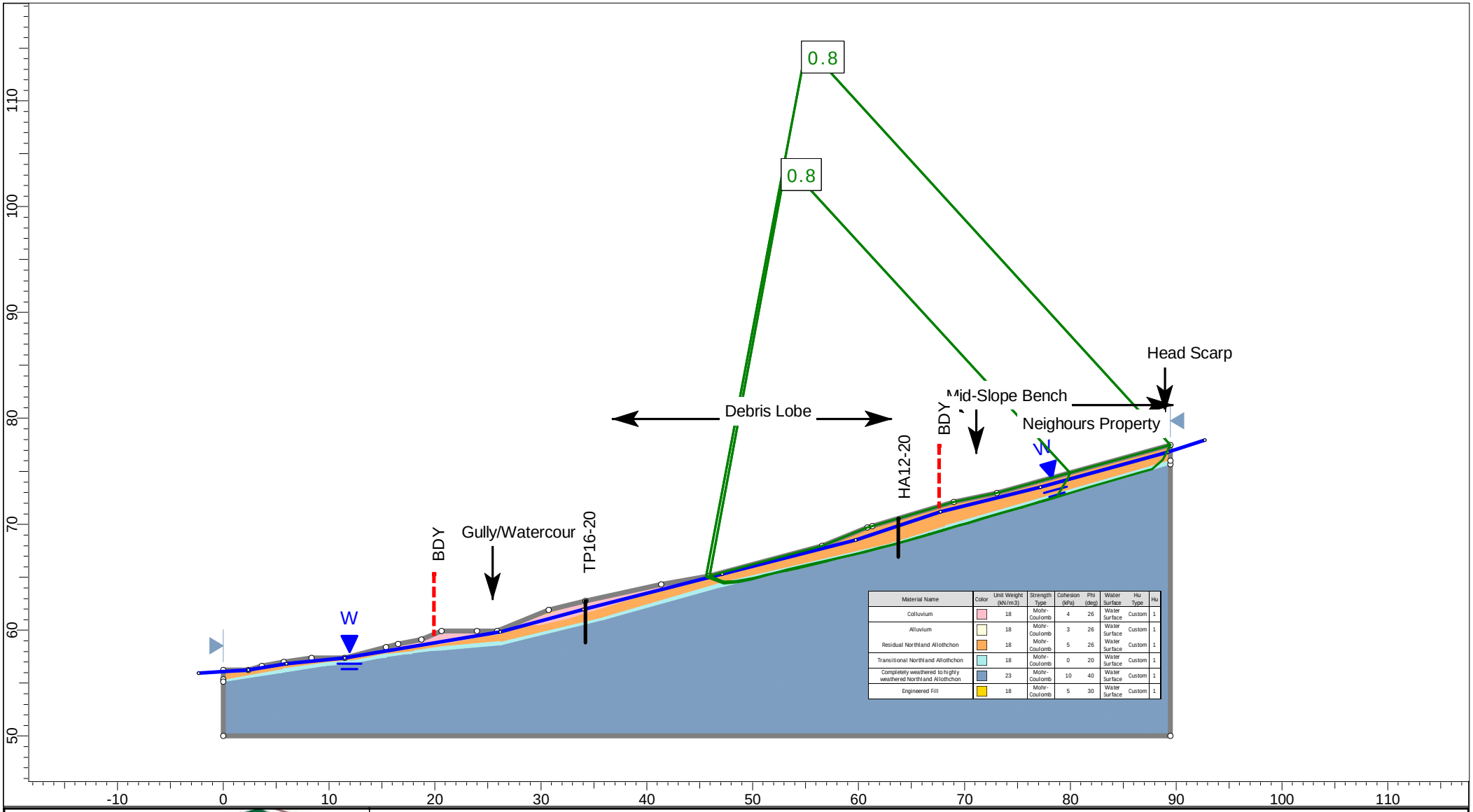
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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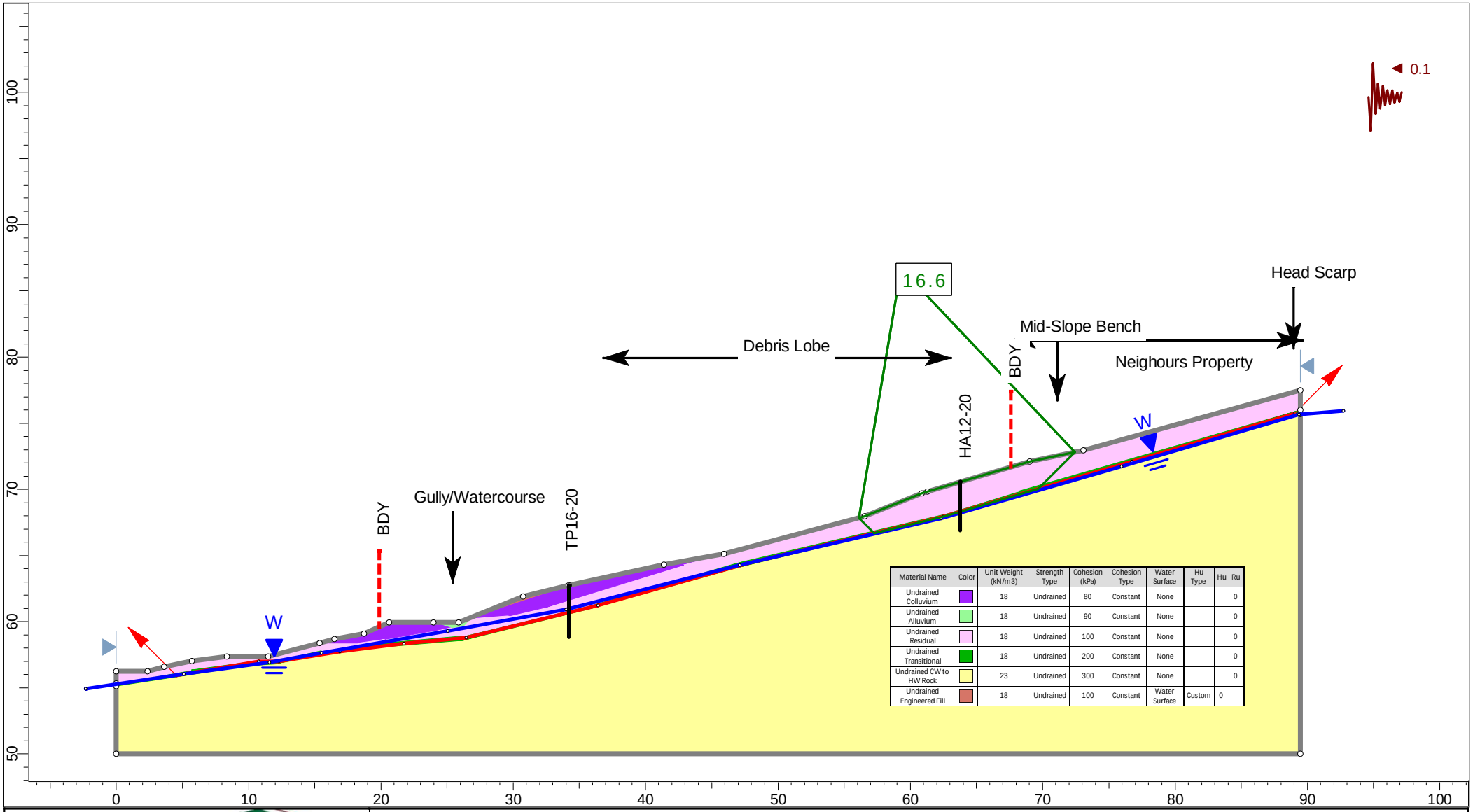
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu	Ru
Undrained Colluvium		18	Undrained	80	Constant	None			0
Undrained Alluvium		18	Undrained	90	Constant	None			0
Undrained Residual		18	Undrained	100	Constant	None			0
Undrained Transitional		18	Undrained	200	Constant	None			0
Undrained CW to HW Rock		23	Undrained	300	Constant	None			0
Undrained Engineered Fill		18	Undrained	100	Constant	Water Surface	Custom	0	

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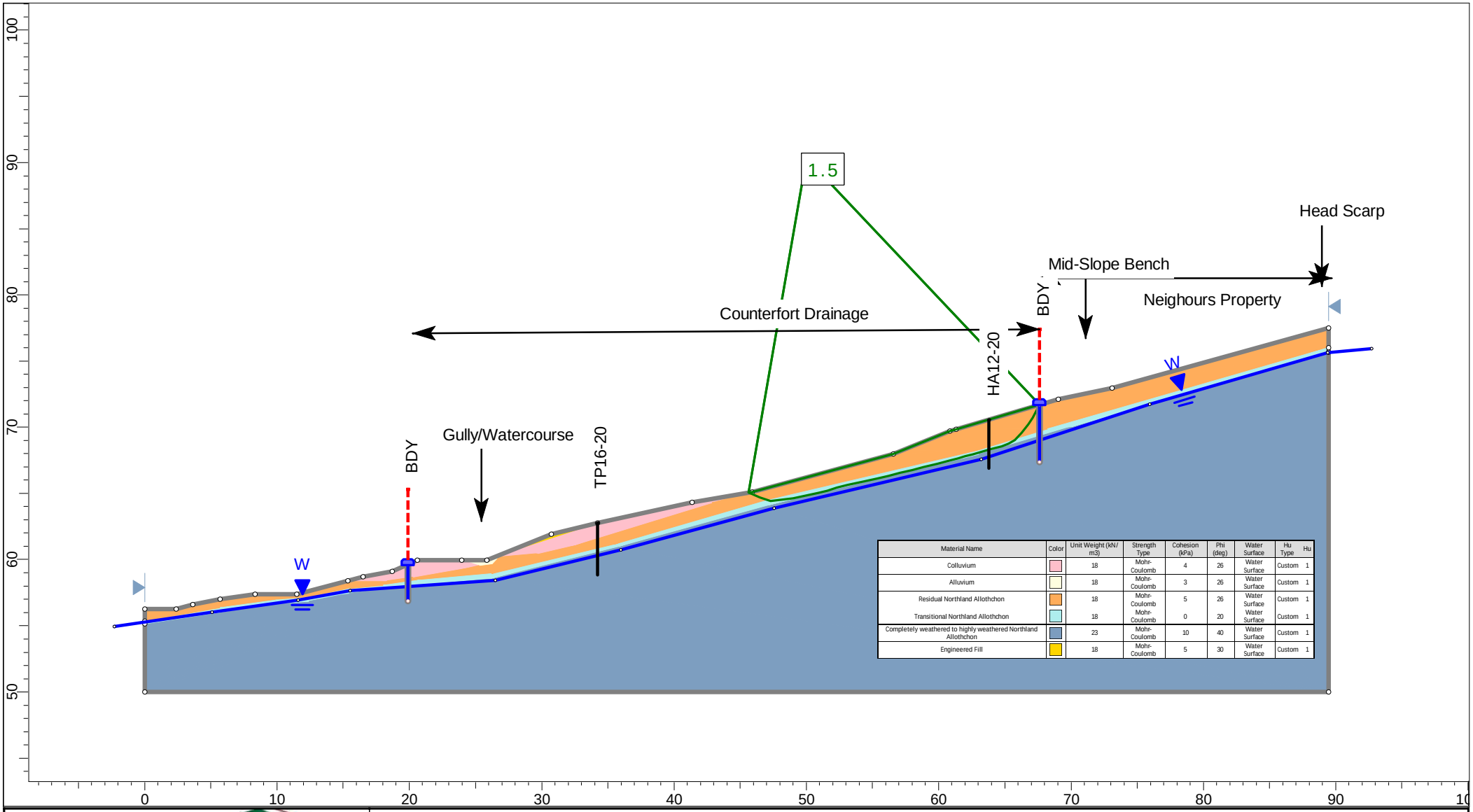
Project	Silverdale South - Stage 3&4		
Analysis Description	Section A - Proposed Profile, Seismic		
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company* Build Rich
			File Name AKL2020-0125 Section A 23082021 SP.slmd



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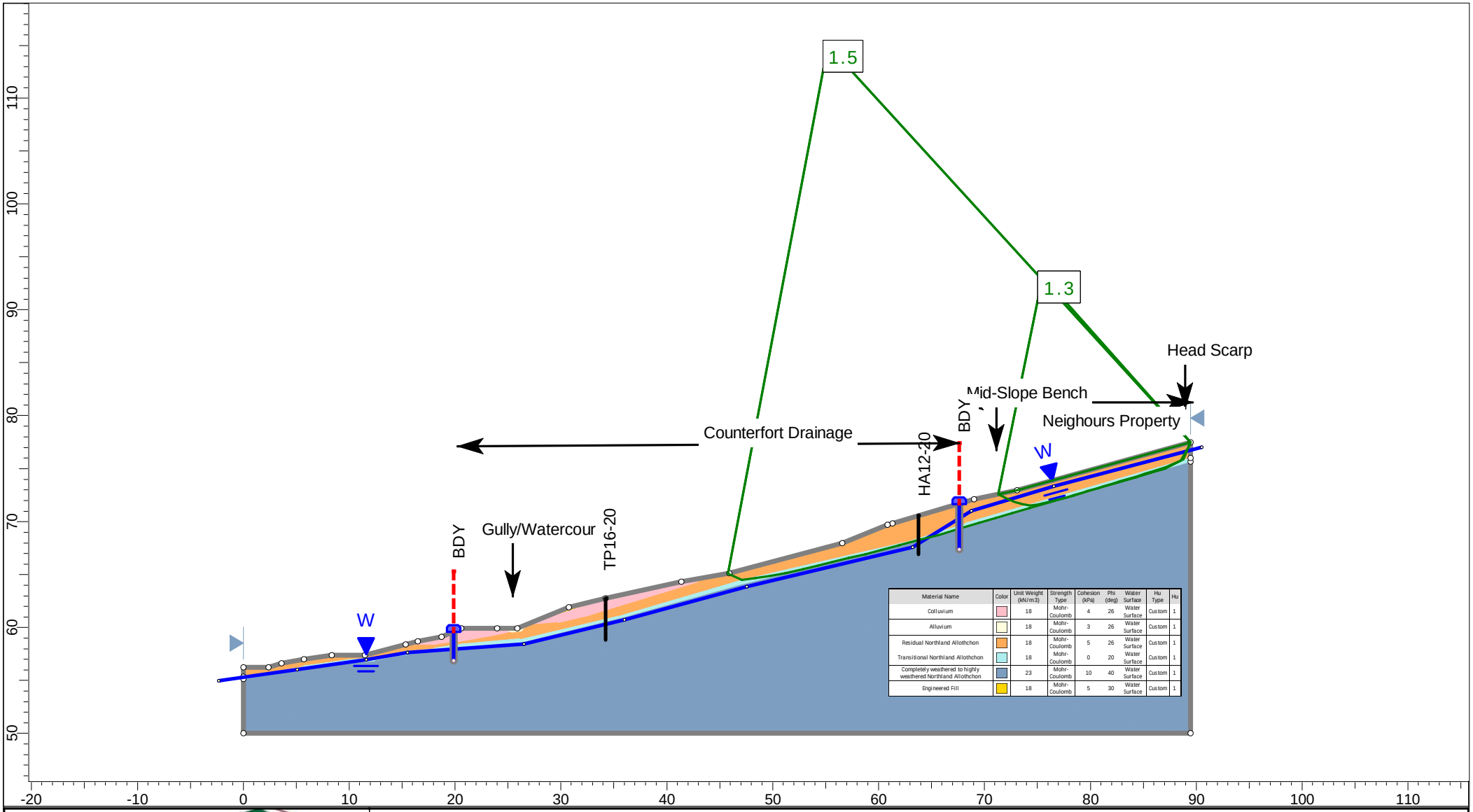
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Remediated , Normal Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section A - Remediated , High Groundwater		
	Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company* Build Rich
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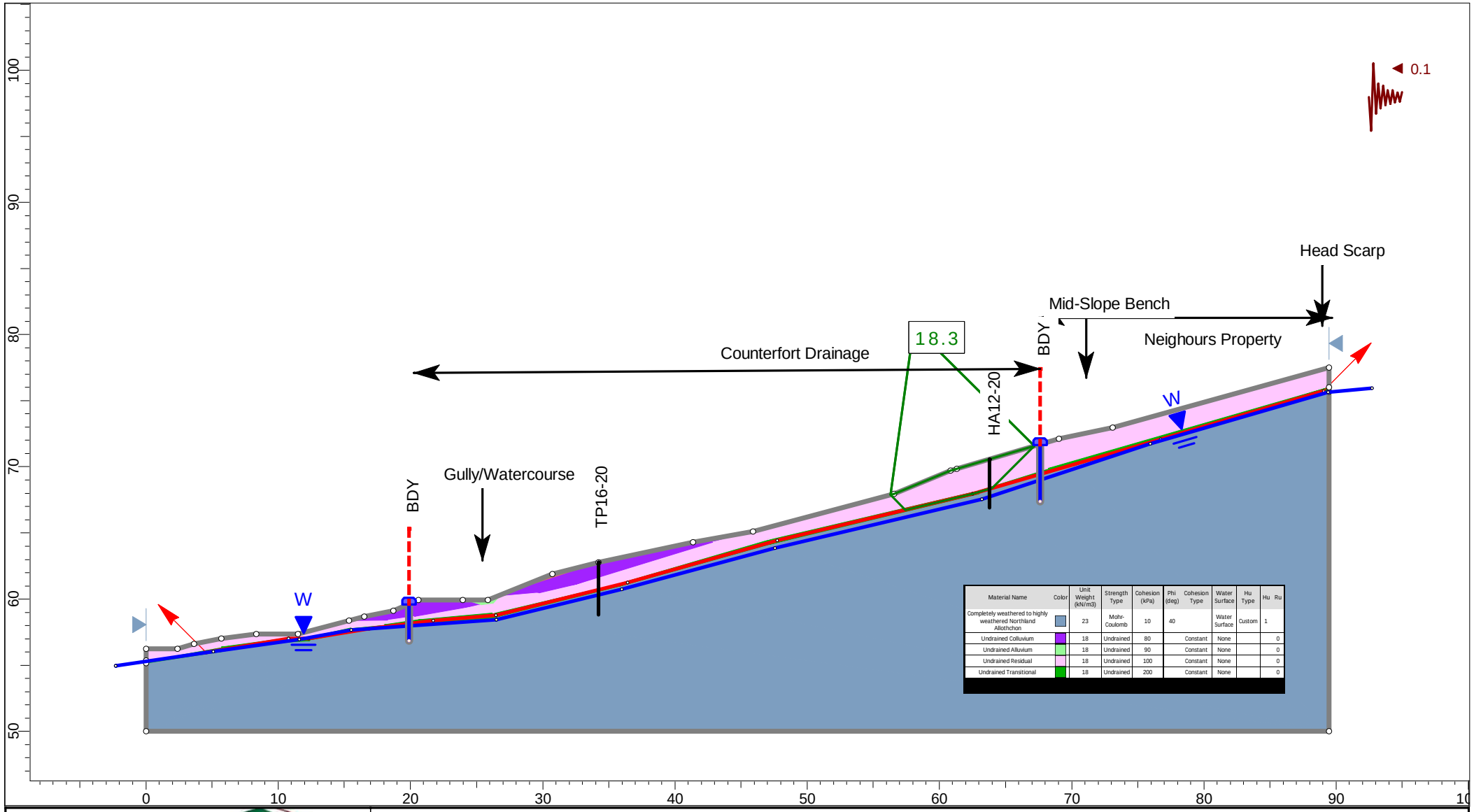
SLIDEINTERP 9.018



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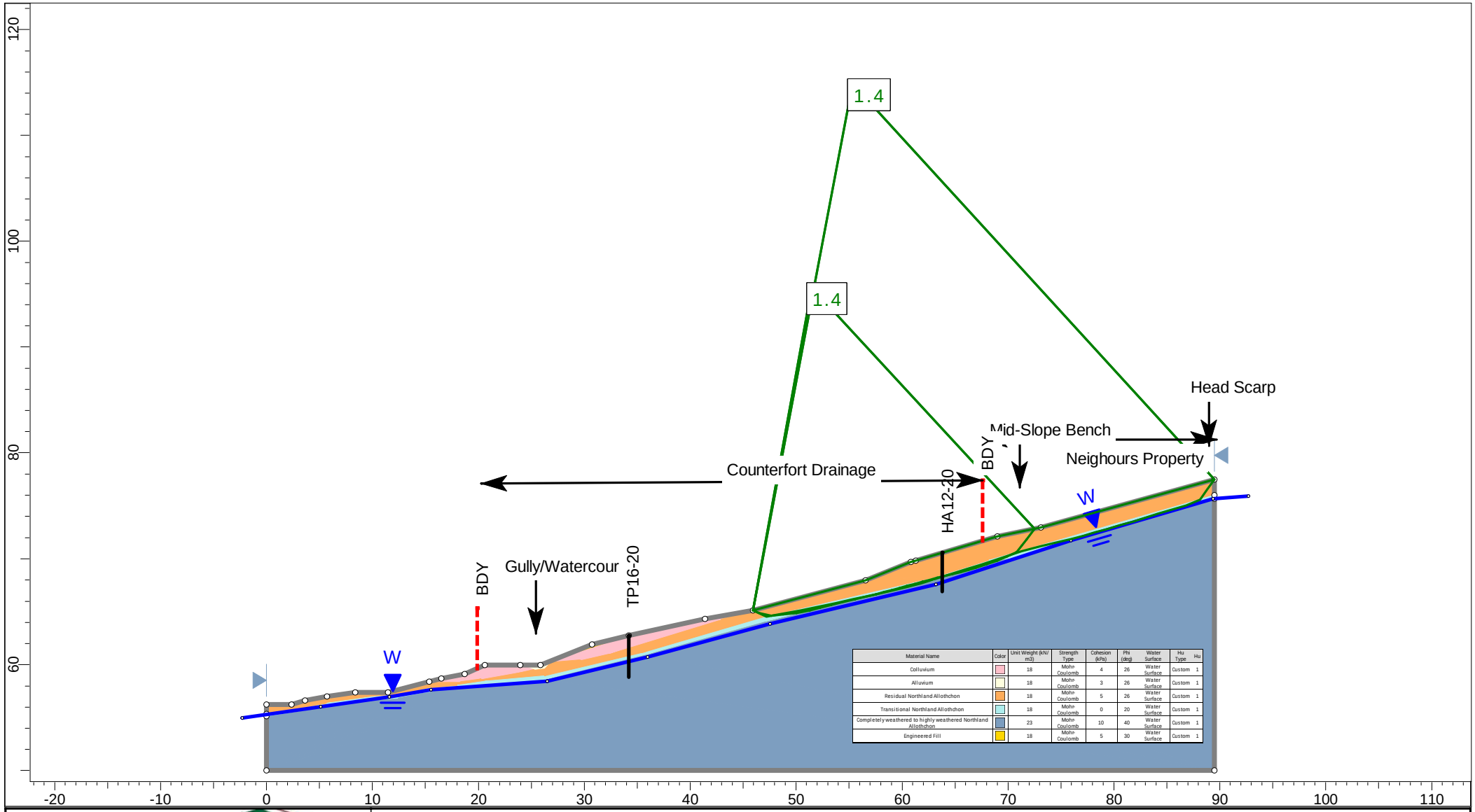
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Remediated , Seismic			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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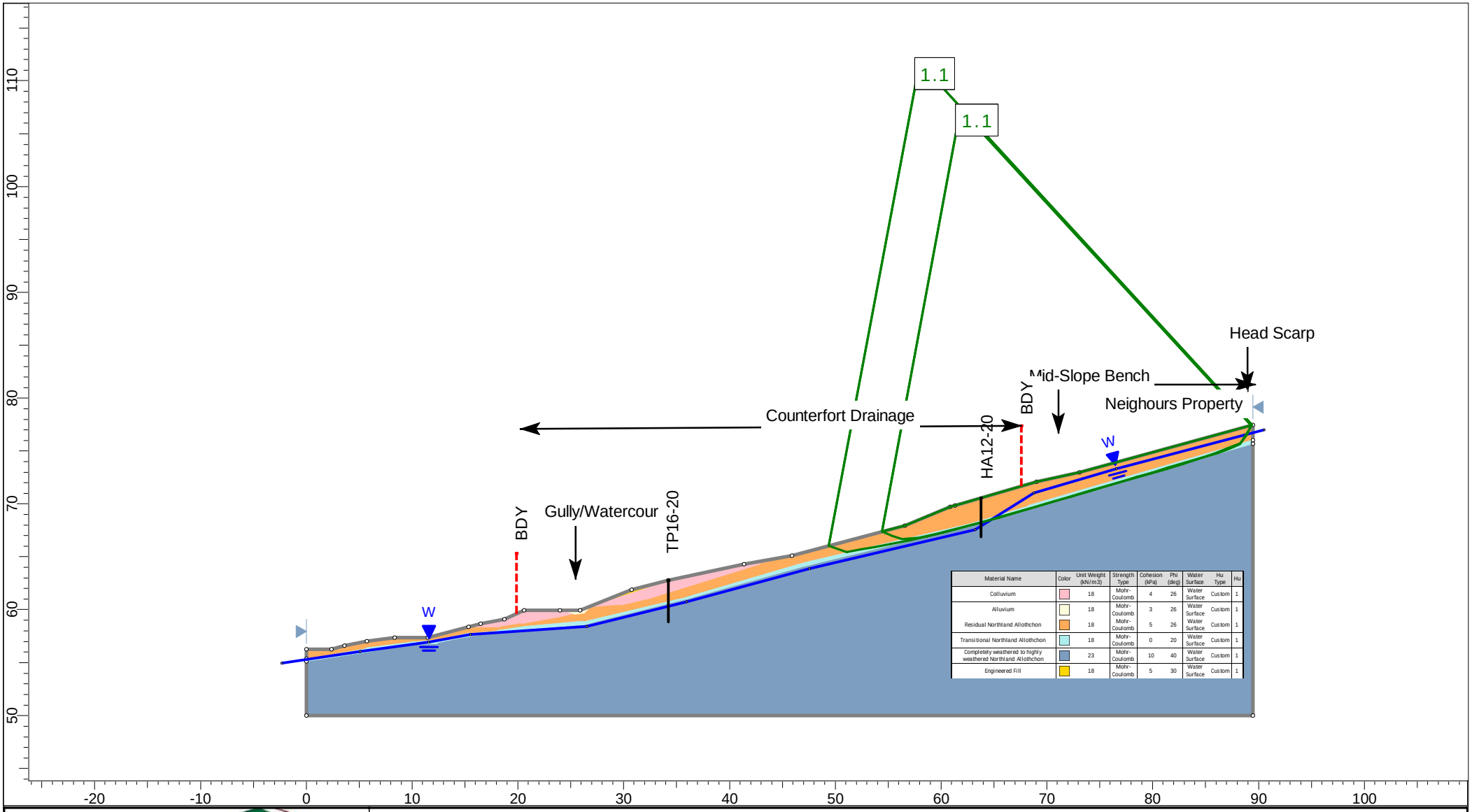
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Counterfort Remediation Only, Normal Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



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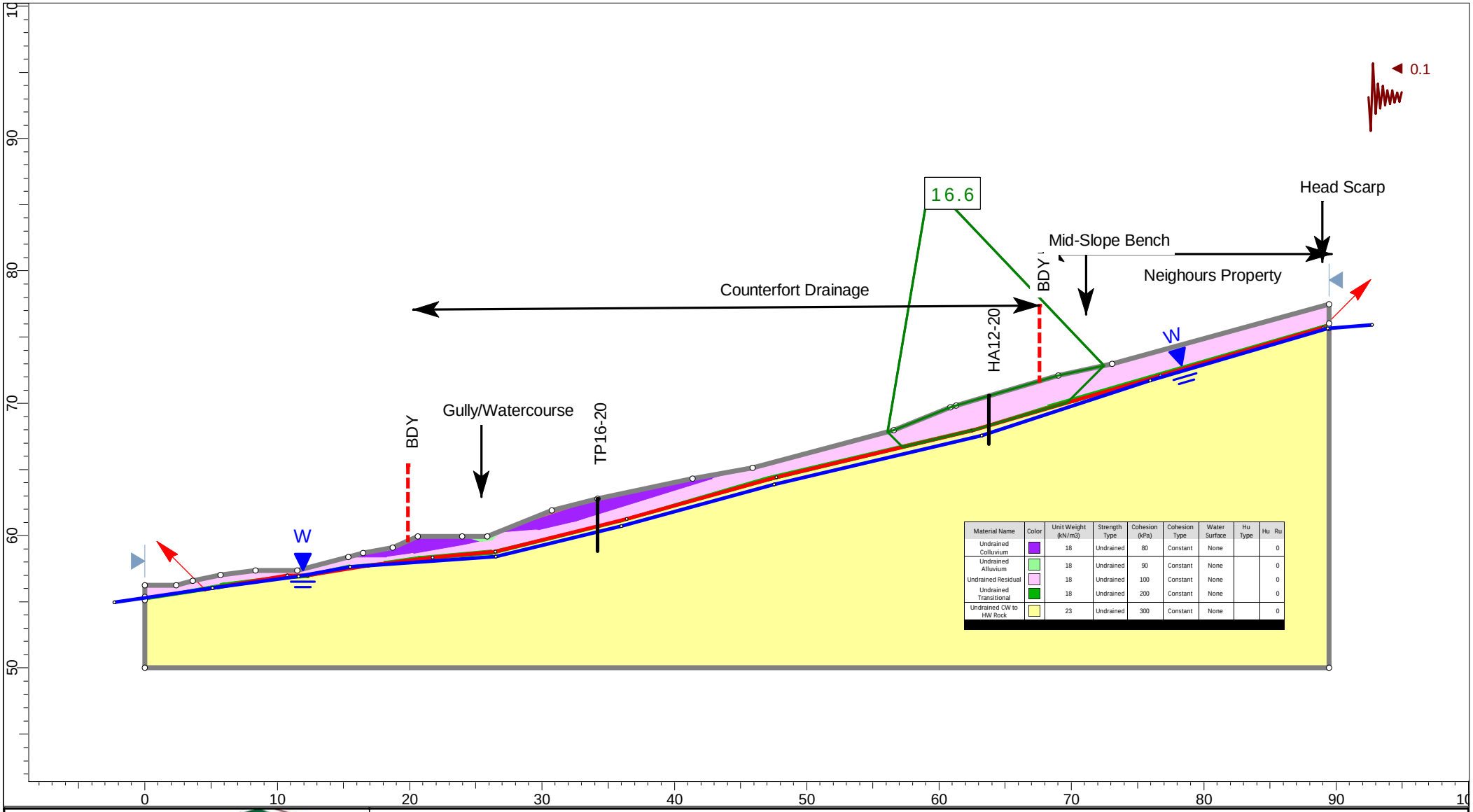
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Counterfort Remediation Only, High Groundwater			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:500	*Company*	Build Rich
			File Name	AKL2020-0125 Section A 23082021 SP.slmd



CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section A - Counterfort Remediation Only, Seismic			
Drawn By SP	*Date:* 2/09/2021	*Scale* 1:400	*Company*	Build Rich
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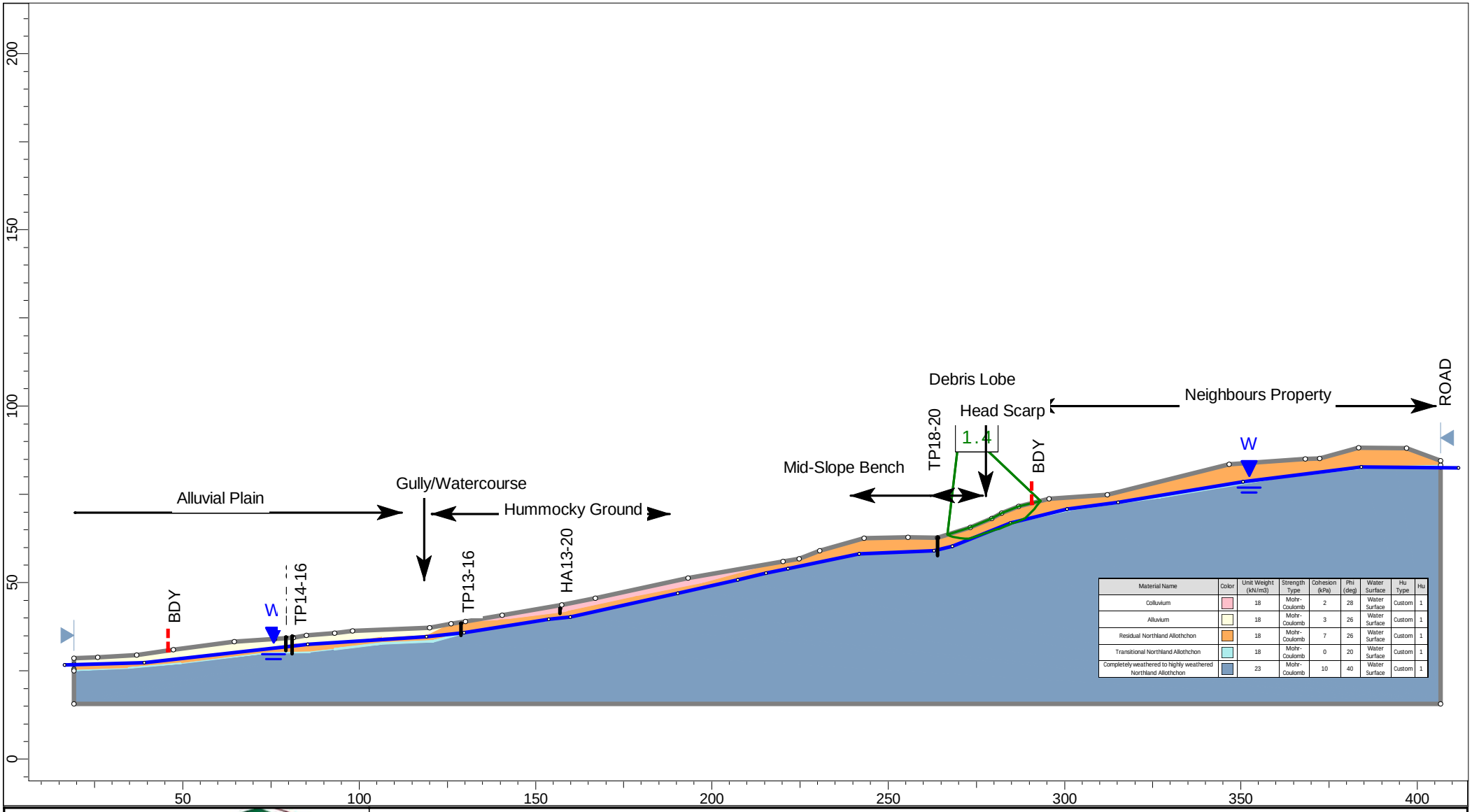

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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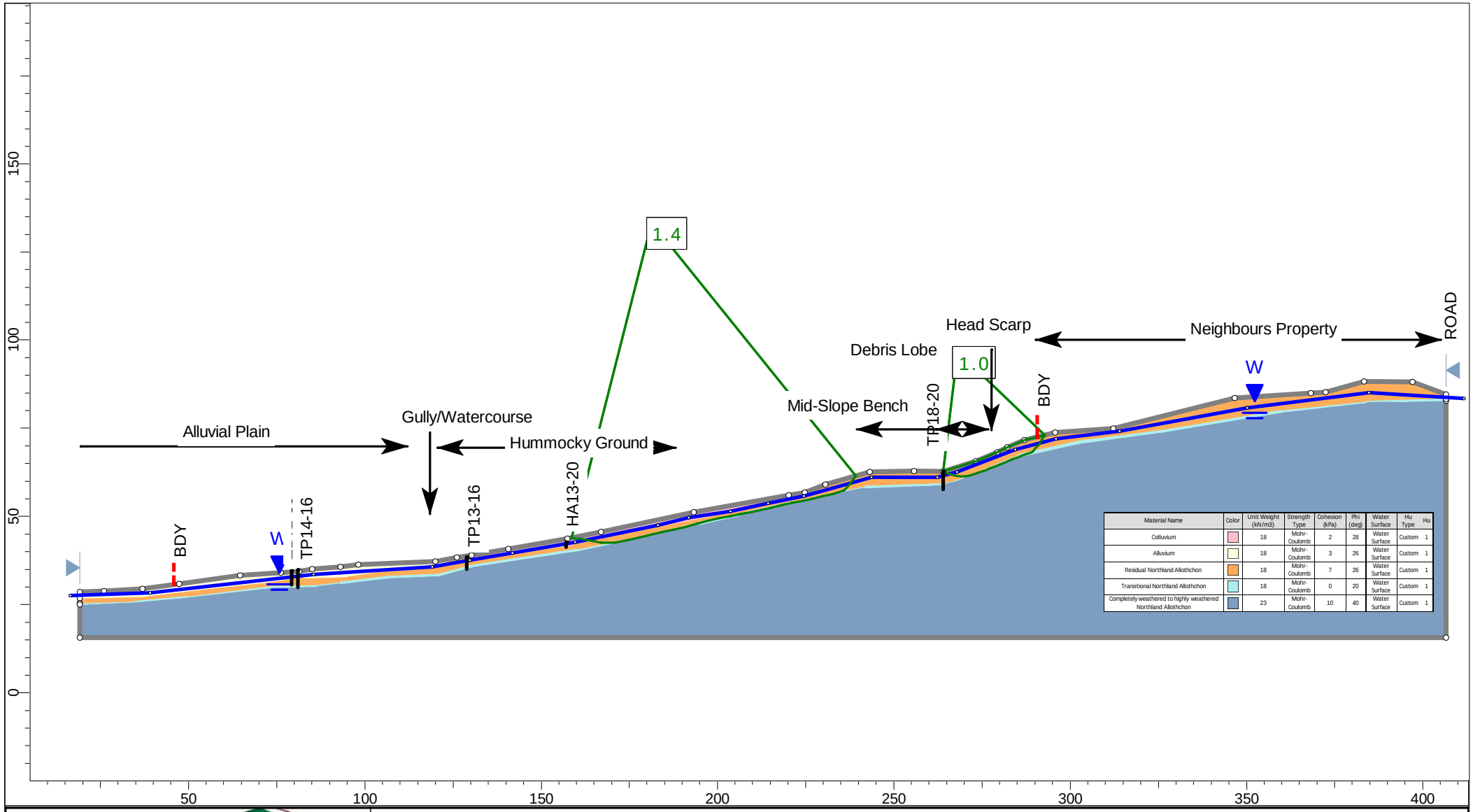
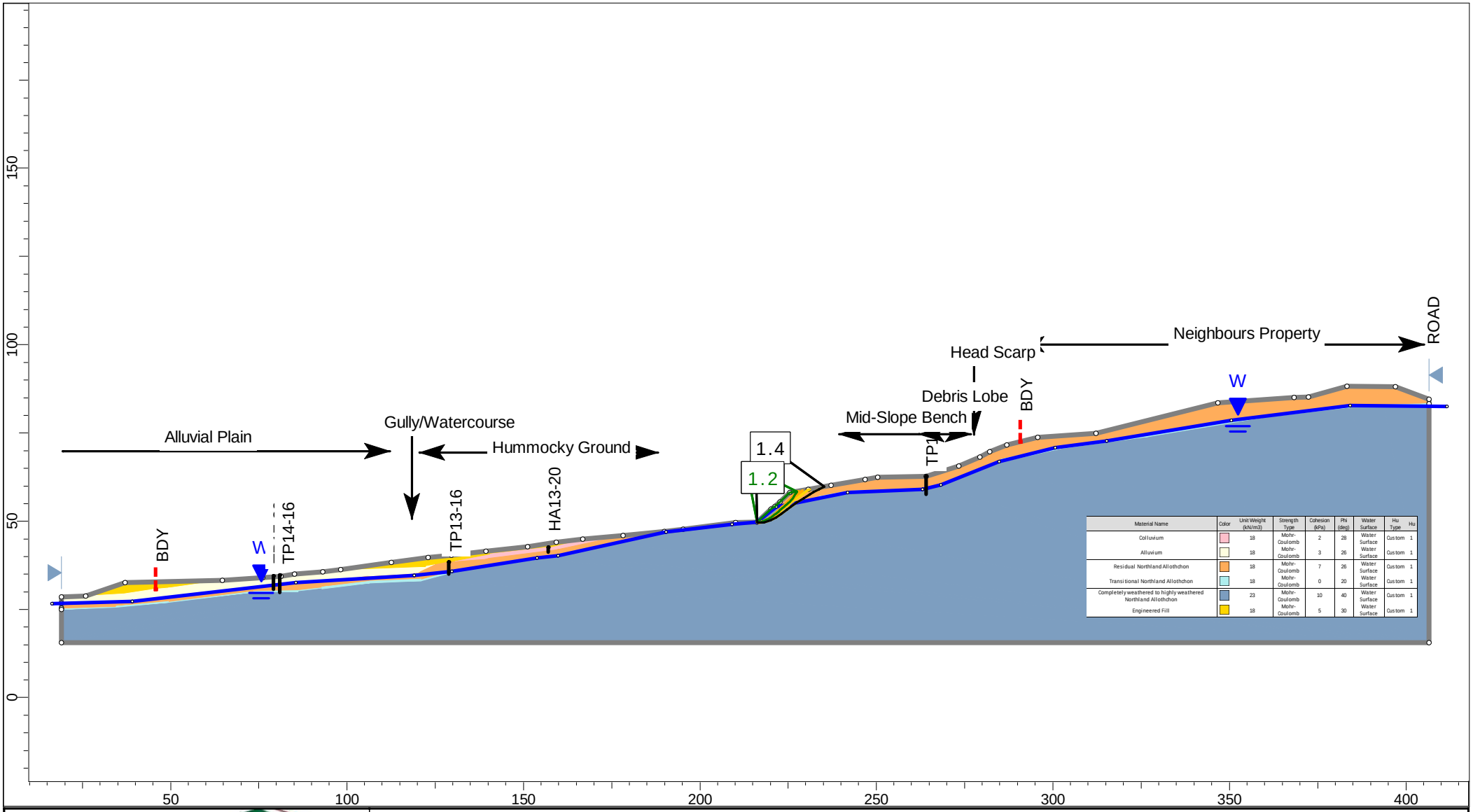
Project	Silverdale South Stage 3&4			
Analysis Description	Section B - Existing, Normal Groundwater			
Drawn By SP	*Date:* 10/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd



CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section B - Existing, High Groundwater			
Drawn By SP	*Date:* 10/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section B - Proposed Profile, Normal Groundwater		
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd

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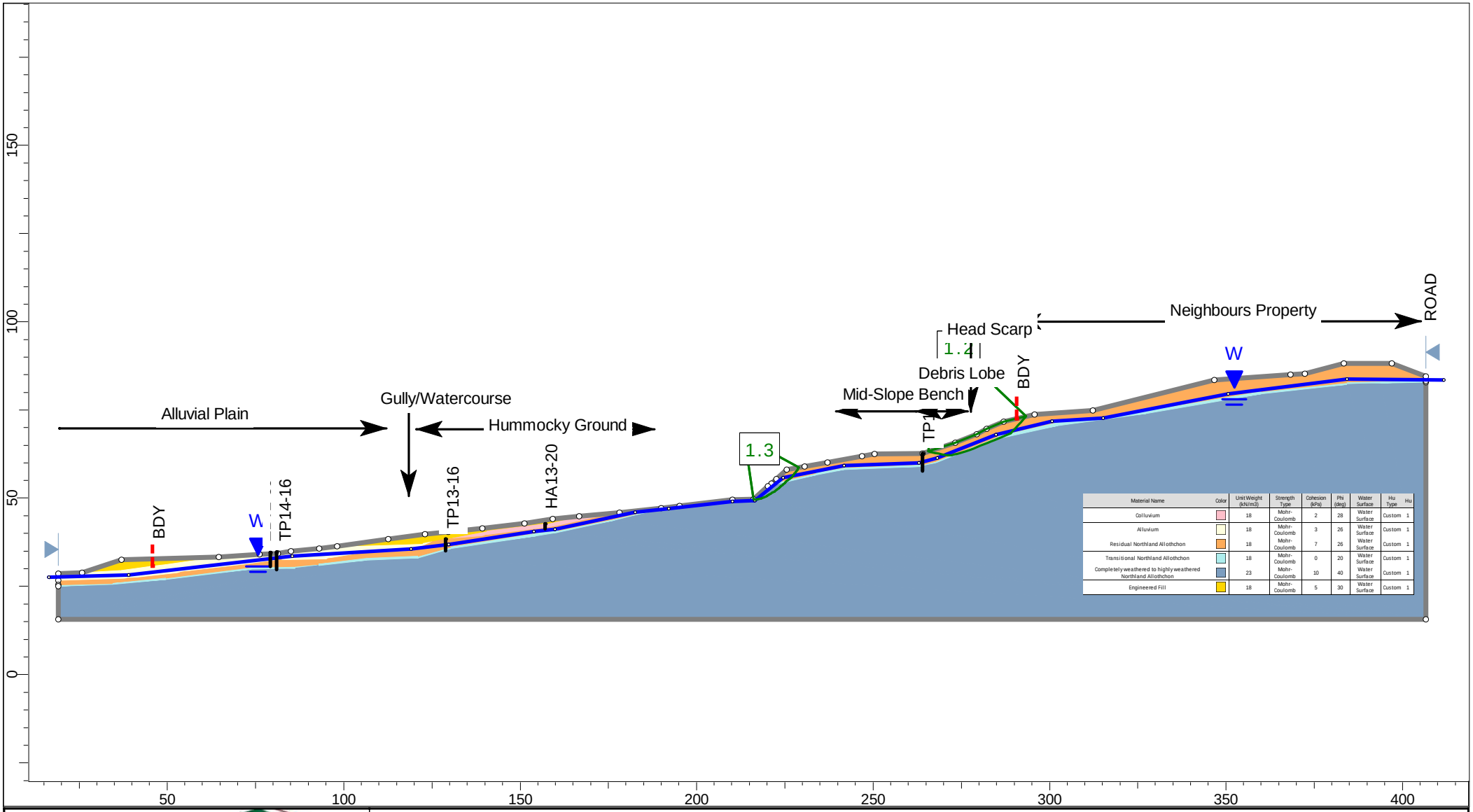

CMW Geosciences	Project: Silverdale South - Stage 3&4			
	Analysis Description: Section B - Proposed Profile, High Groundwater			
	Drawn By: SP	Date: 3/09/2021	Scale: 1:1500	Company: Build Rich
				File Name: AKL2020-0125 Section B Proposed 16082021 SP.slmd

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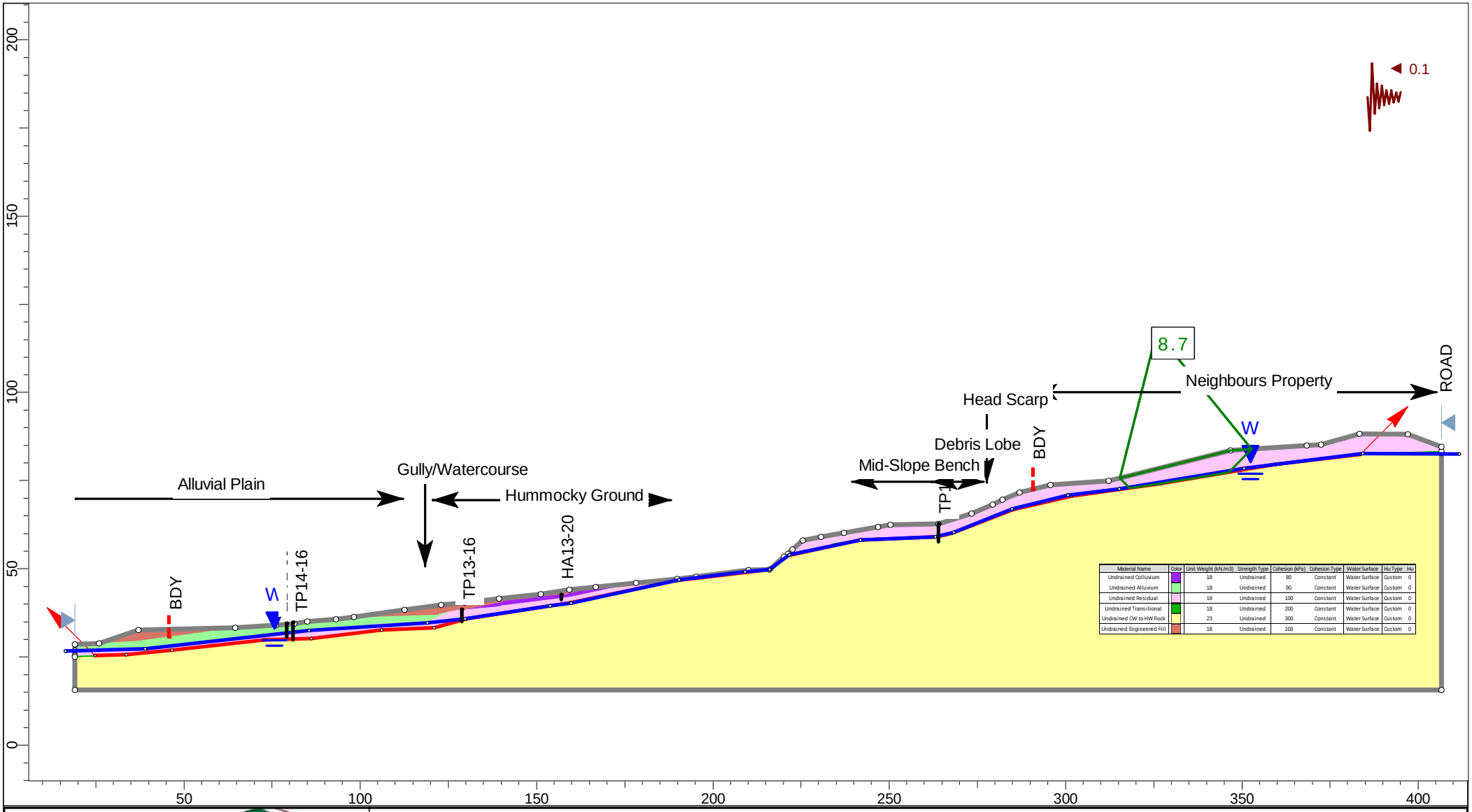

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu
Undrained Colluvium		18	Undrained	80	Constant	Water Surface	Custom	0
Undrained Alluvium		18	Undrained	90	Constant	Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant	Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant	Water Surface	Custom	0
Undrained CW to HW Rock		23	Undrained	300	Constant	Water Surface	Custom	0
Undrained Engineered Fill		18	Undrained	100	Constant	Water Surface	Custom	0

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SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section B - Proposed Profile, Seismic			
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company*	Build Rich
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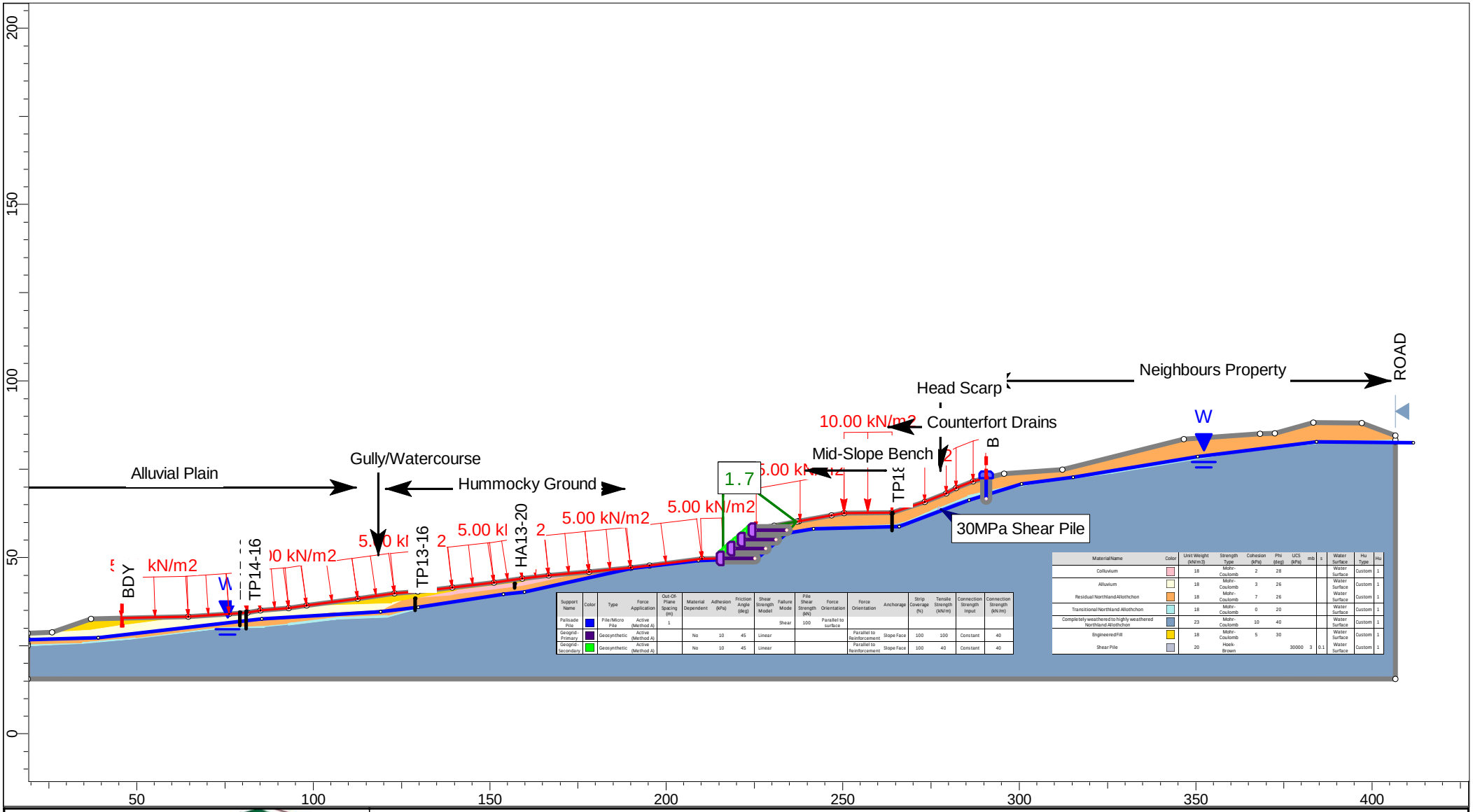
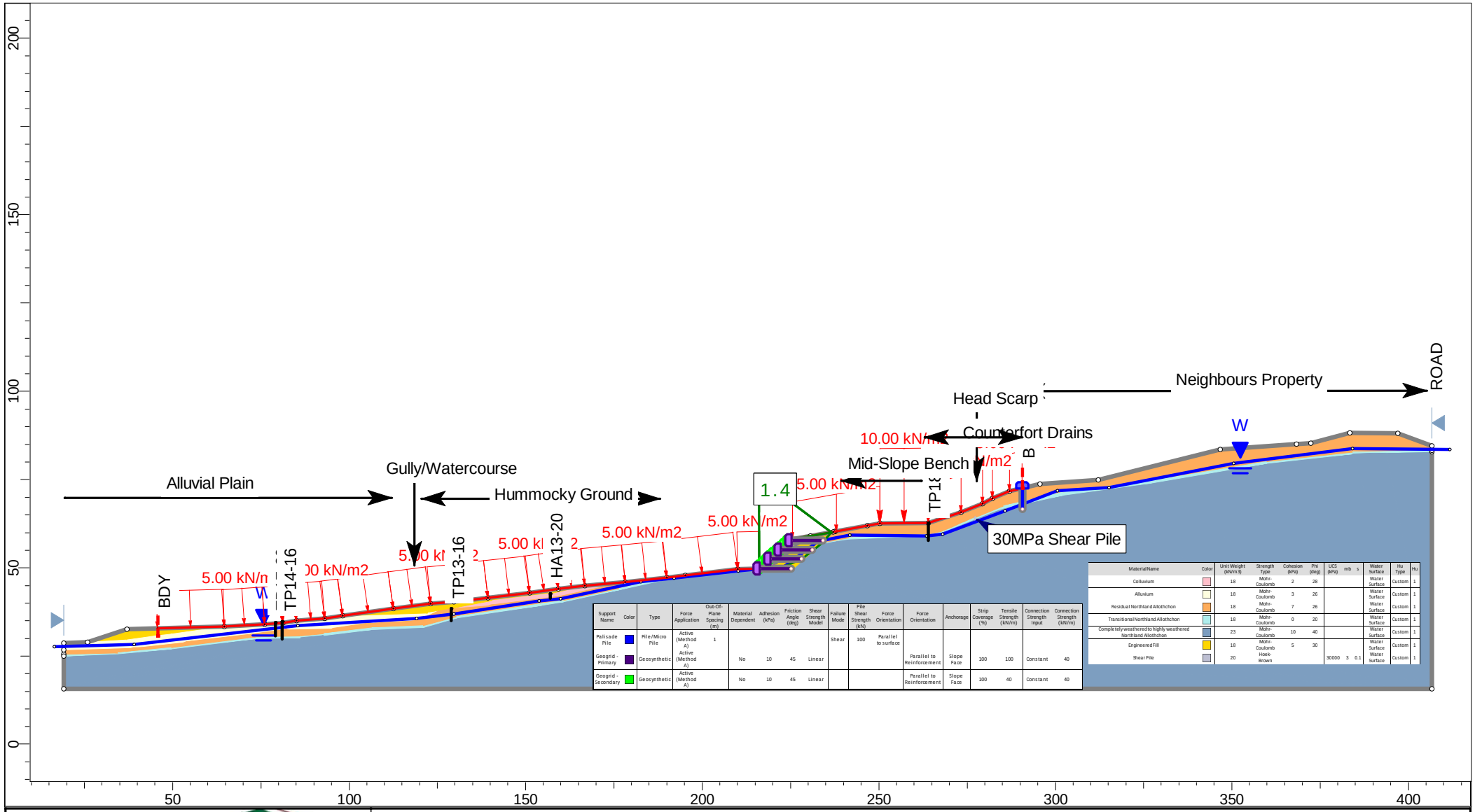


CMW Geosciences	Project: Silverdale South - Stage 3&4		
	Analysis Description: Section B - Remediated Profile MSE Wall, Normal Groundwater		
Drawn By: SP	Date: 3/09/2021	Scale: 1:1500	Company: Build Rich
			File Name: AKL2020-0125 Section B Proposed 16082021 SP.slmd

SLIDEINTERP 9.018



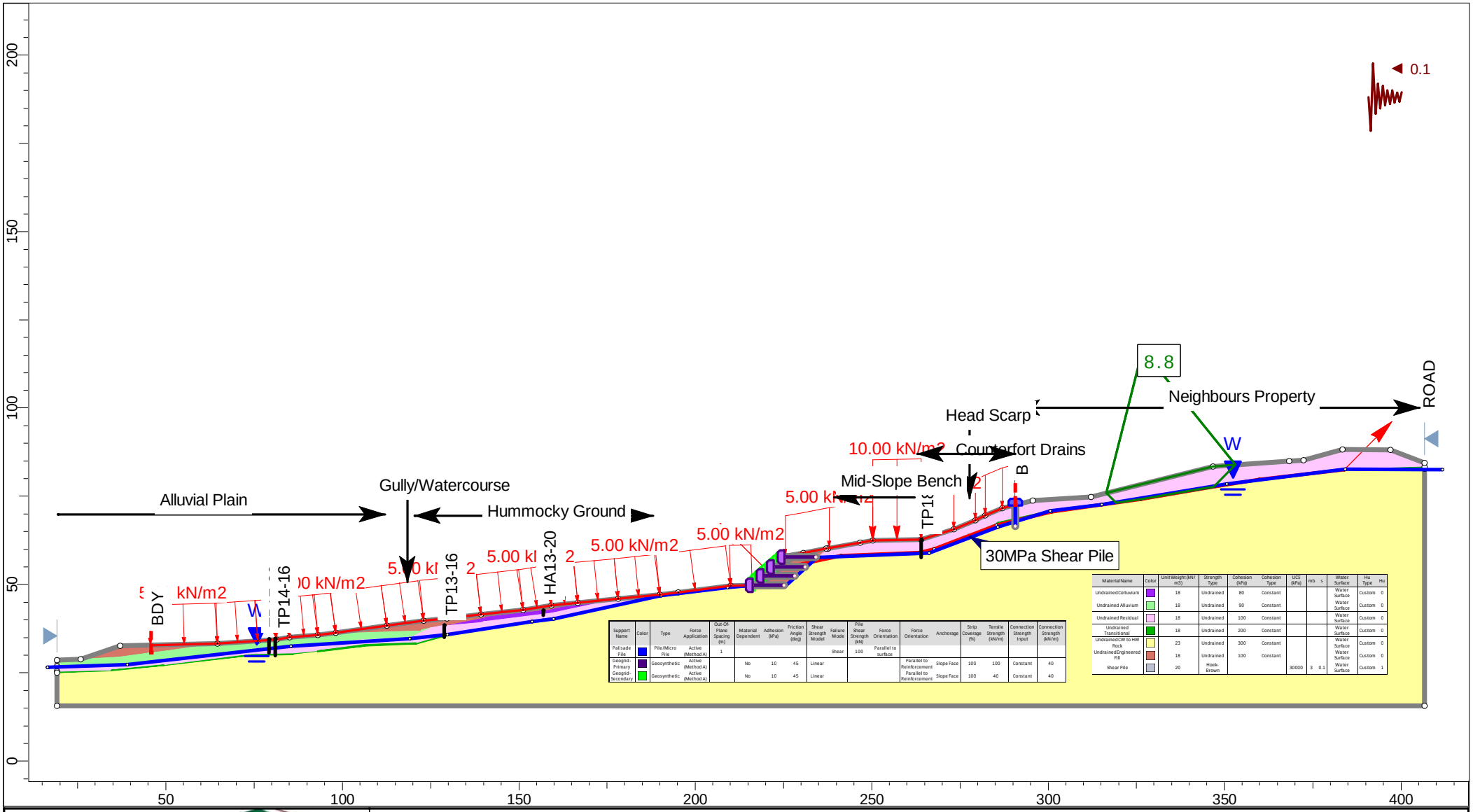
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1					Shear	100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

MaterialName	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28				Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26				Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26				Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20				Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40				Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30				Water Surface	Custom	1
Shear Pile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1

CMW Geosciences

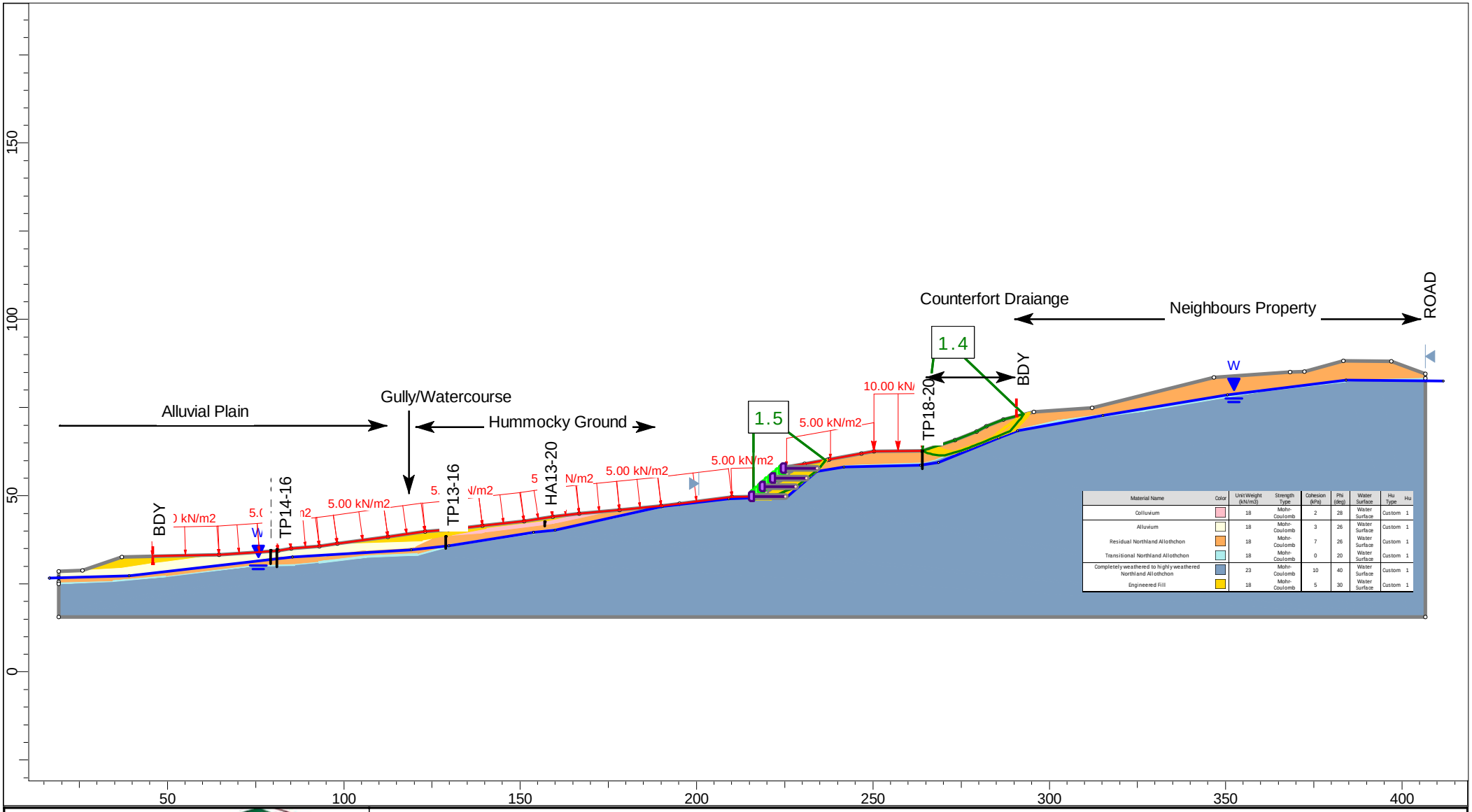
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section B - Remediated Profile MSE Wall, High Groundwater		
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
			File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd



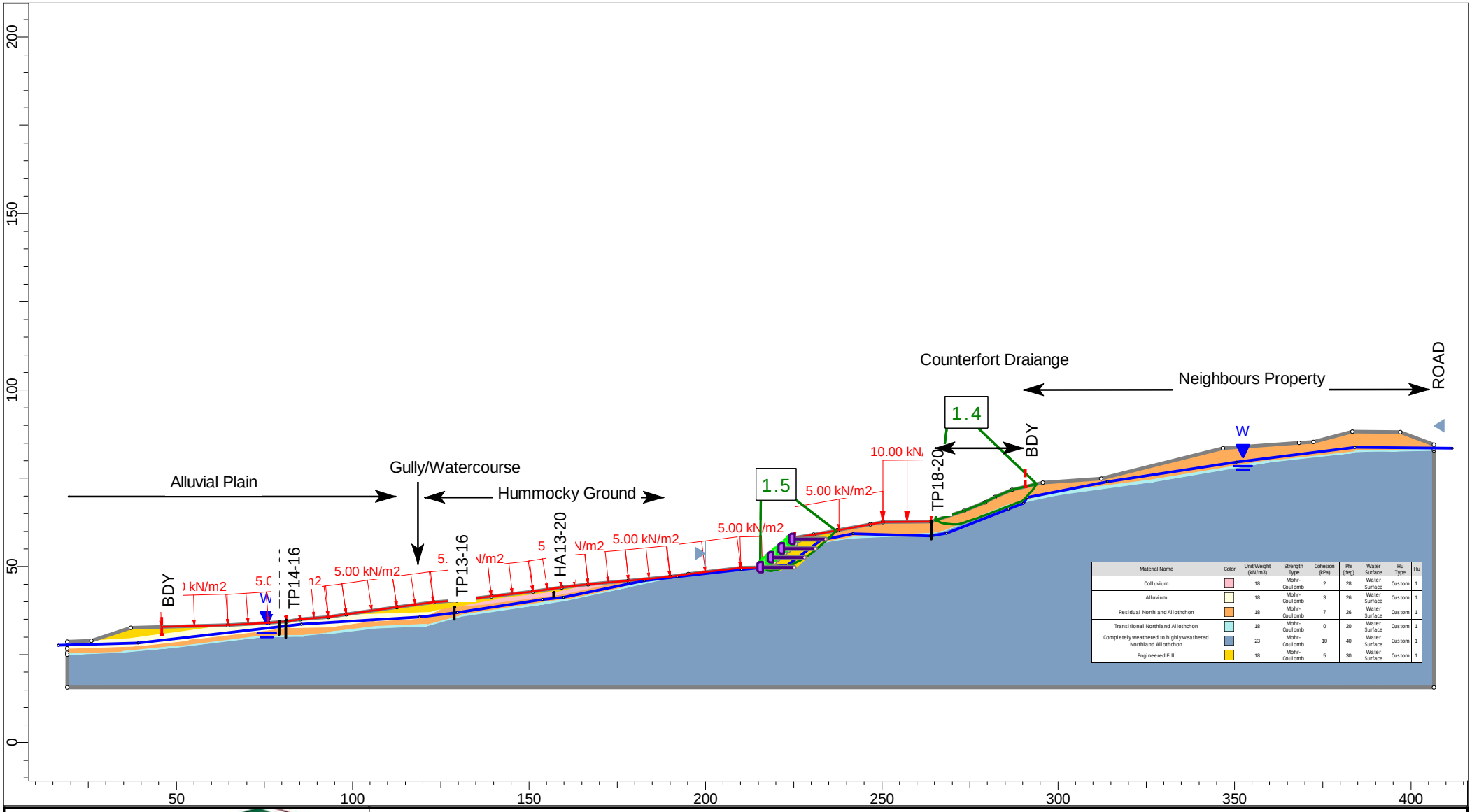
CMW Geosciences	Project: Silverdale South - Stage 3&4		
	Analysis Description: Section B - Remediated Profile MSE Wall, Seismic		
Drawn By: SP	Date: 3/09/2021	Scale: 1:1500	Company: Build Rich
			File Name: AKL2020-0125 Section B Proposed 16082021 SP.slmd

SLIDEINTERP 9.018



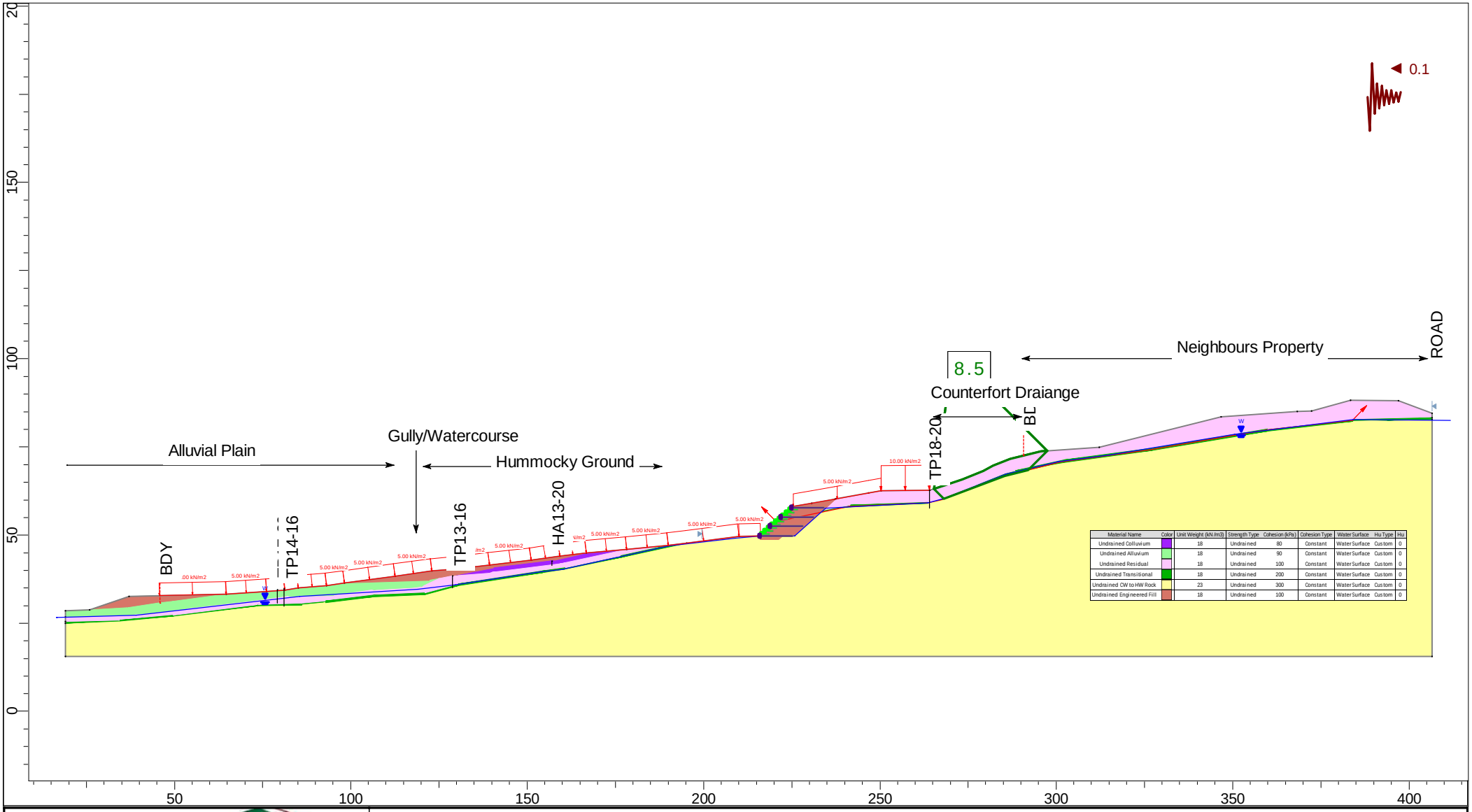
CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section B - Counterfort Remediation Only, Normal Groundwater		
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd

SLIDEINTERP 9.018



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section B - Counterfort Remediation Only, High Groundwater		
	Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section B Proposed 16082021 SP.slmd

SLIDEINTERP 9.018



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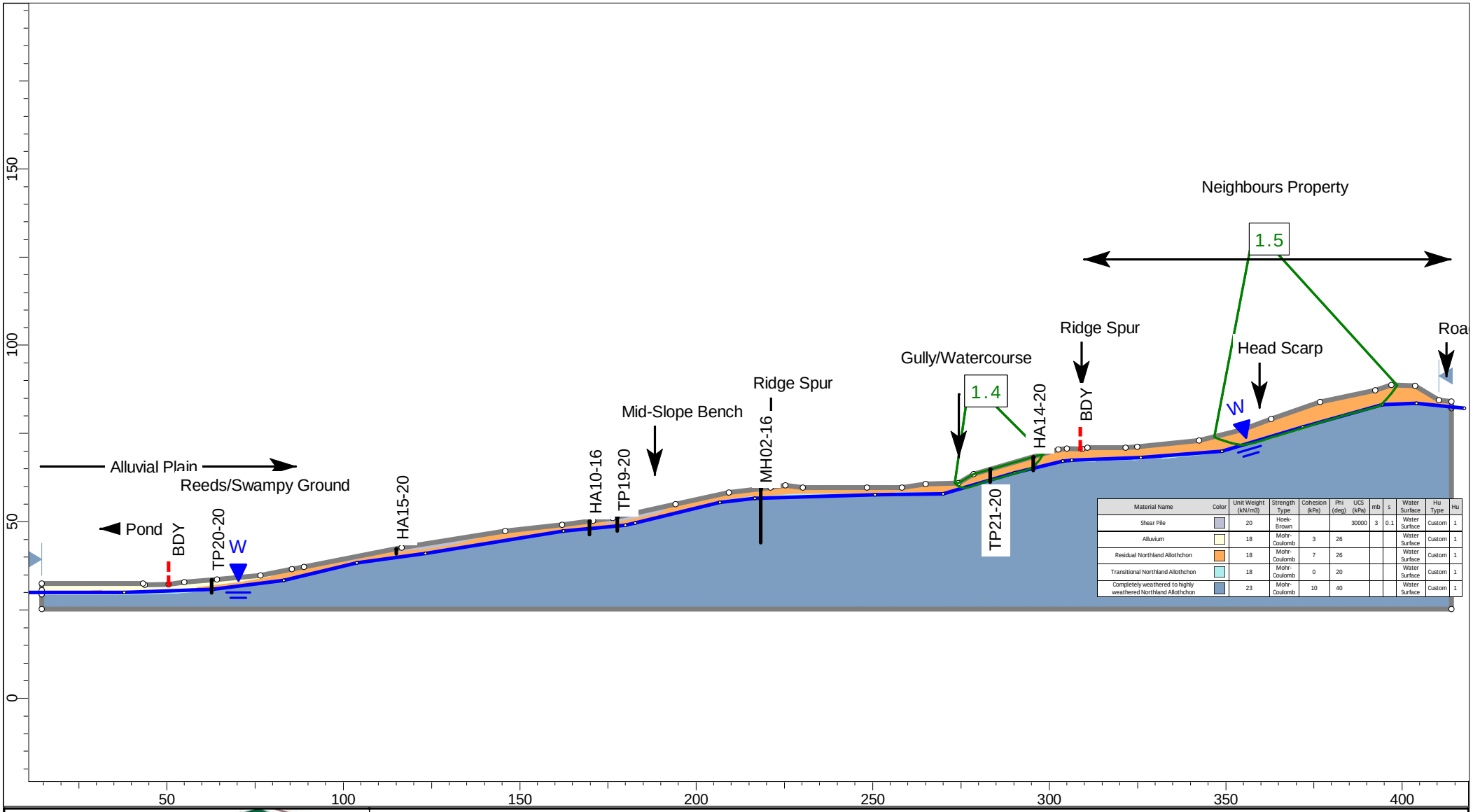
SLIDEINTERP 9.018

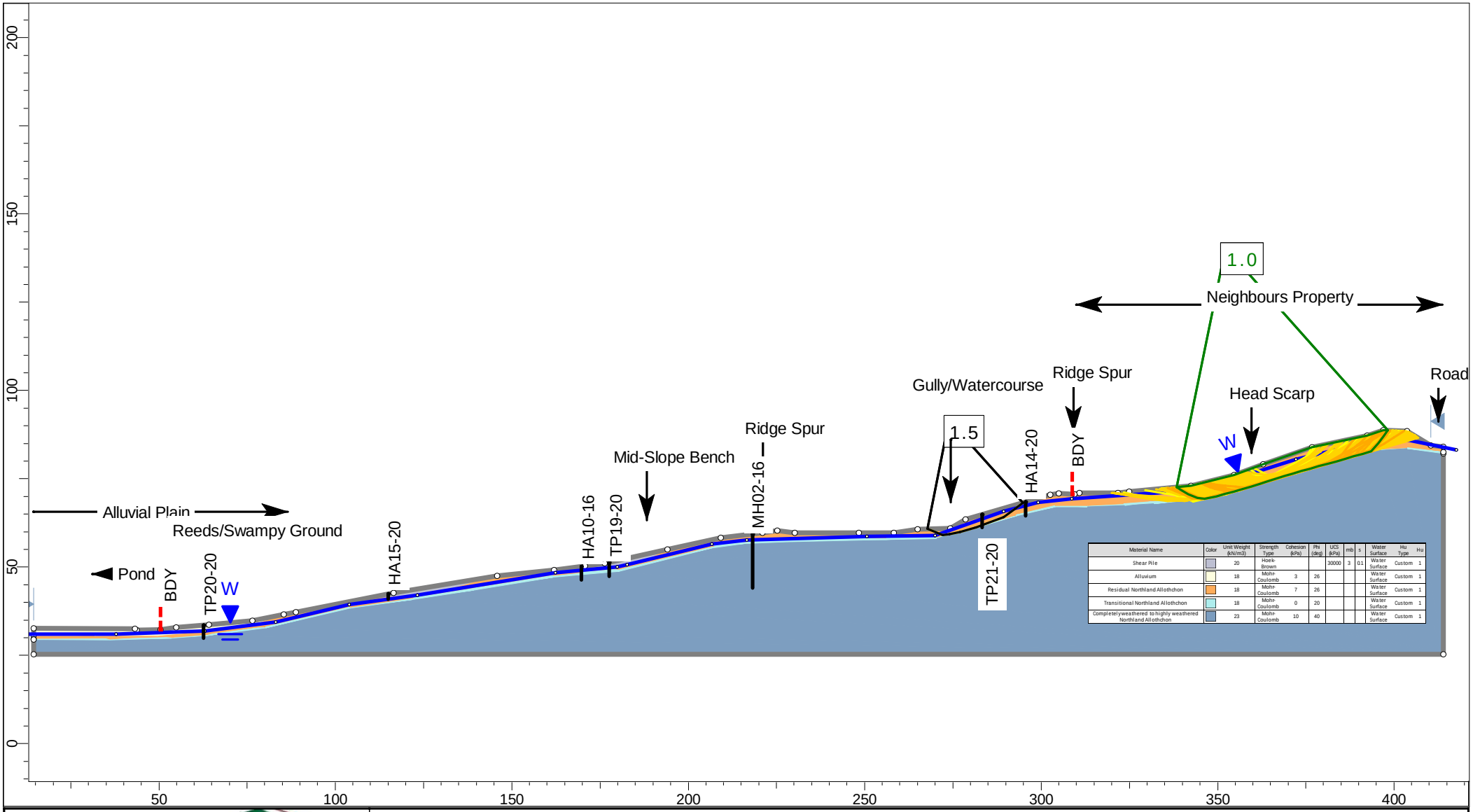
Project	Silverdale South - Stage 3&4			
Analysis Description	Section B - Counterfort Remediation Only, Seismic			
Drawn By SP	*Date:* 3/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section B Proposed 16082021 SP.slmd



CMW Geosciences

SLIDEINTERP 9.018

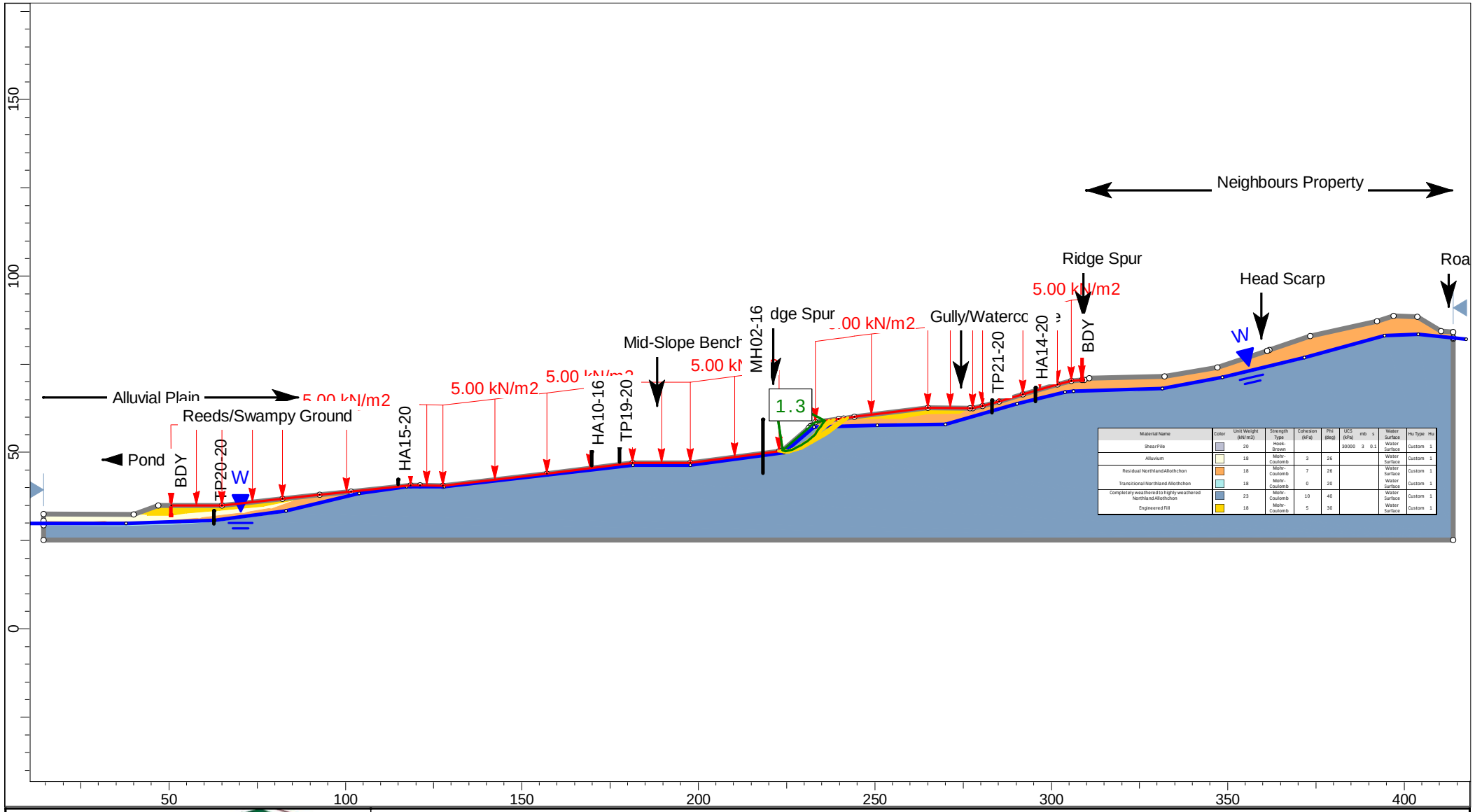
Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section C - Existing Profile, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
			File Name AKL2020-0125 Section C 6092021 SP.slmd



CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section C - Existing Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section C 6092021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	UCS (kPa)	mb	s	Water Surface	Hu Type	Hu
ShearPile		20	Hoek-Brown			30000	3	0.1	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26				Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26				Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20				Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40				Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30				Water Surface	Custom	1

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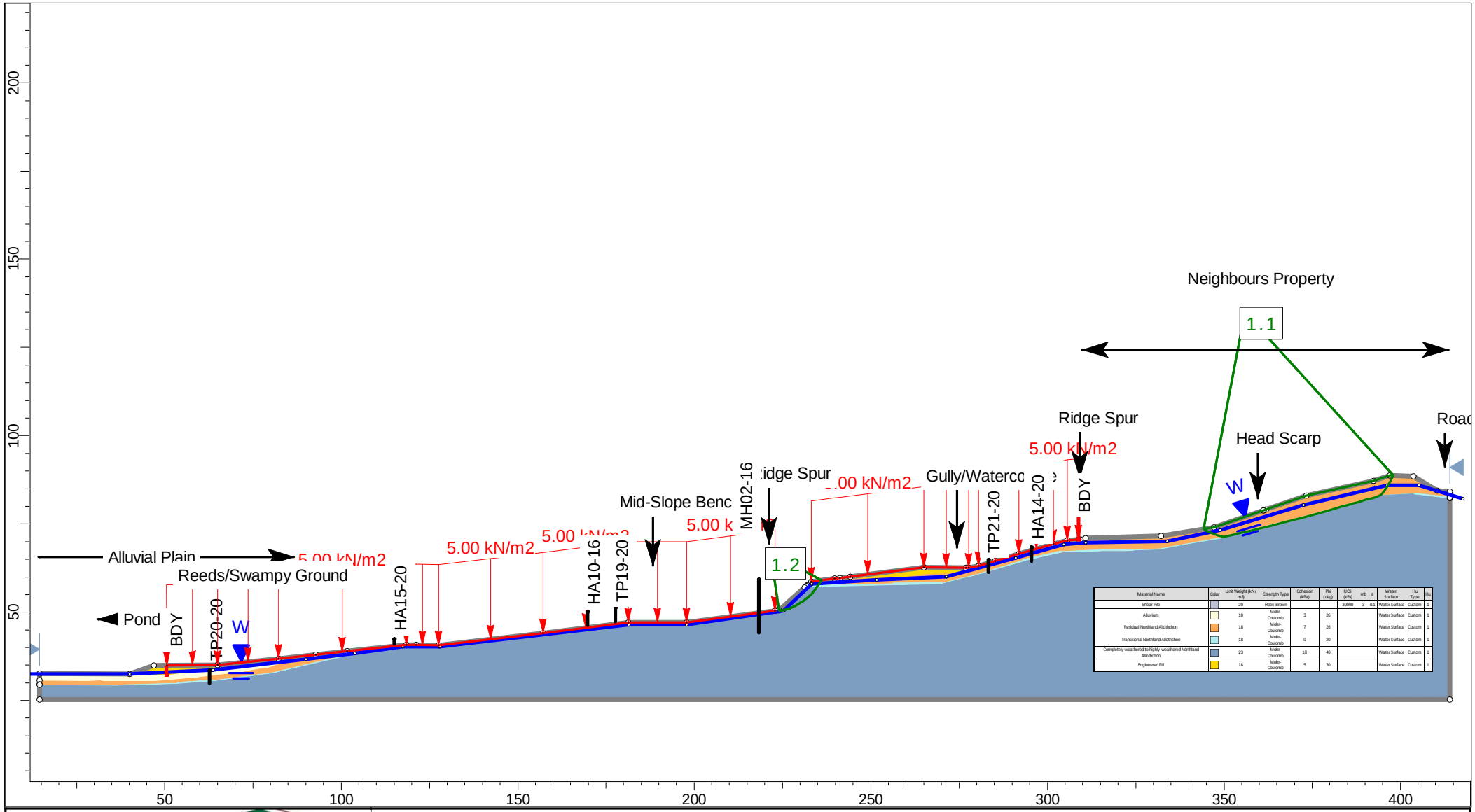
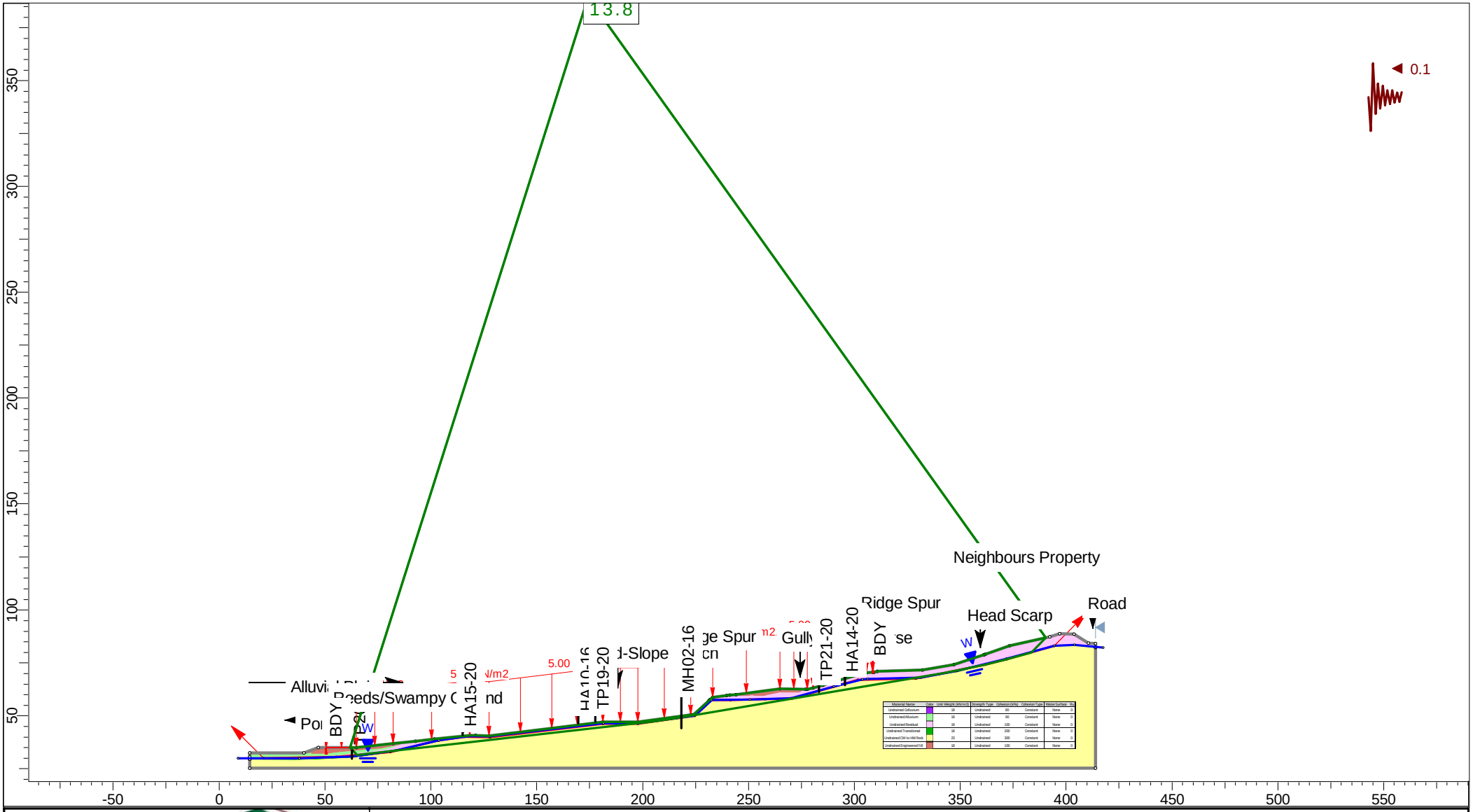
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section C - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company*	Build Rich
			File Name	AKL2020-0125 Section C 6092021 SP.slmd



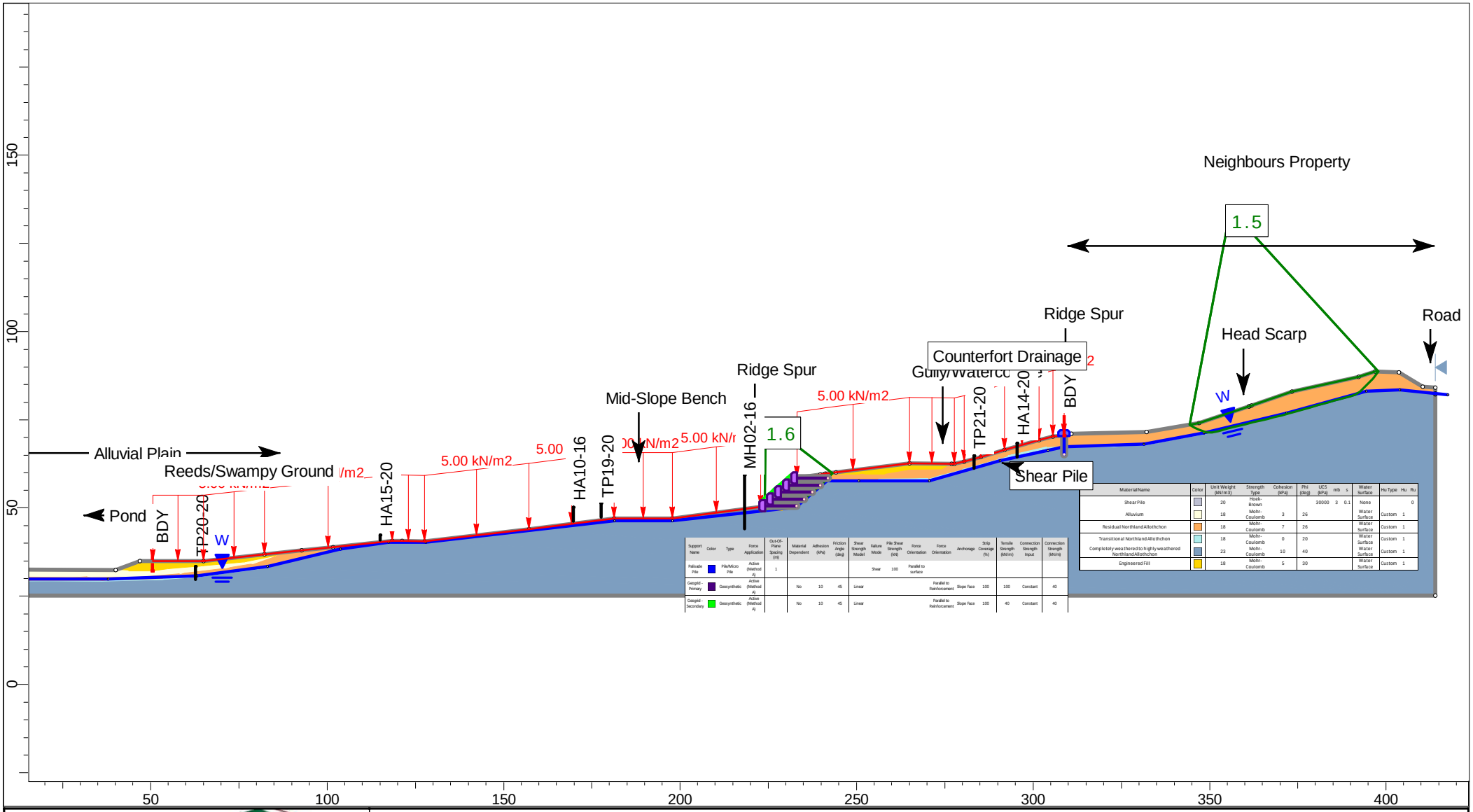
CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Proposed Profile, High Groundwater		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERP 9.018



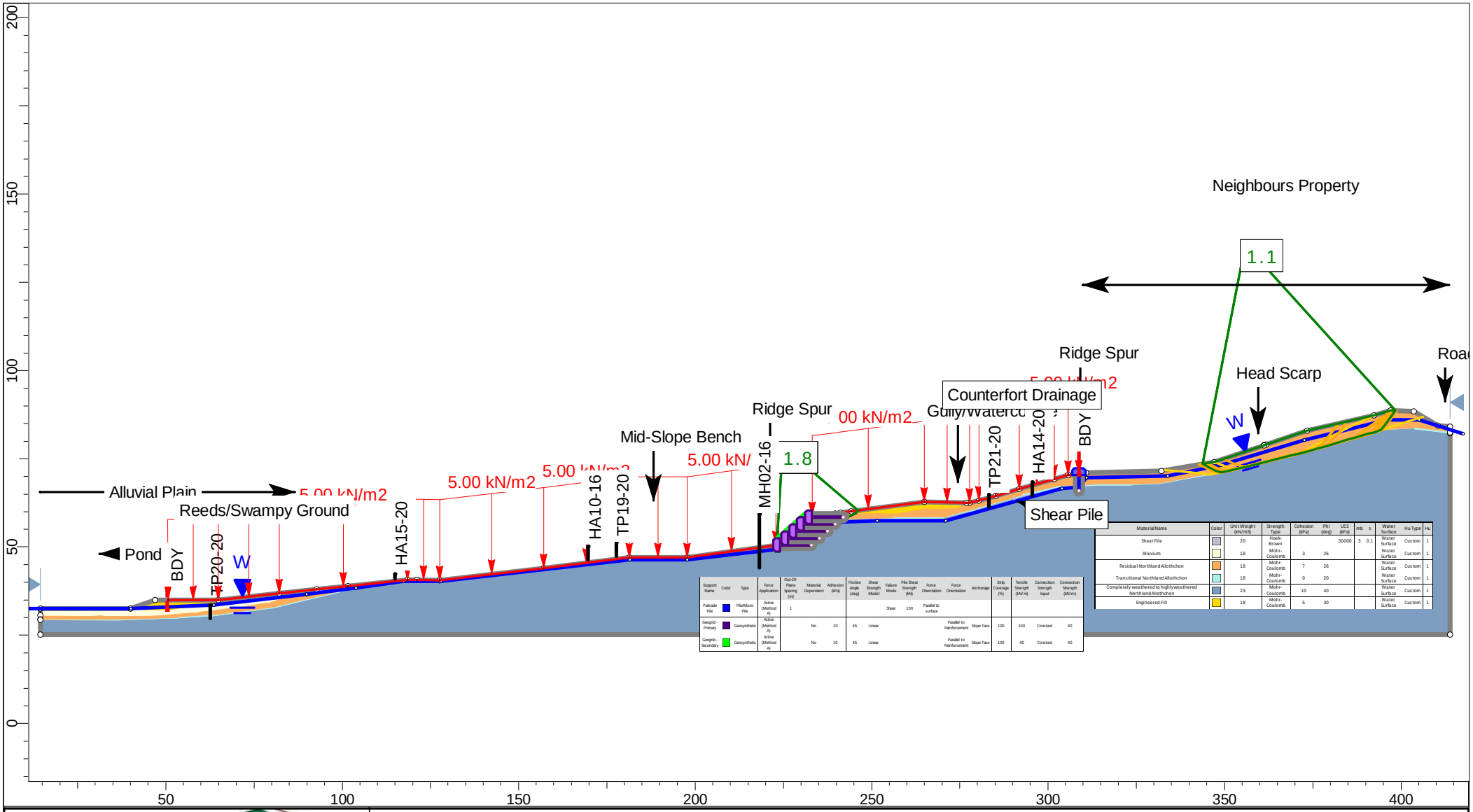
CMW Geosciences	Project	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Proposed Profile, Seismic		
	Drawn By: SP	Date: 6/09/2021	Scale: 1:2500	Company: Build Rich
				File Name: AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERP 9.018



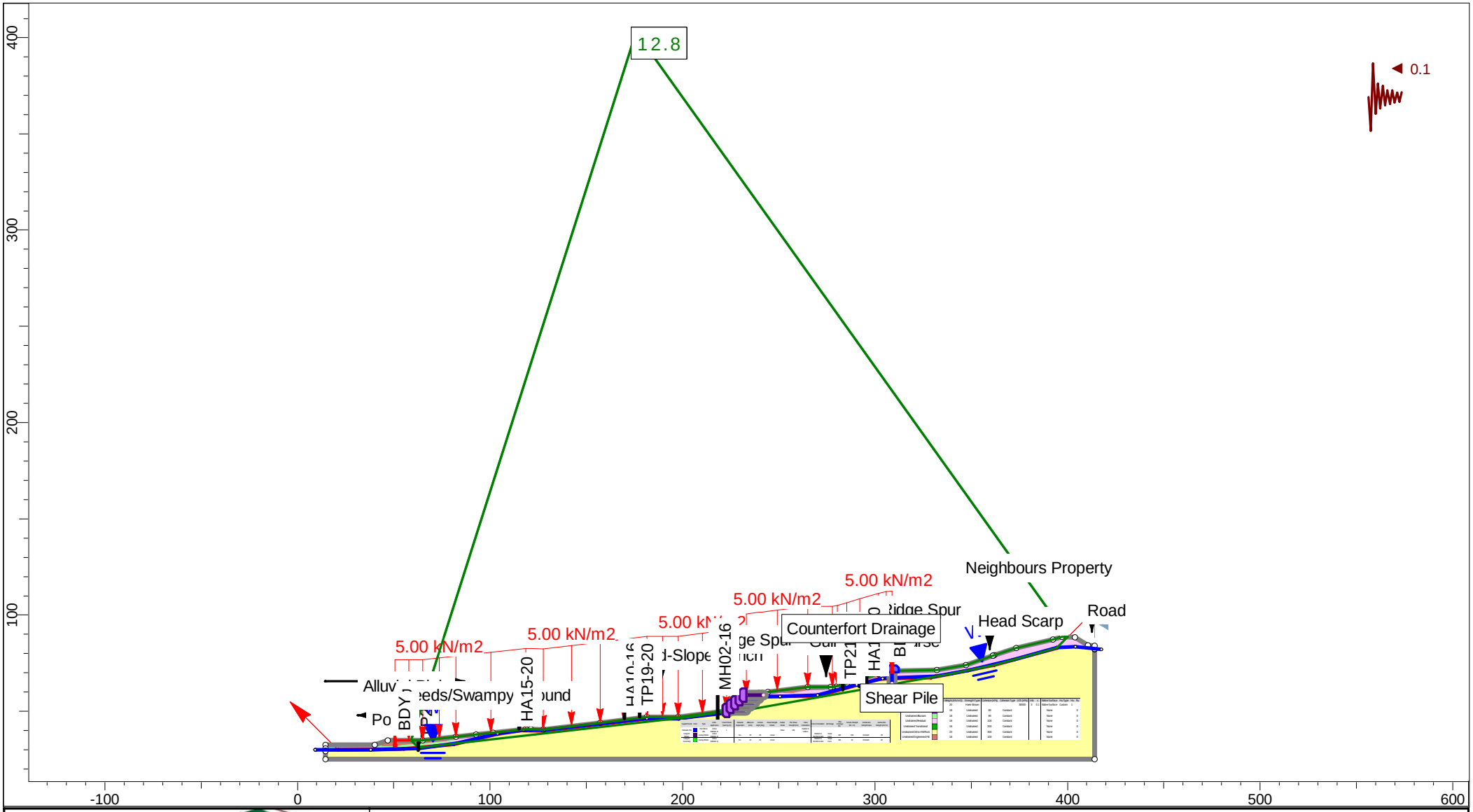
CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Remediated, Normal Groundwater		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERP 9.018



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Remediated, High Groundwater		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
				File Name AKL2020-0125 Section C 6092021 SP.slmd

SLIDEINTERP 9.018



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section C - Remediated, Seismic		
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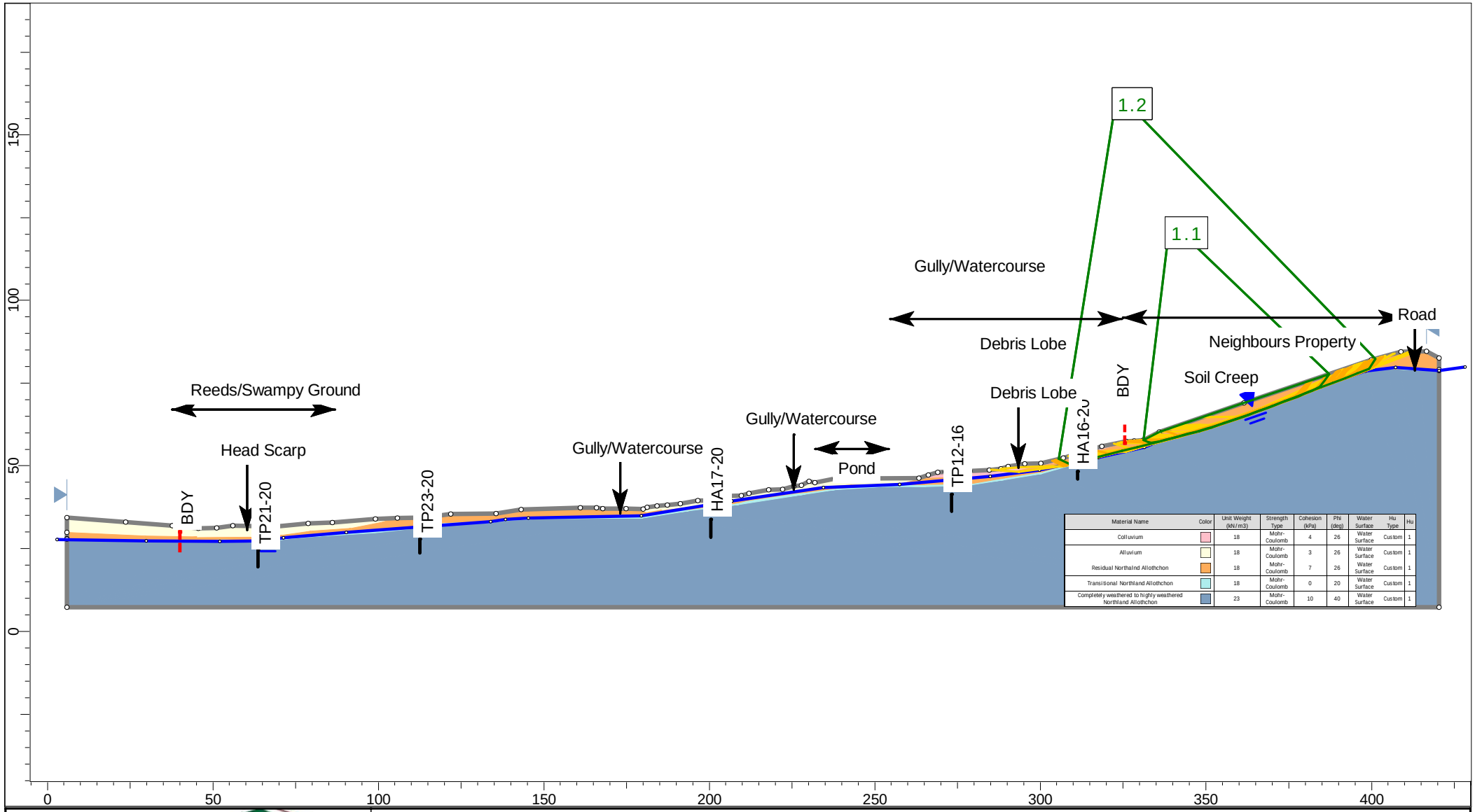
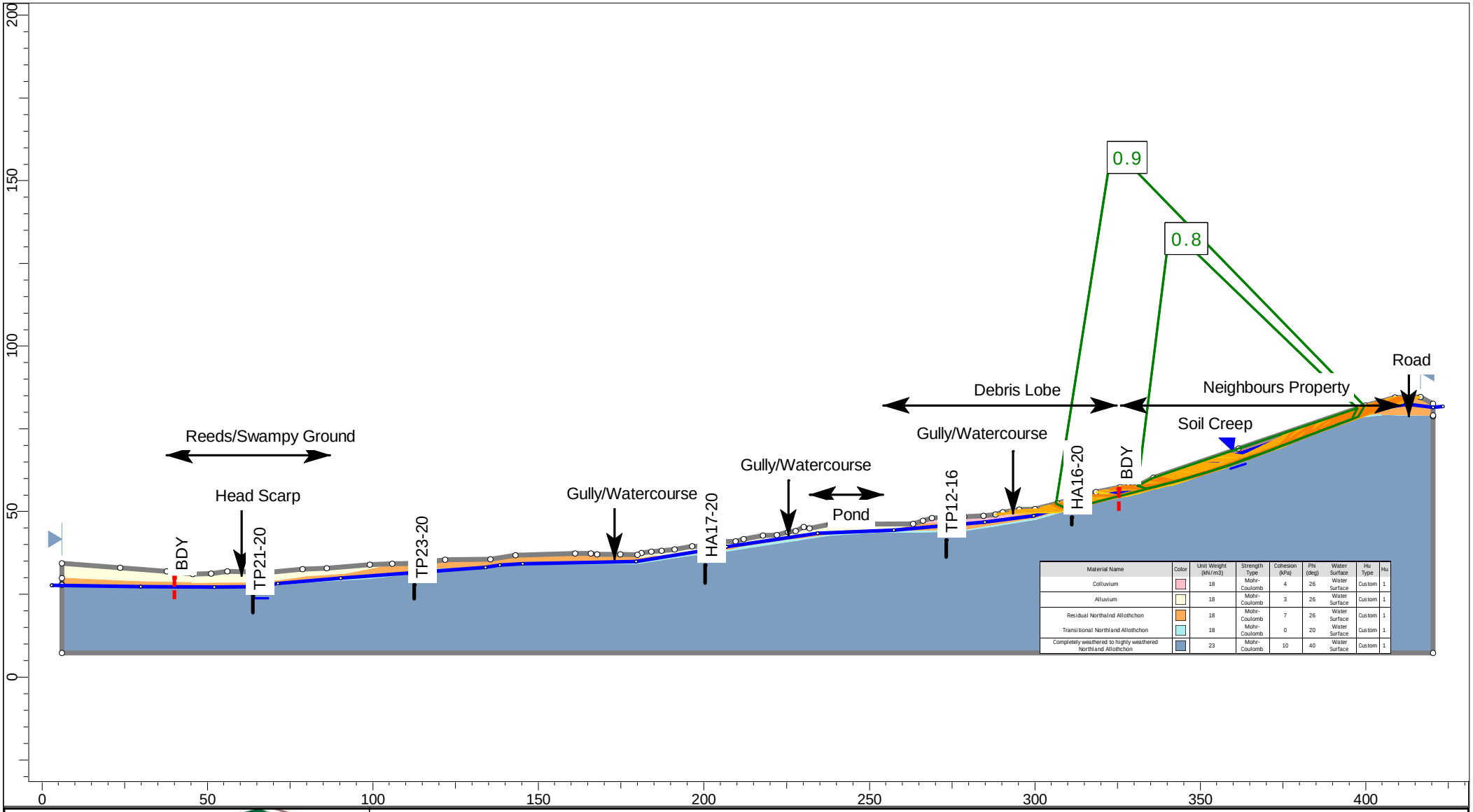
SLIDEINTERPRET 9.018



CMW Geosciences	*Project*	Silverdale South Stage 3&4		
	Analysis Description	Section D - Existing Profile, Normal Groundwater		
	Drawn By SP	*Date:* 29/09/2021	*Scale* 1:1600	*Company* Build Rich
				File Name AKL2020-0125 Section D 17082021 SP.slmd

SLIDEINTERP 9.018



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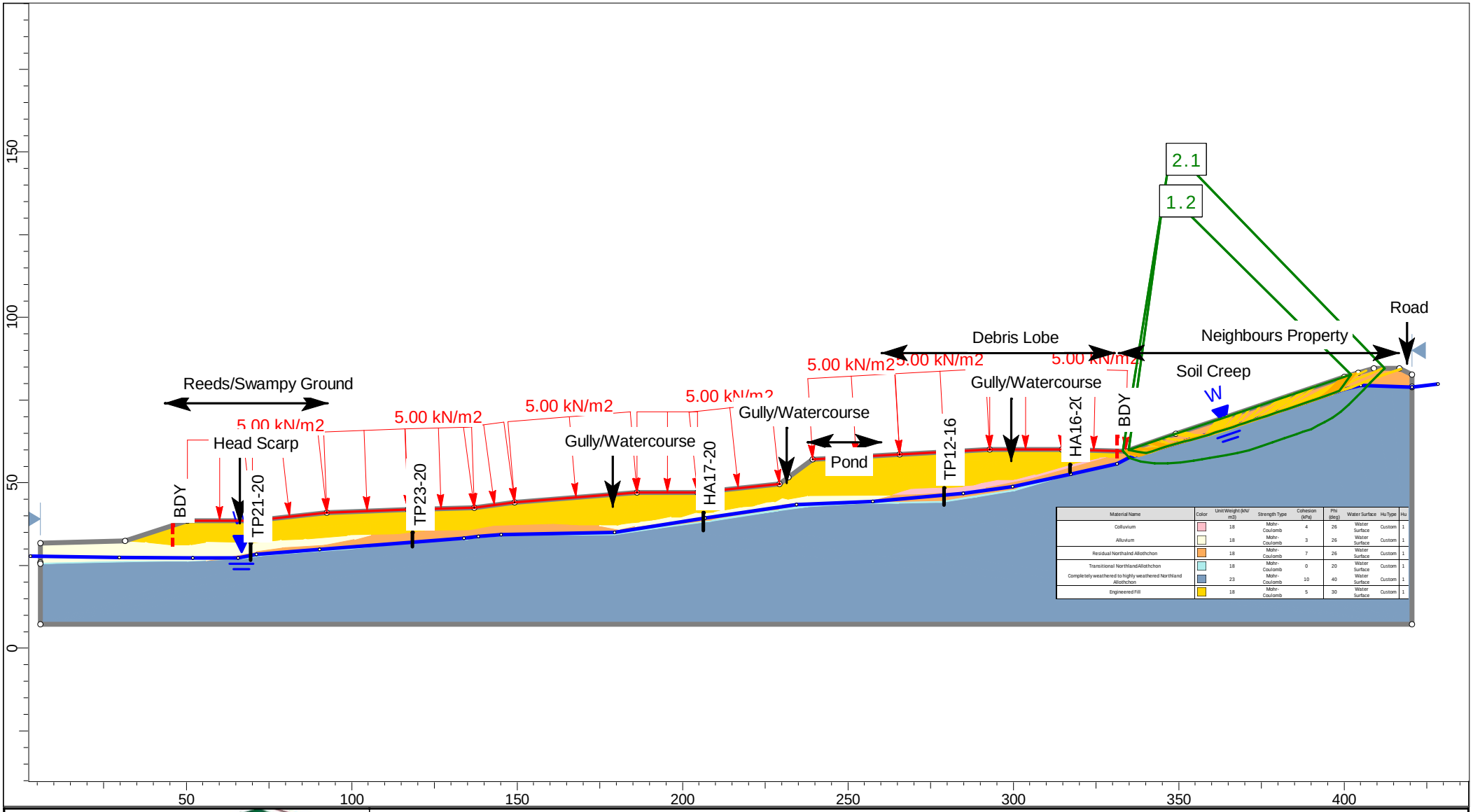
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section D - Existing Profile, High Groundwater		
Drawn By SP	*Date:* 29/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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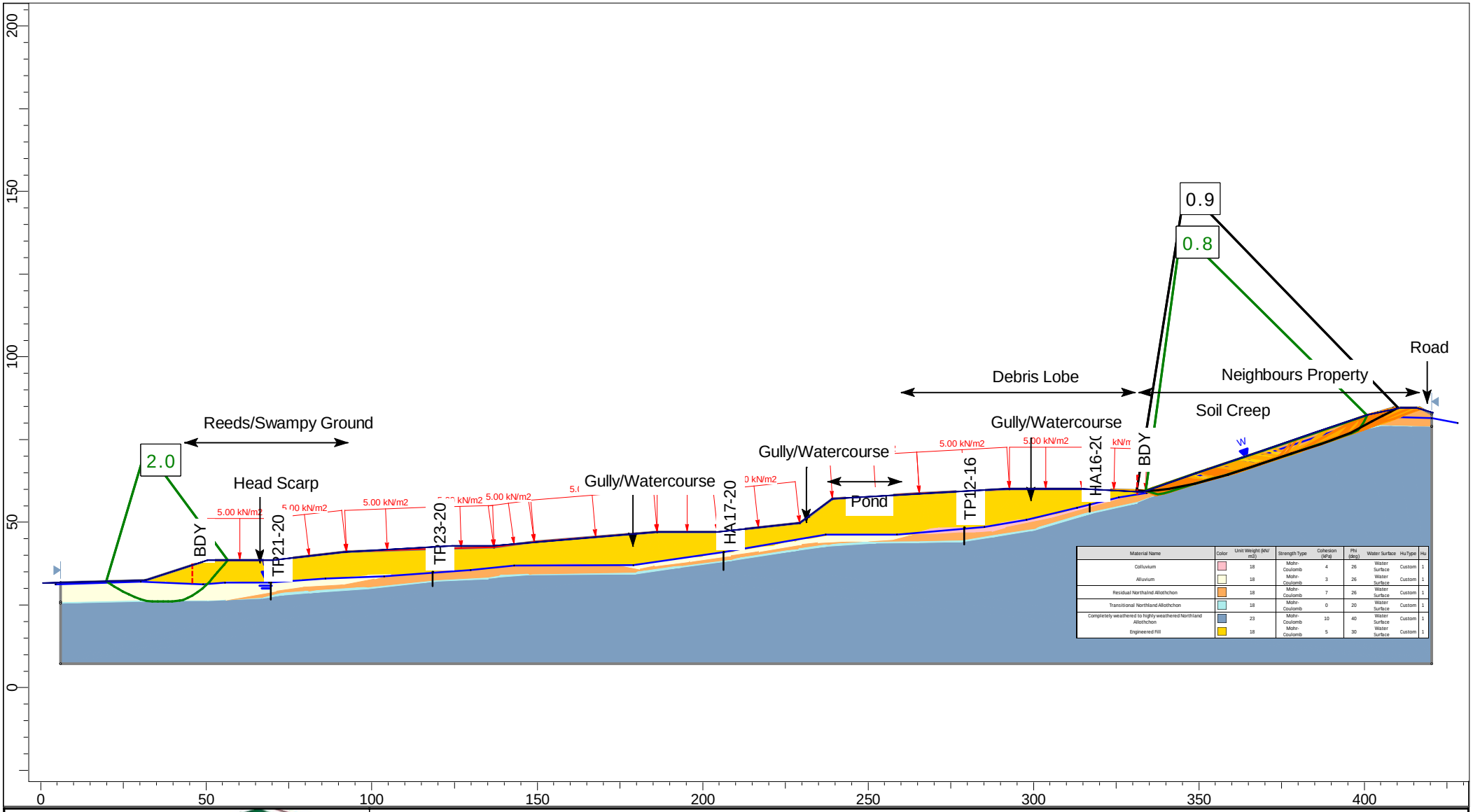
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Proposed Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	HuType	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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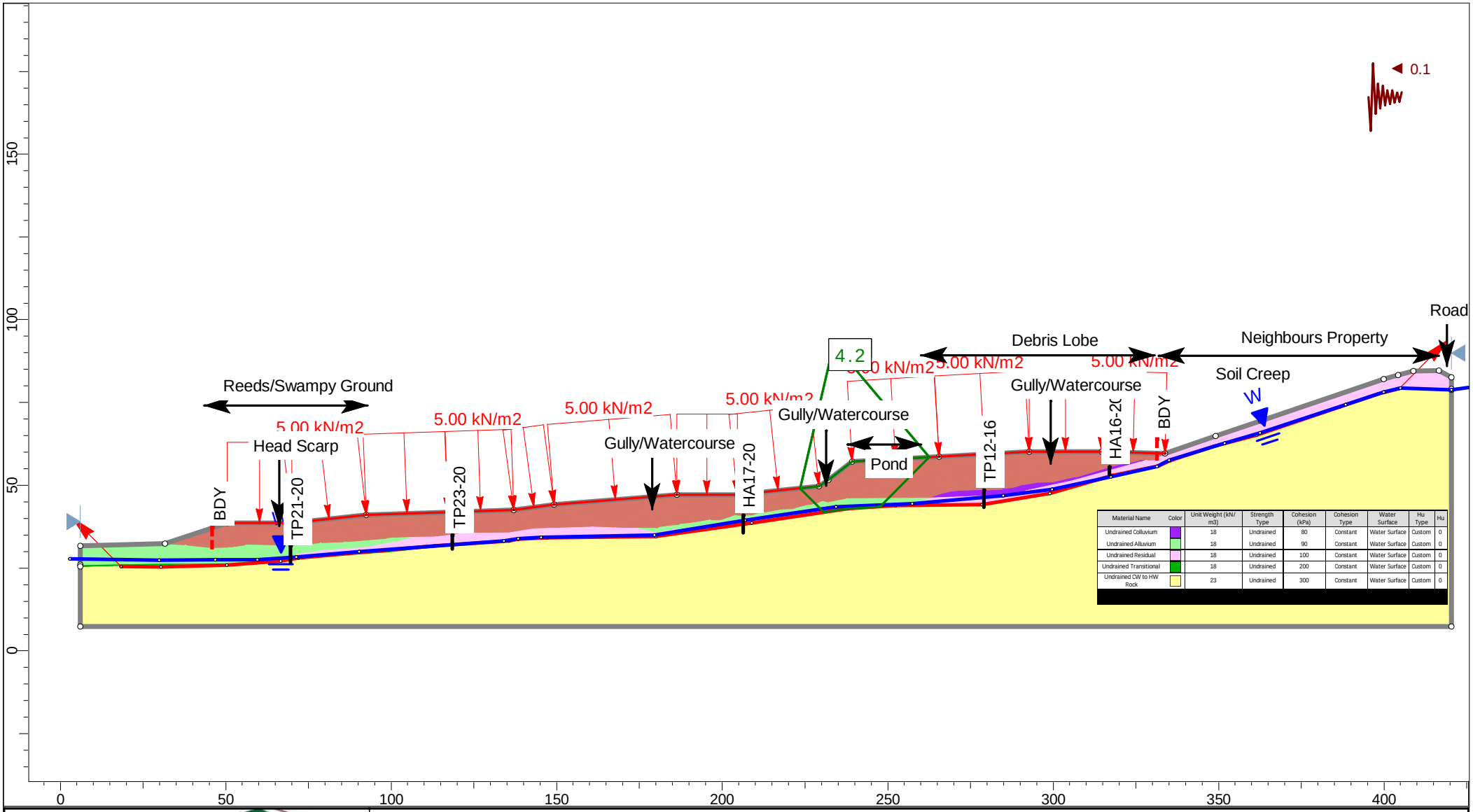
SLIDEINTERP 9.018

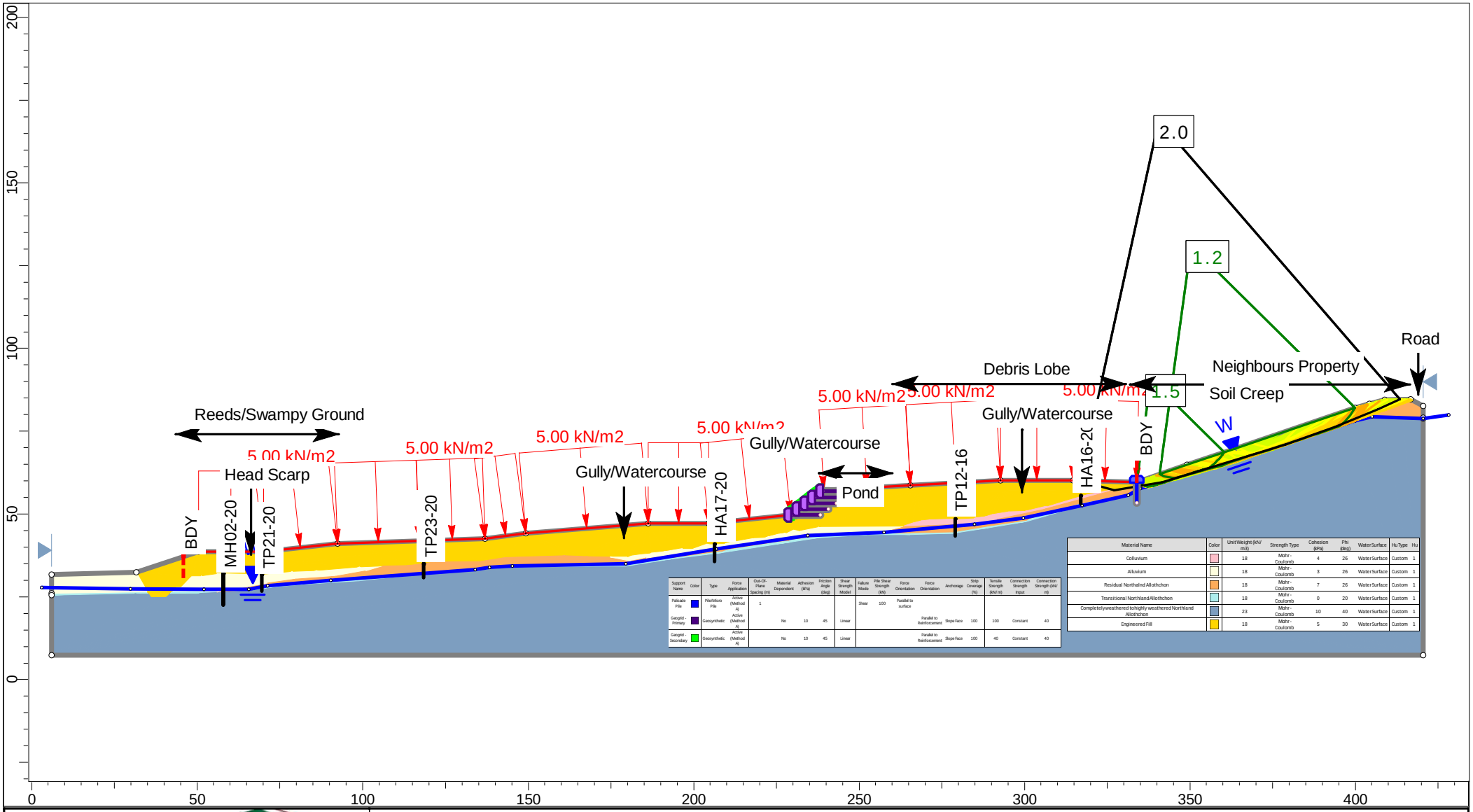
Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Proposed Profile, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



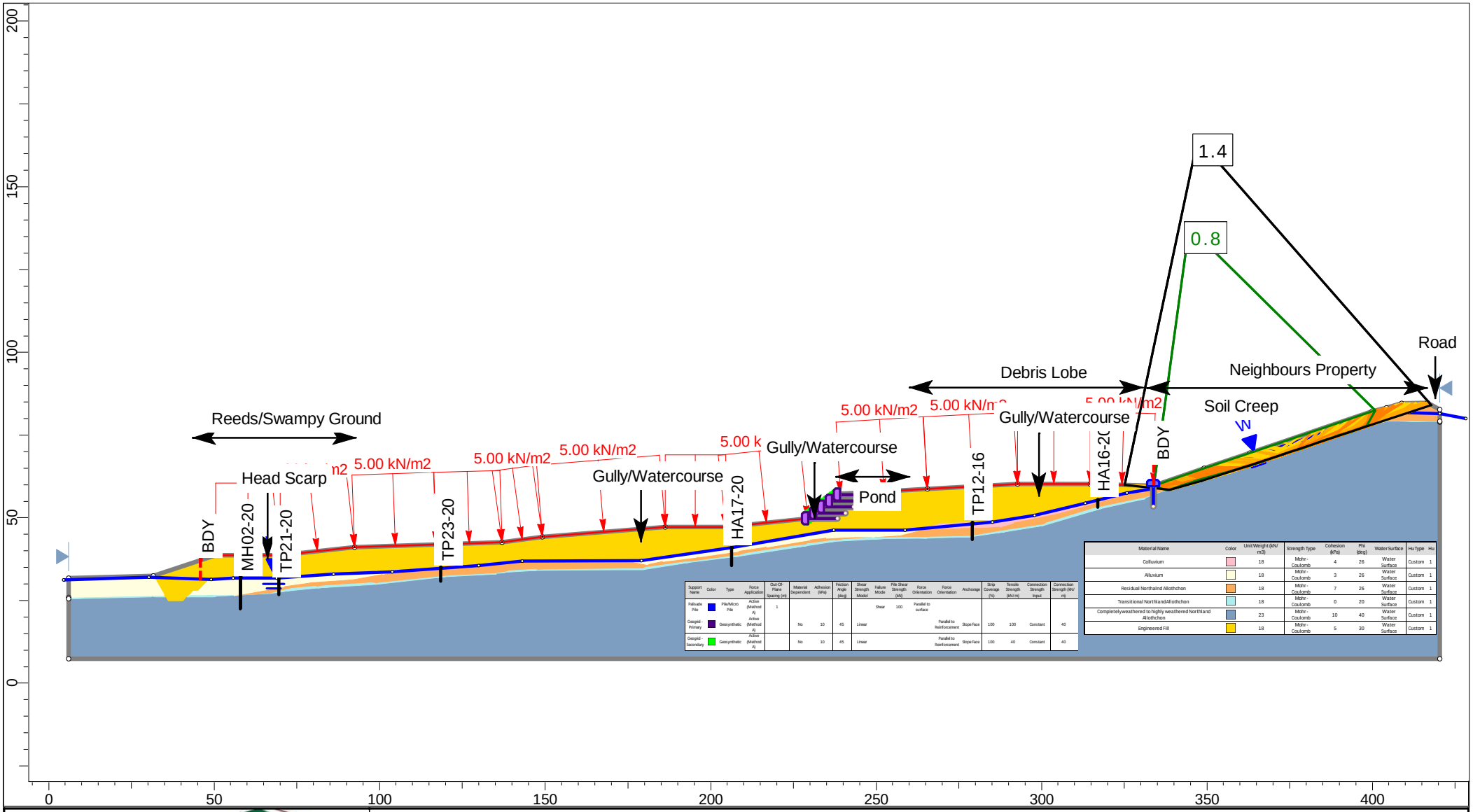
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	WaterSurface	Custom	1
Alluvium		18	Mohr-Coulomb	3	26	WaterSurface	Custom	1
Residual Northalnd Alloithchon		18	Mohr-Coulomb	7	26	WaterSurface	Custom	1
Transitional Northland Alloithchon		18	Mohr-Coulomb	0	20	WaterSurface	Custom	1
Completely weathered to highly weathered Northland Alloithchon		23	Mohr-Coulomb	10	40	WaterSurface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	WaterSurface	Custom	1

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1					Shear	100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

CMW Geosciences

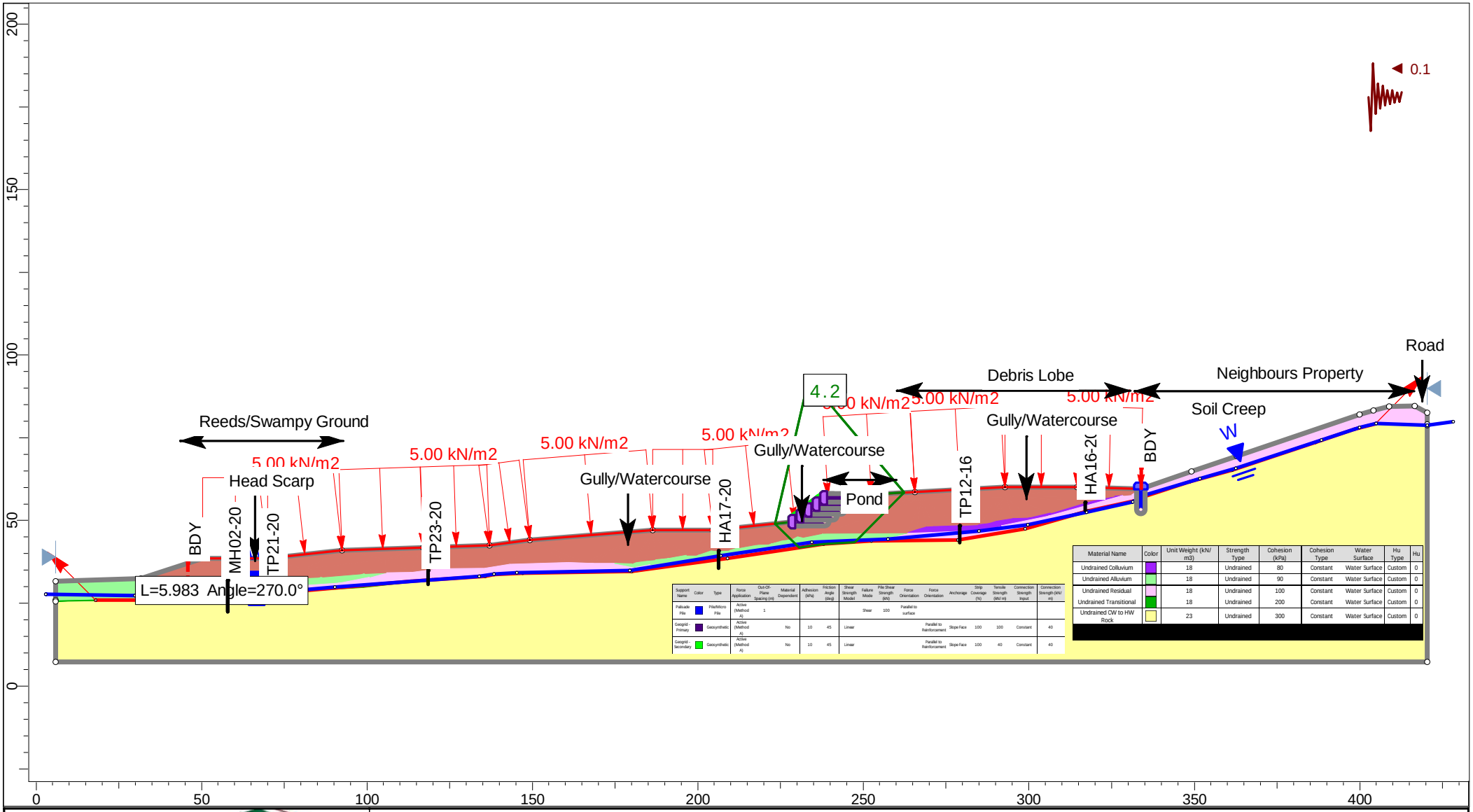
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section D - Remediated, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section D 17082021 SP.slmd



CMW Geosciences	*Project*	Silverdale South - Stage 3&4		
	Analysis Description	Section Section D - Remediated, High Groundwater		
	Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
				File Name AKL2020-0125 Section D 17082021 SP.slmd

SLIDEINTERP 9.018



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu
Undrained Colluvium		18	Undrained	80	Constant	Water Surface	Custom	0
Undrained Alluvium		18	Undrained	90	Constant	Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant	Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant	Water Surface	Custom	0
Undrained CW to HW Rock		23	Undrained	300	Constant	Water Surface	Custom	0

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (m)	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Failure Mode	Pile Shear Strength (kN)	Force Orientation	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Palisade Pile		Pile/Micro Pile	Active (Method A)	1				Shear		100	Parallel to surface						
Geogrid - Primary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)		No	10	45	Linear				Parallel to Reinforcement	Slope Face	100	40	Constant	40

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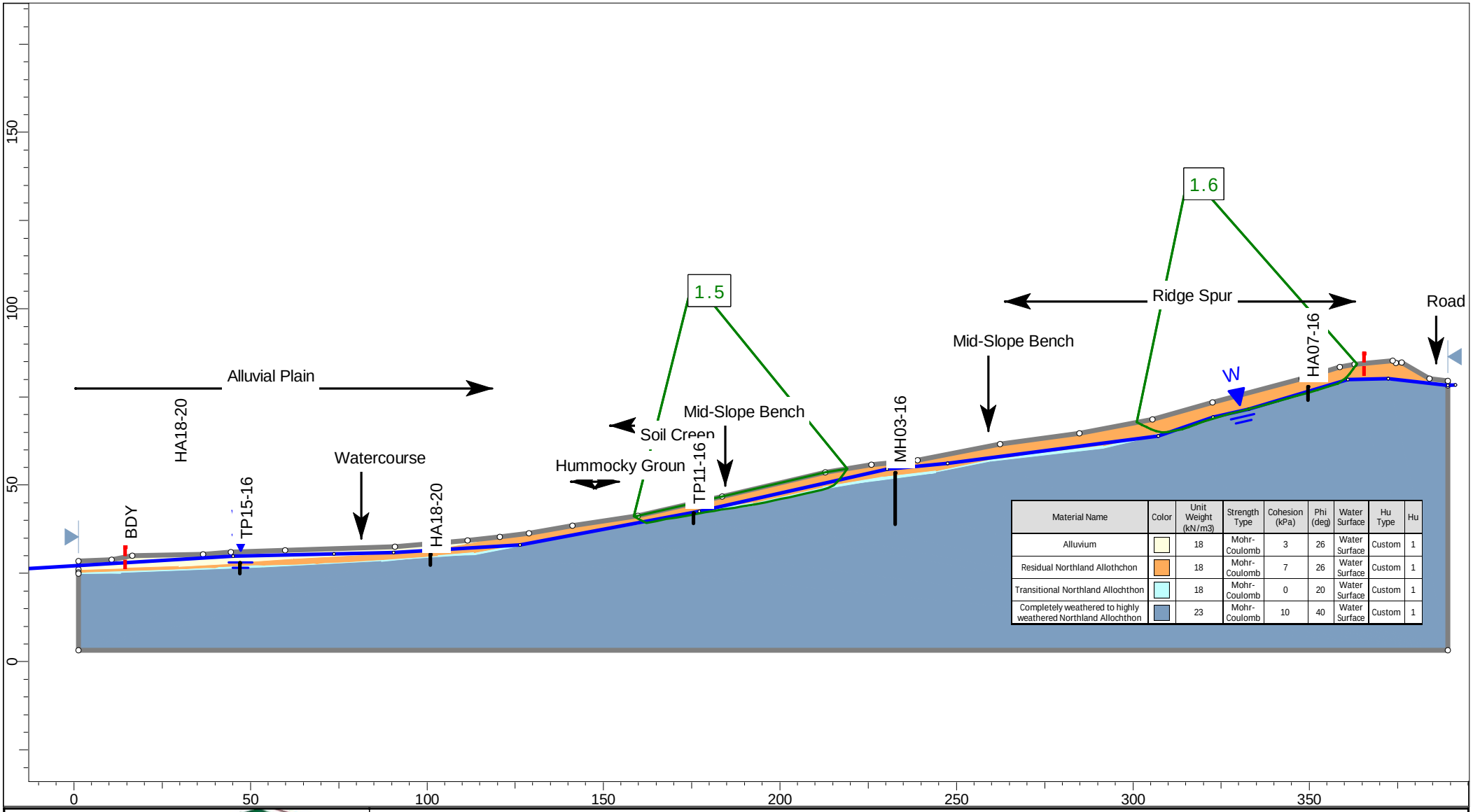
Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section D - Remediated, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section D 17082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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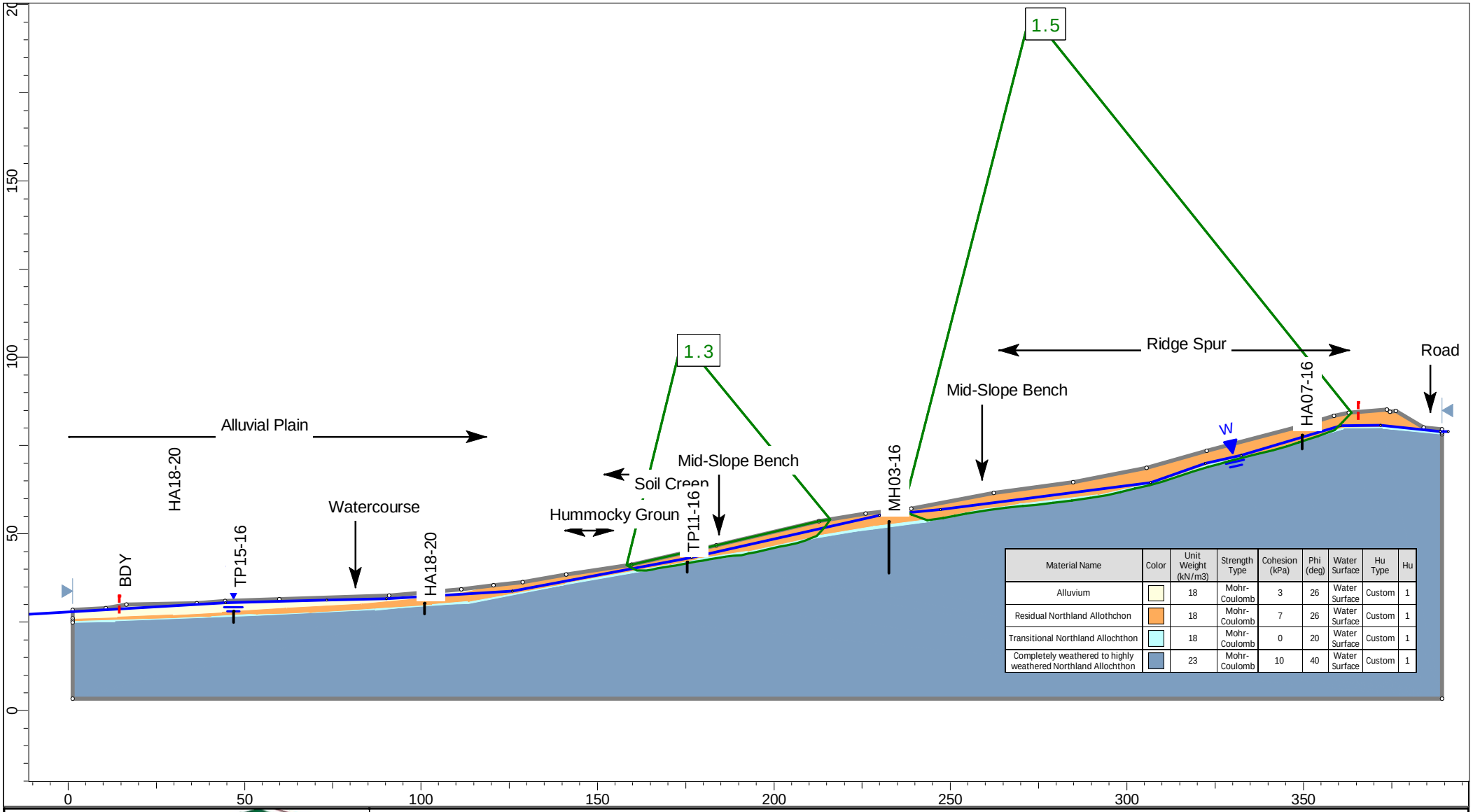
Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section E - Exisiting Profile, Normal Groundwater		
Drawn By: SP	Date: 6/09/2021	Scale 1:1500	Company Build Rich
			File Name AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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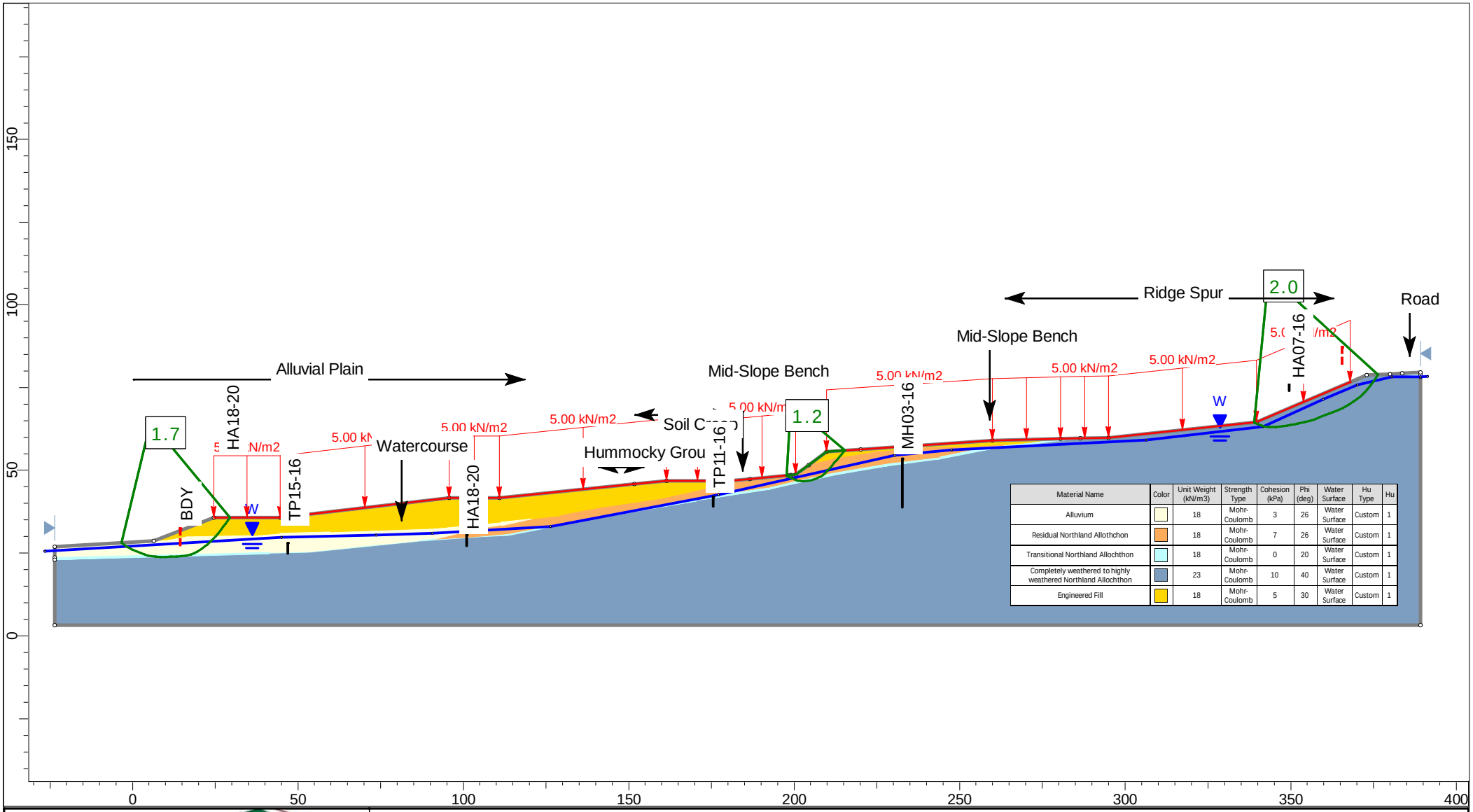
SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section E - Exisiting Profile, High Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1500	*Company* Build Rich
			File Name AKL2020-0125 Section E 18082021 SP.slmd

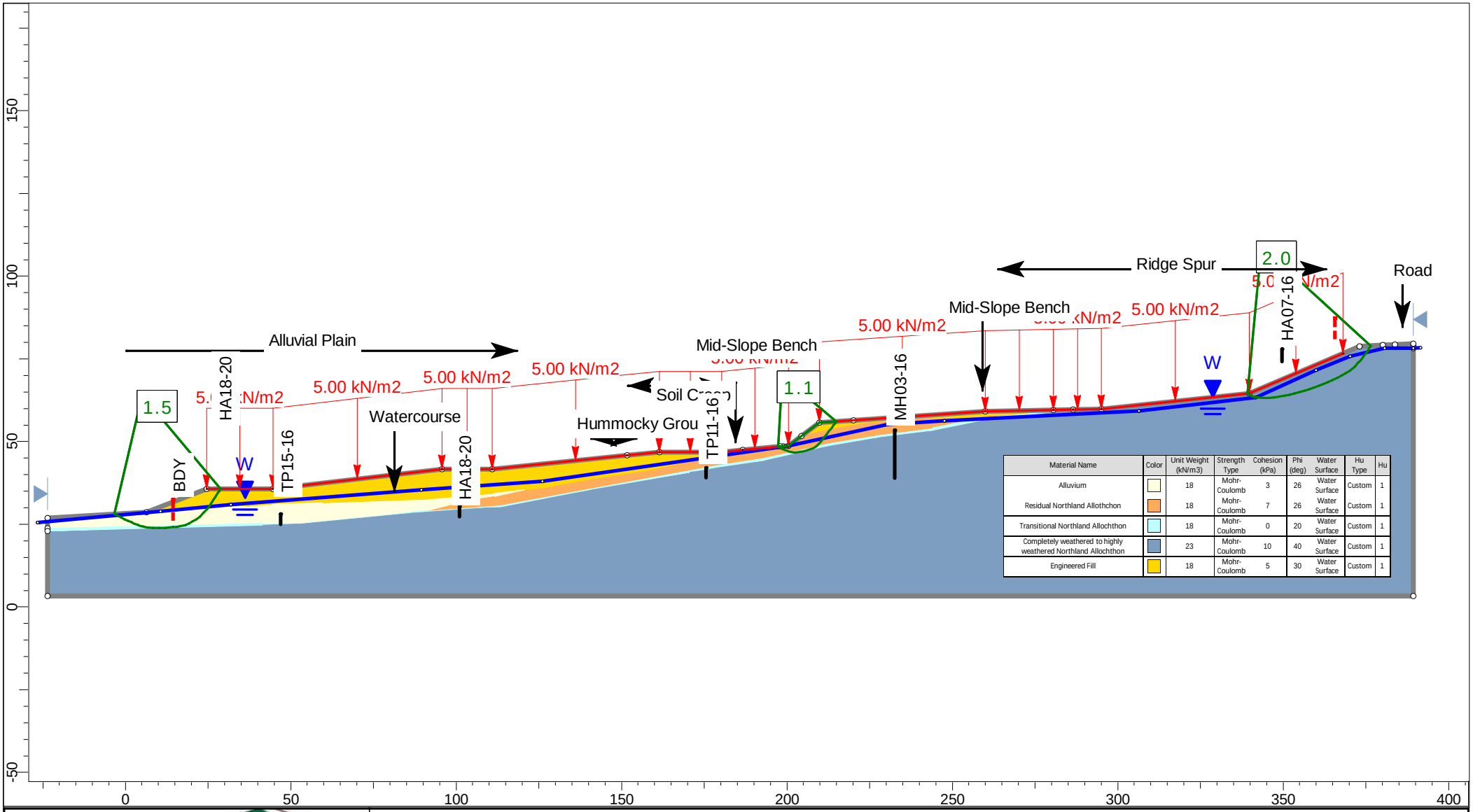


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4		
Analysis Description	Section Section E - Proposed Profile, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section E 18082021 SP.slmd

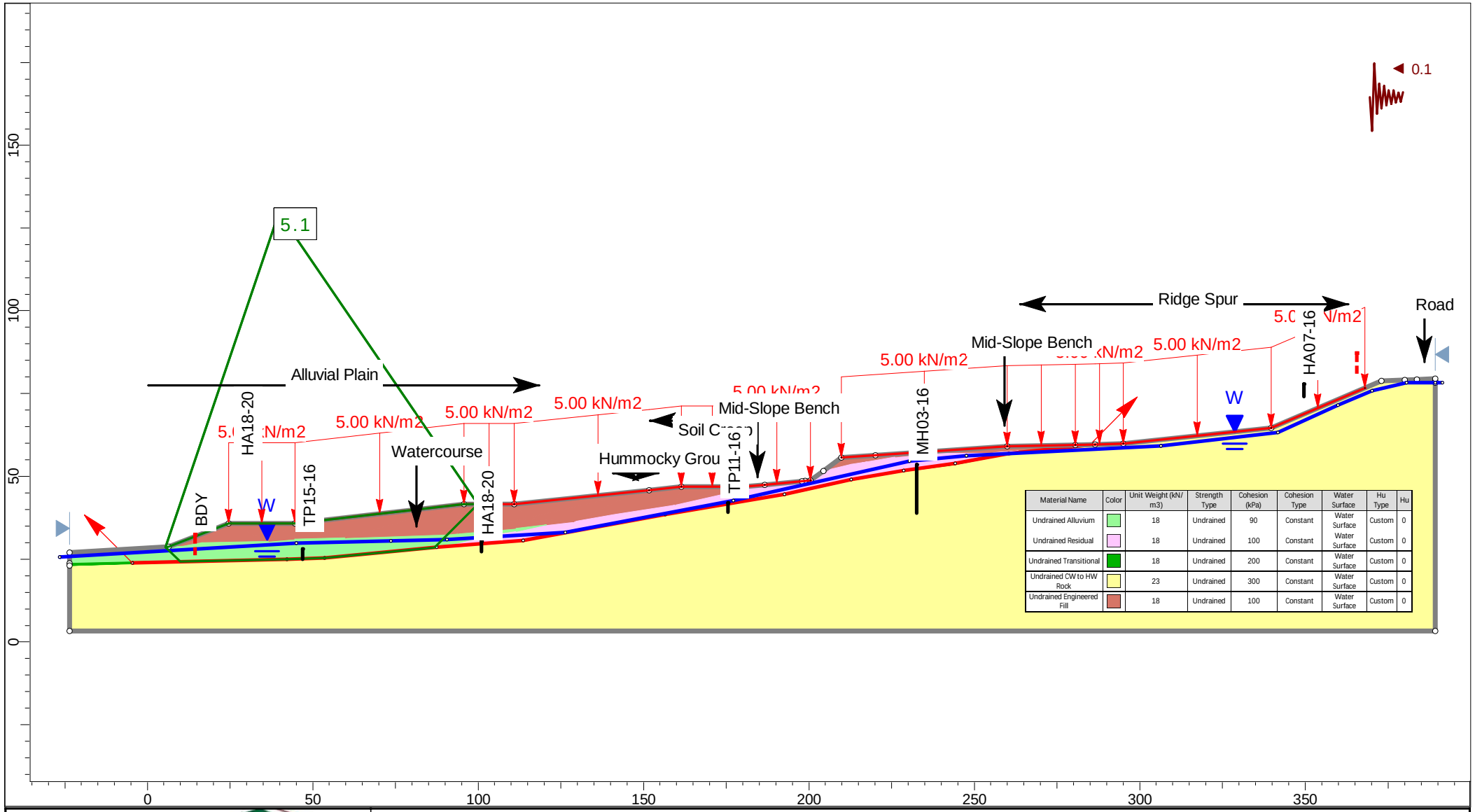


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Alluvium		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section E - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section E 18082021 SP.slmd



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Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section E - Proposed Profile, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
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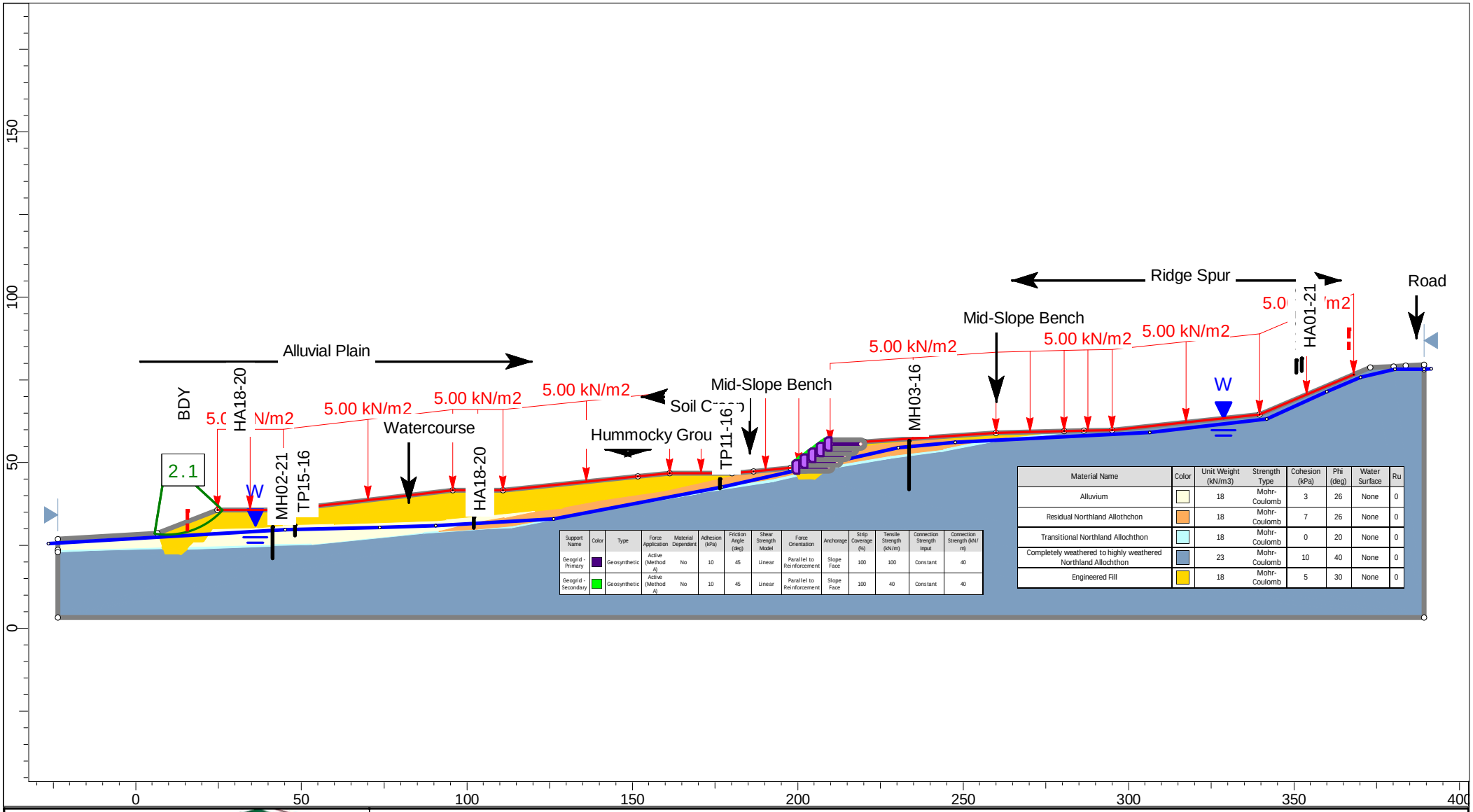

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Alluvium		18	Mohr-Coulomb	3	26	None	0
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineered Fill		18	Mohr-Coulomb	5	30	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

CMW Geosciences

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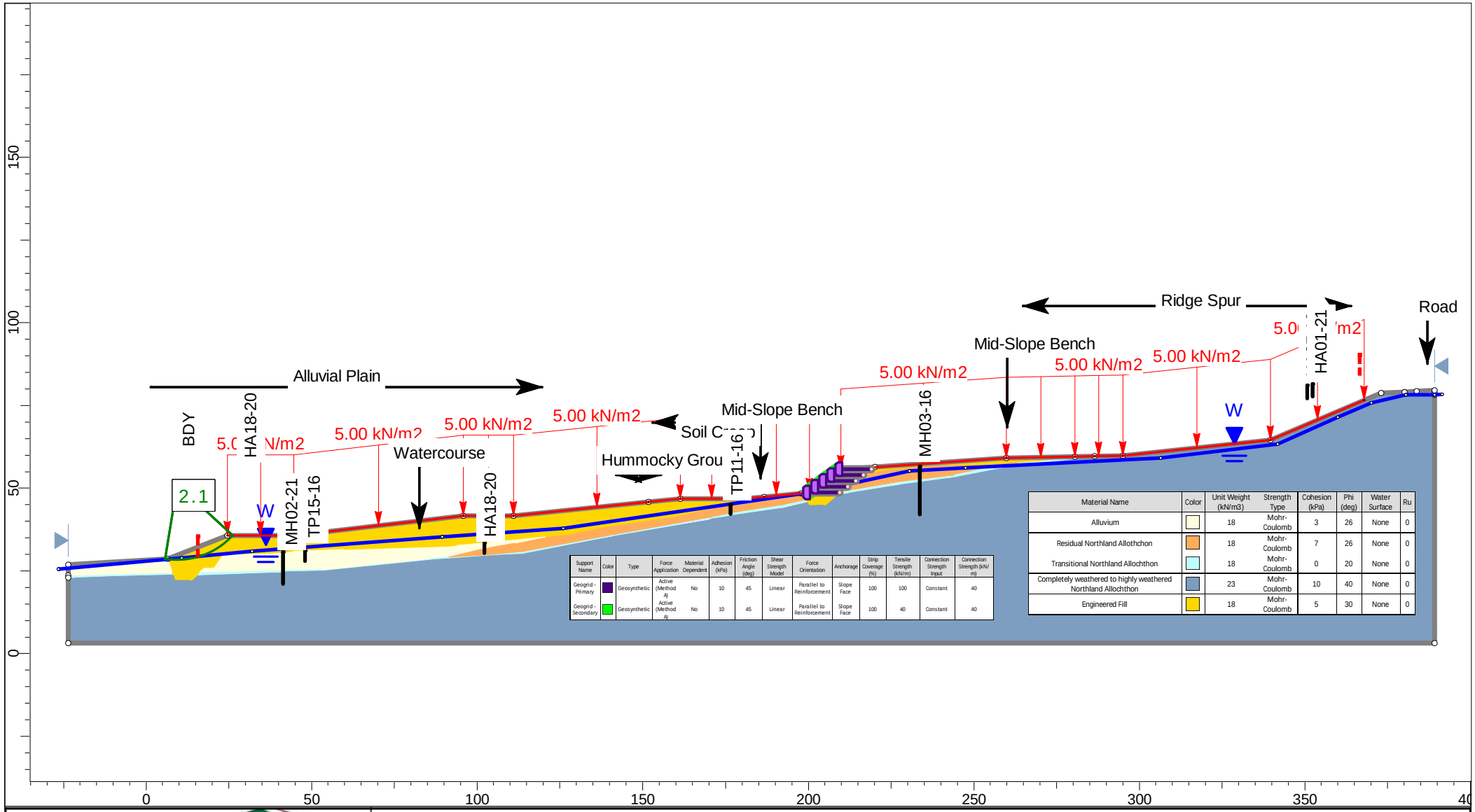
Project	Silverdale South - Stage 3&4			
Analysis Description	Section Section E - Remediated, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section E 18082021 SP.slmd



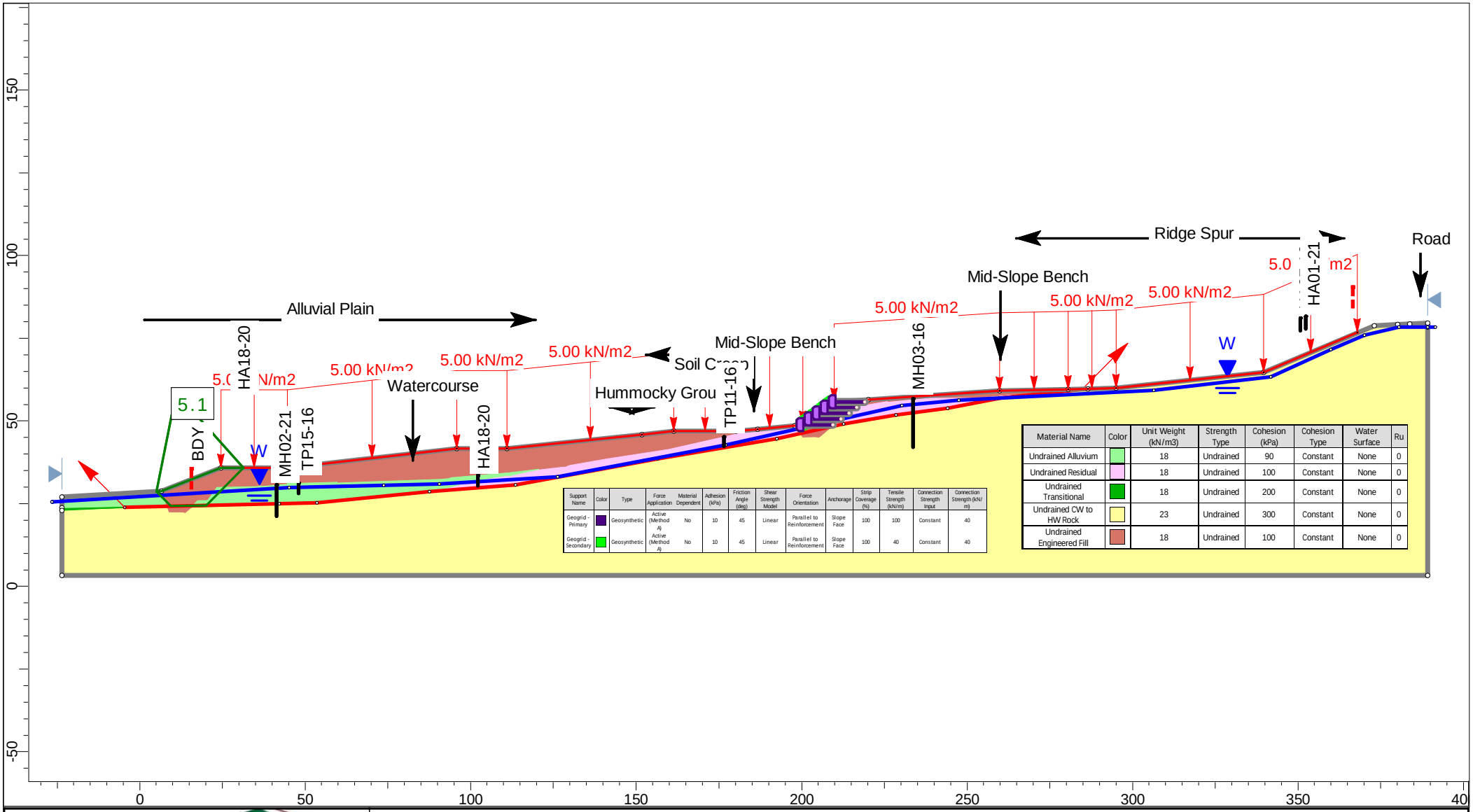
Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Alluvium		18	Mohr-Coulomb	3	26	None	0
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineered Fill		18	Mohr-Coulomb	5	30	None	0

CMW Geosciences

SLIDEINTERP 9.018

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section Section E - Remediated, High Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
			File Name AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Undrained Alluvium		18	Undrained	90	Constant	None	0
Undrained Residual		18	Undrained	100	Constant	None	0
Undrained Transitional		18	Undrained	200	Constant	None	0
Undrained CW to HW Rock		23	Undrained	300	Constant	None	0
Undrained Engineered Fill		18	Undrained	100	Constant	None	0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

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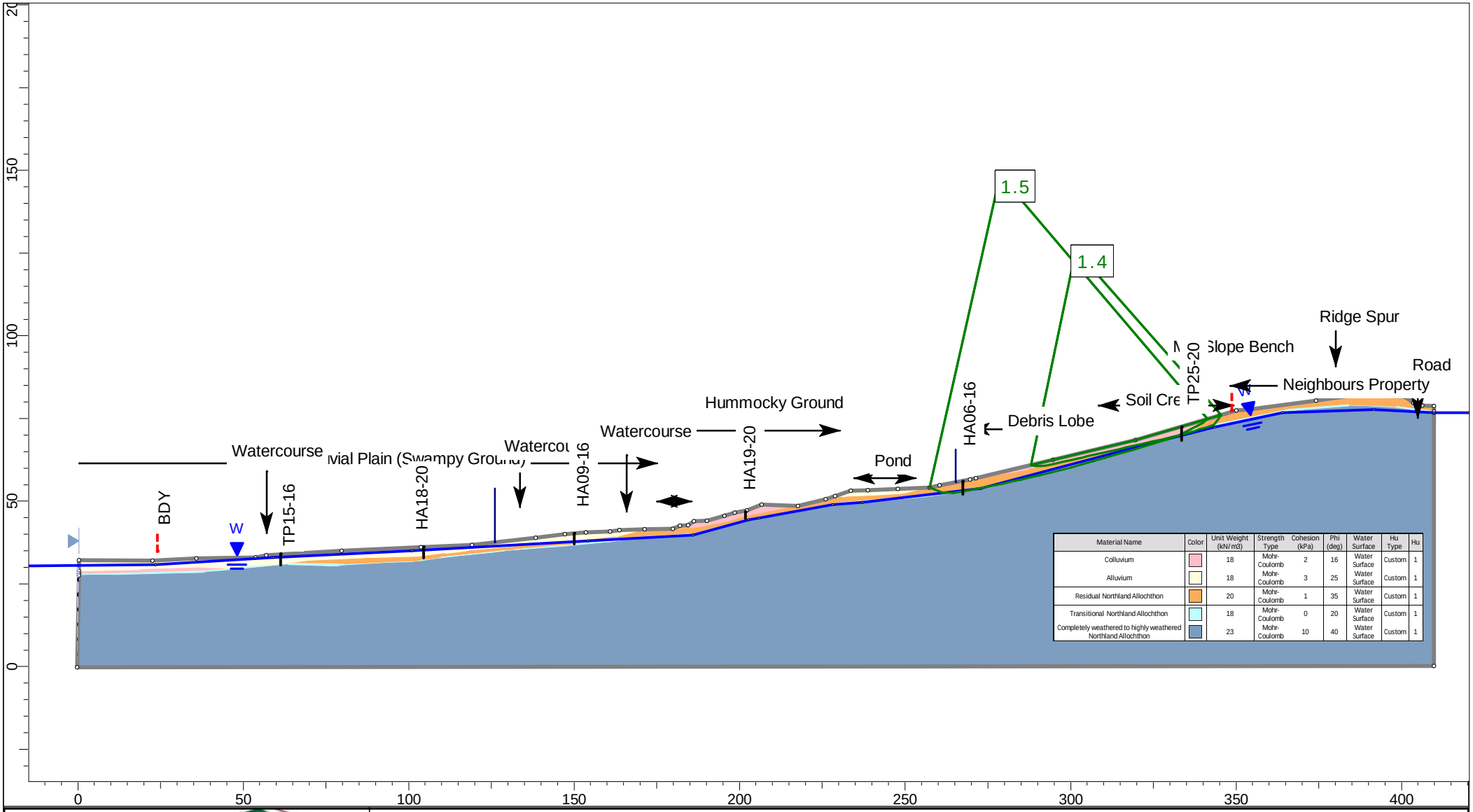
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section Section E - Remediated, Seismic		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
			File Name AKL2020-0125 Section E 18082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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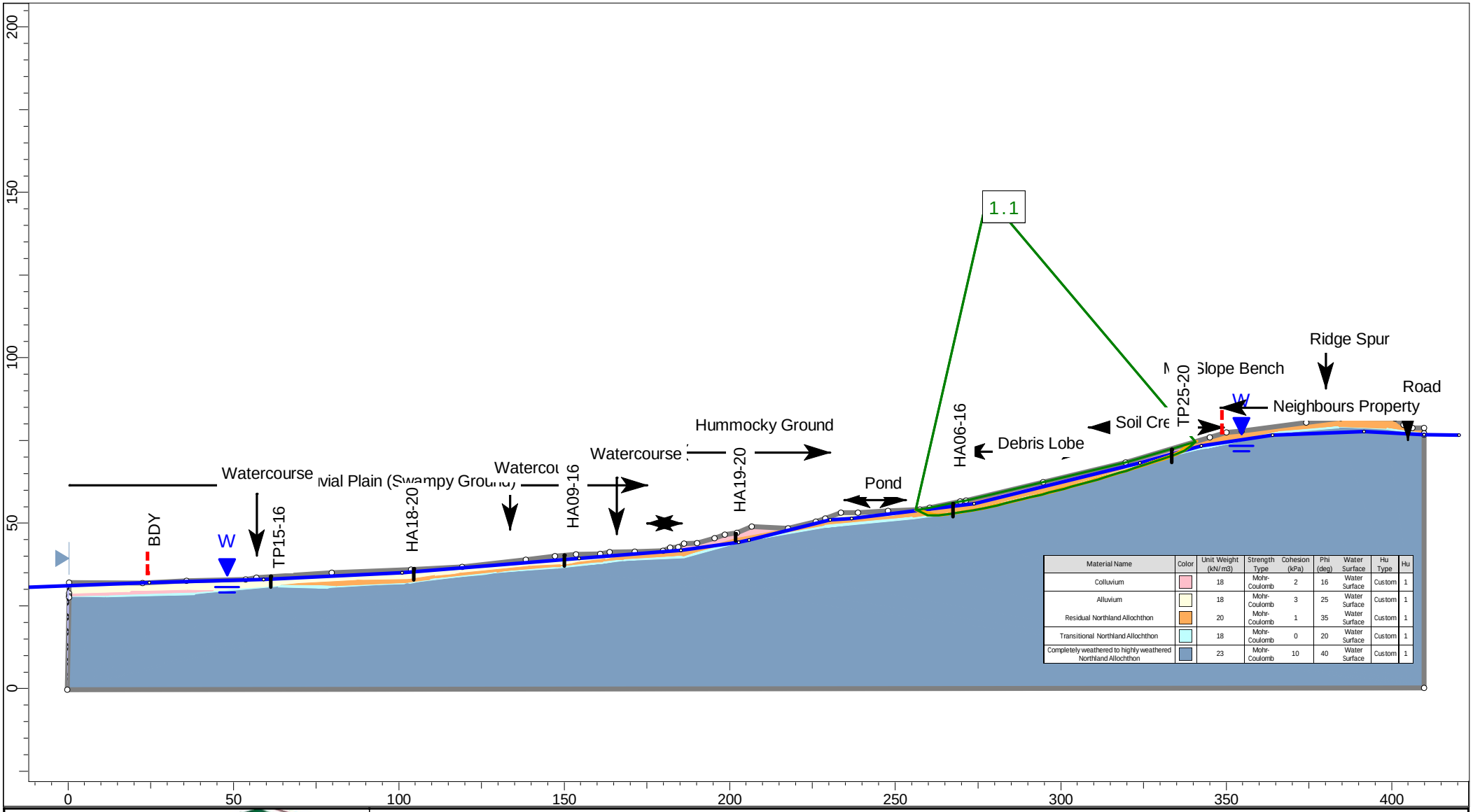
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section Section F - Existing Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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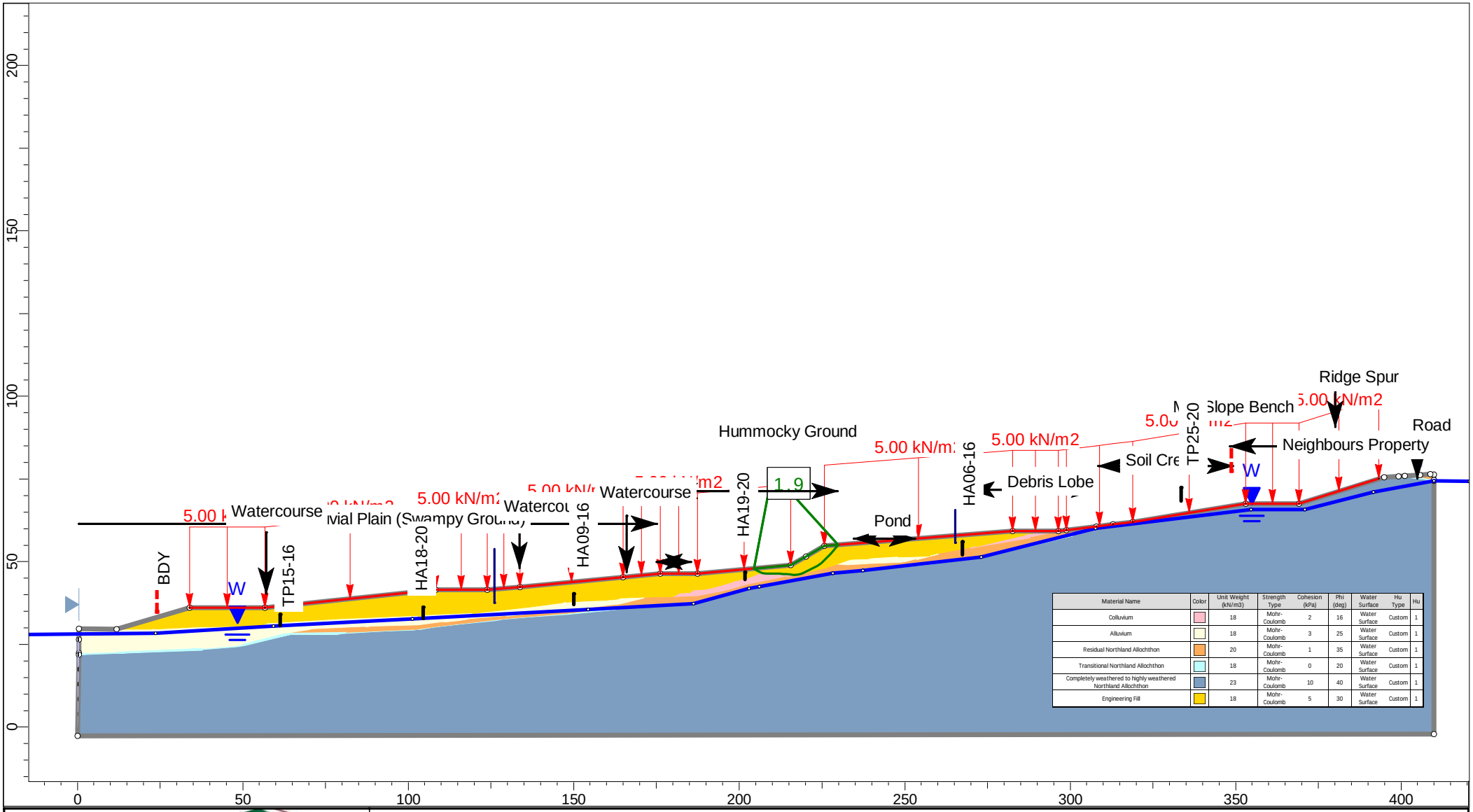
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section Section F - Existing Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineering Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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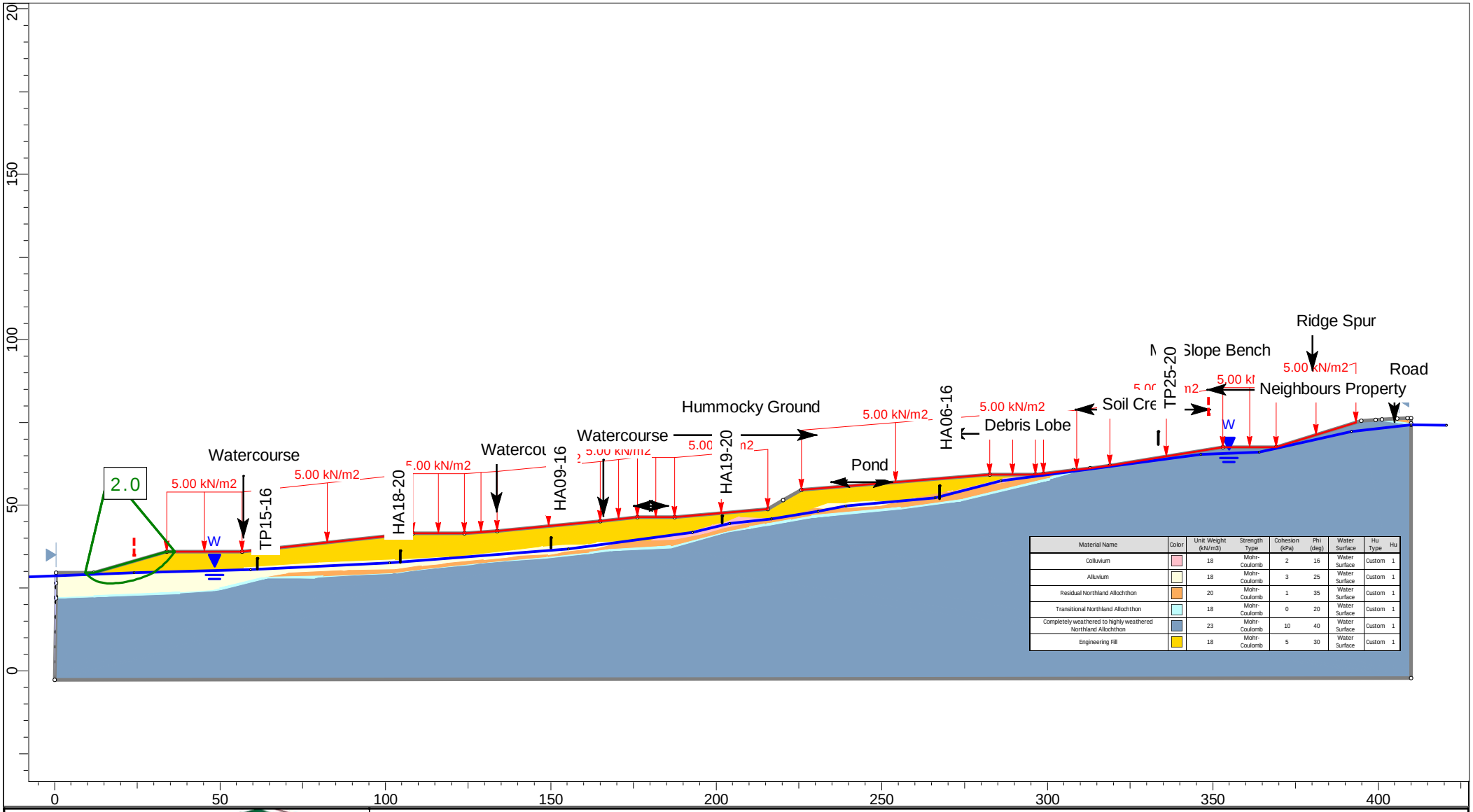
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4		
Analysis Description	Section F - Proposed Profile, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company* Build Rich
			File Name AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	16	Water Surface	Custom	1
Alluvium		18	Mohr-Coulomb	3	25	Water Surface	Custom	1
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineering Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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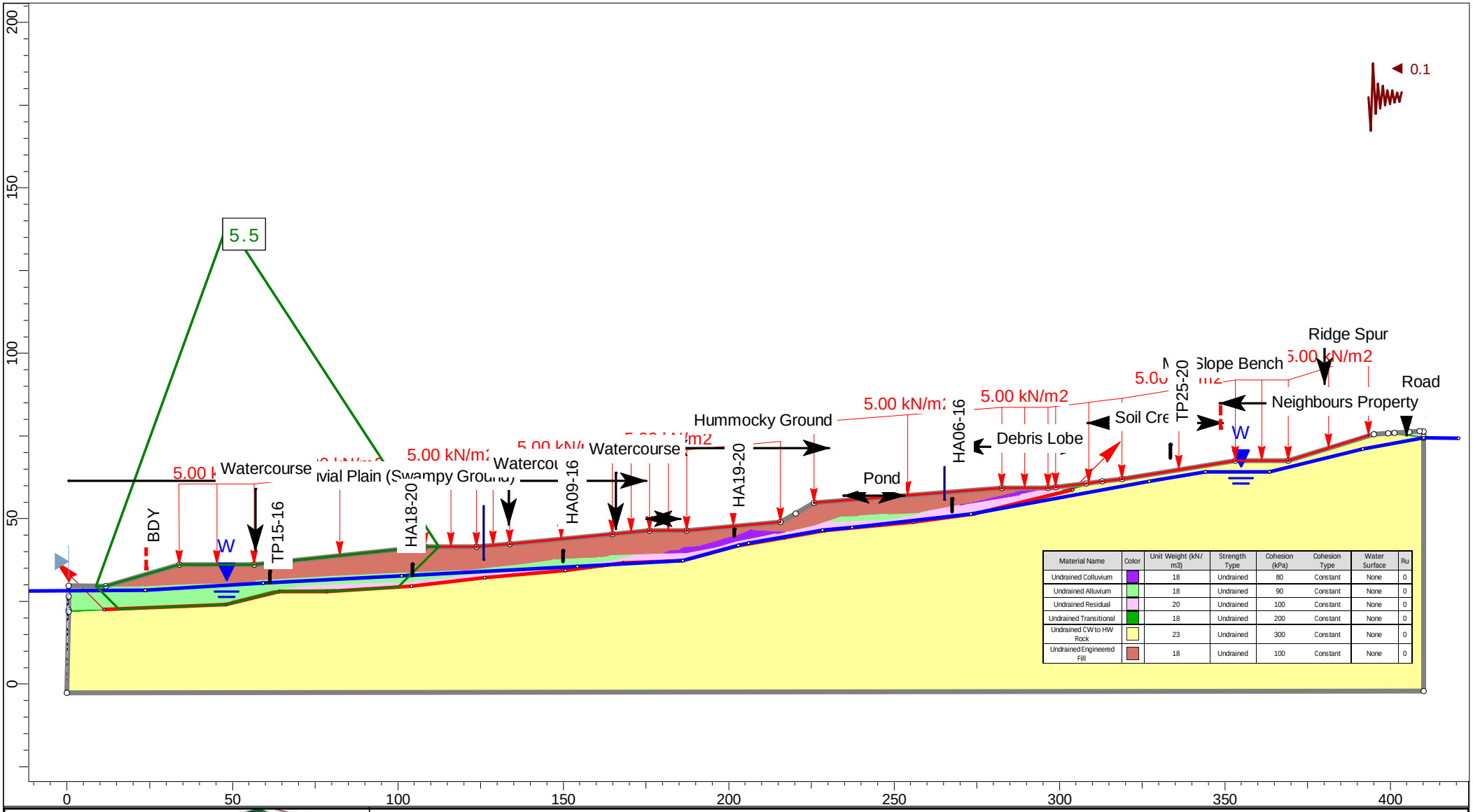
Project	Silverdale Stage 3&4			
Analysis Description	Section F - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Undrained Colluvium		18	Undrained	80	Constant	None	0
Undrained Alluvium		18	Undrained	90	Constant	None	0
Undrained Residual		20	Undrained	100	Constant	None	0
Undrained Transitional		18	Undrained	200	Constant	None	0
Undrained CW to HW Rock		23	Undrained	300	Constant	None	0
Undrained Engineered Fill		18	Undrained	100	Constant	None	0

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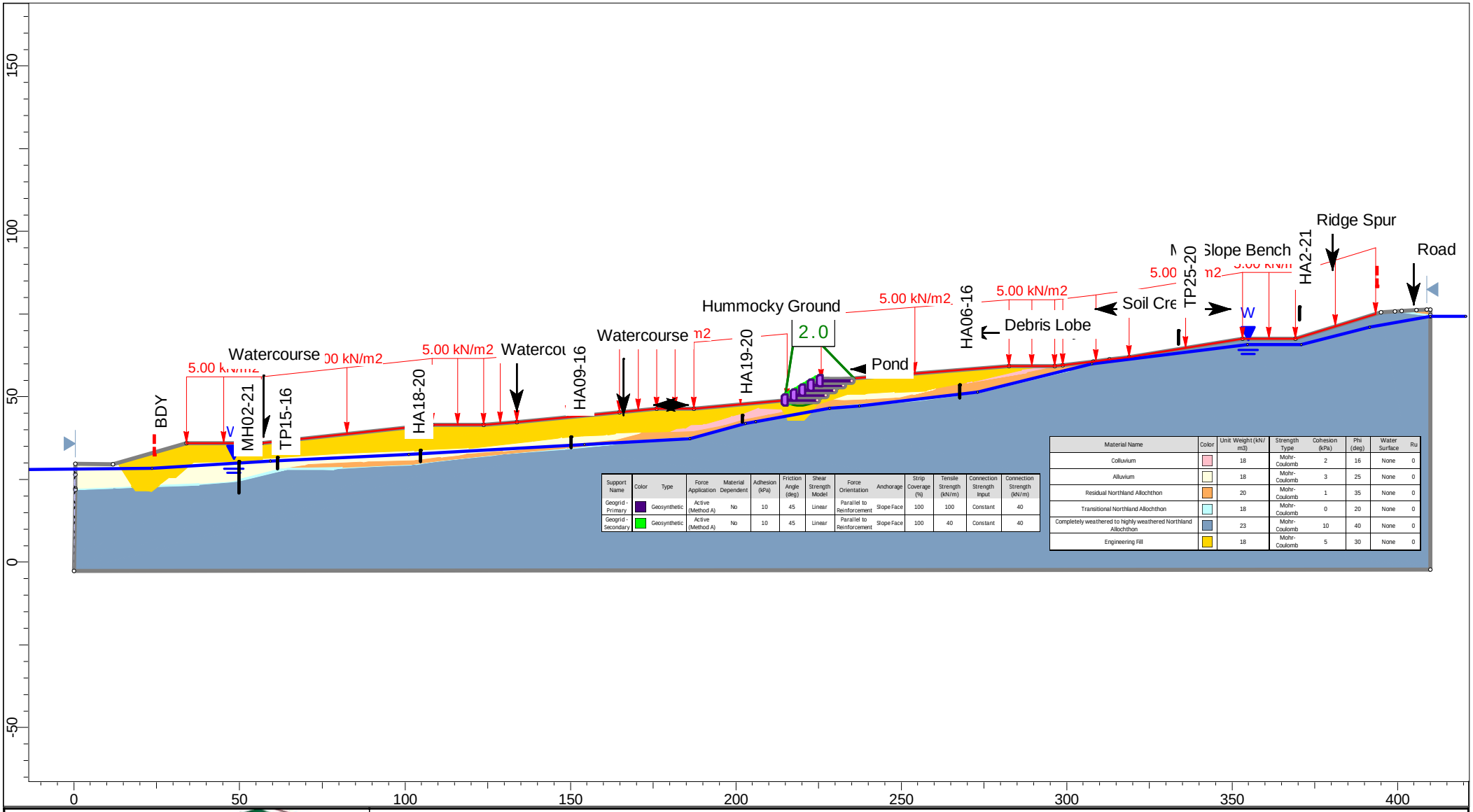
SLIDEINTERP 9.018

Project	Silverdale Stage 3&4			
Analysis Description	Section F - Proposed Profile, Seismic			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*	Build Rich
			File Name	AKL2020-0125 Section F 20082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Colluvium		18	Mohr-Coulomb	2	16	None	0
Alluvium		18	Mohr-Coulomb	3	25	None	0
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineering Fill		18	Mohr-Coulomb	5	30	None	0

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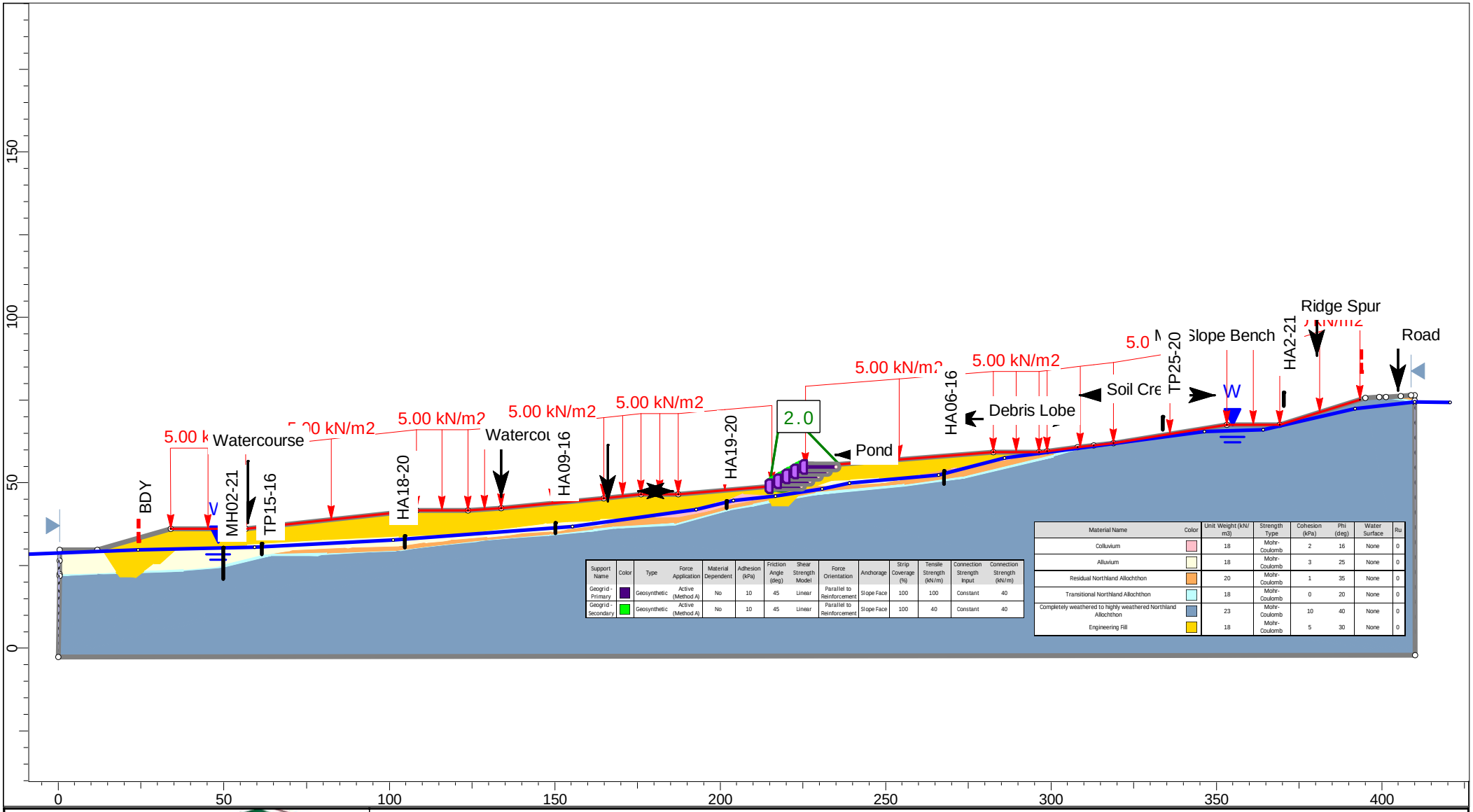
Project	Silverdale South Stage 3&4		
Analysis Description	Section F - Remediated, Normal Groundwater		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
			File Name AKL2020-0125 Section F 20082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Colluvium		18	Mohr-Coulomb	2	16	None	0
Alluvium		18	Mohr-Coulomb	3	25	None	0
Residual Northland Allochthon		20	Mohr-Coulomb	1	35	None	0
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	None	0
Completely weathered to highly weathered Northland Allochthon		23	Mohr-Coulomb	10	40	None	0
Engineering Fill		18	Mohr-Coulomb	5	30	None	0

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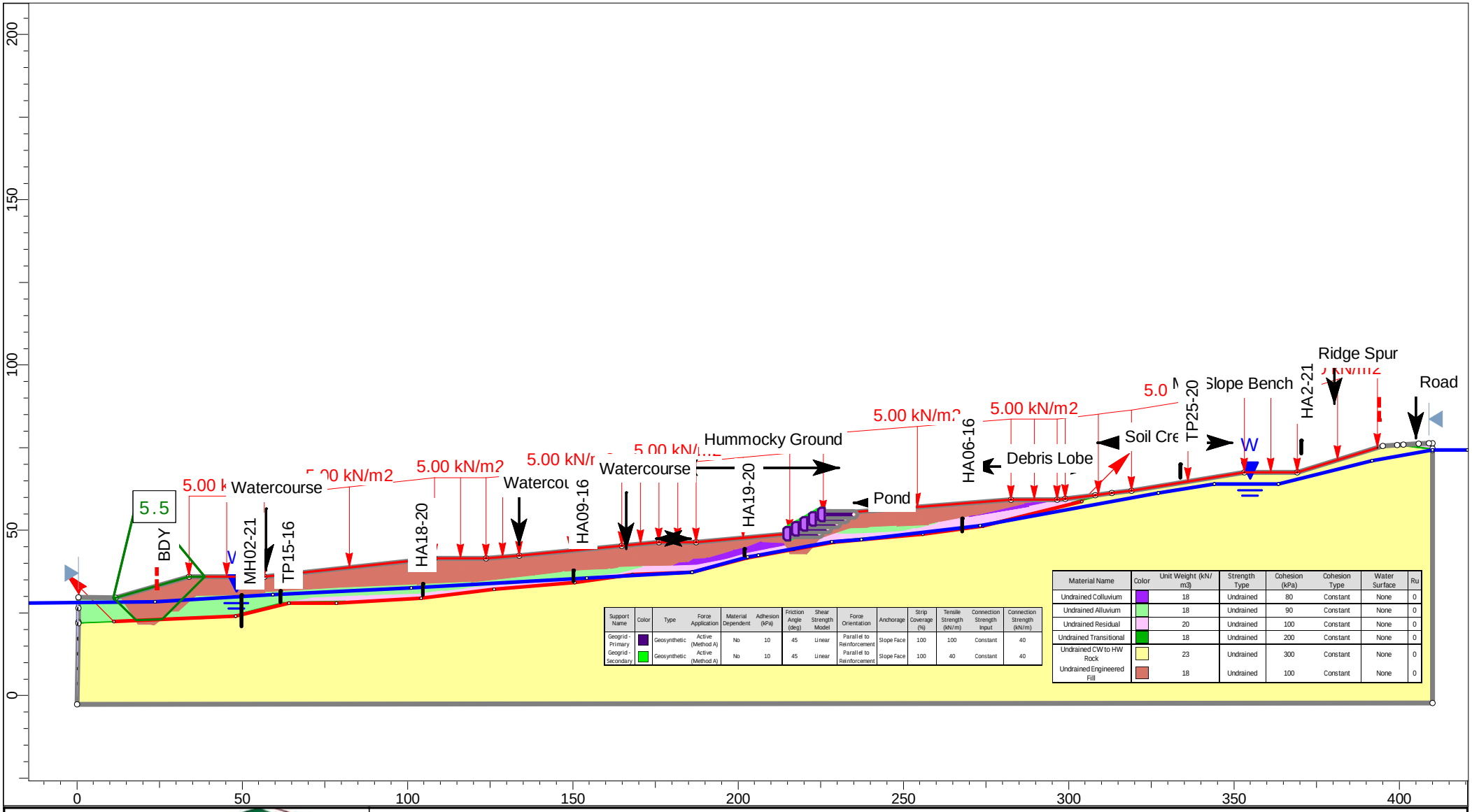
SLIDEINTERP 9.018

Project: Silverdale South Stage 3&4

Analysis Description: Section F - Remediated, High Groundwater

Drawn By: SP | *Date:* 6/09/2021 | *Scale* 1:1600 | *Company*

File Name: AKL2020-0125 Section F 20082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Undrained Colluvium		18	Undrained	80	Constant	None	0
Undrained Alluvium		18	Undrained	90	Constant	None	0
Undrained Residual		20	Undrained	100	Constant	None	0
Undrained Transitional		18	Undrained	200	Constant	None	0
Undrained CW to HW Rock		23	Undrained	300	Constant	None	0
Undrained Engineered Fill		18	Undrained	100	Constant	None	0

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SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section F - Remediated, Seismic		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:1600	*Company*
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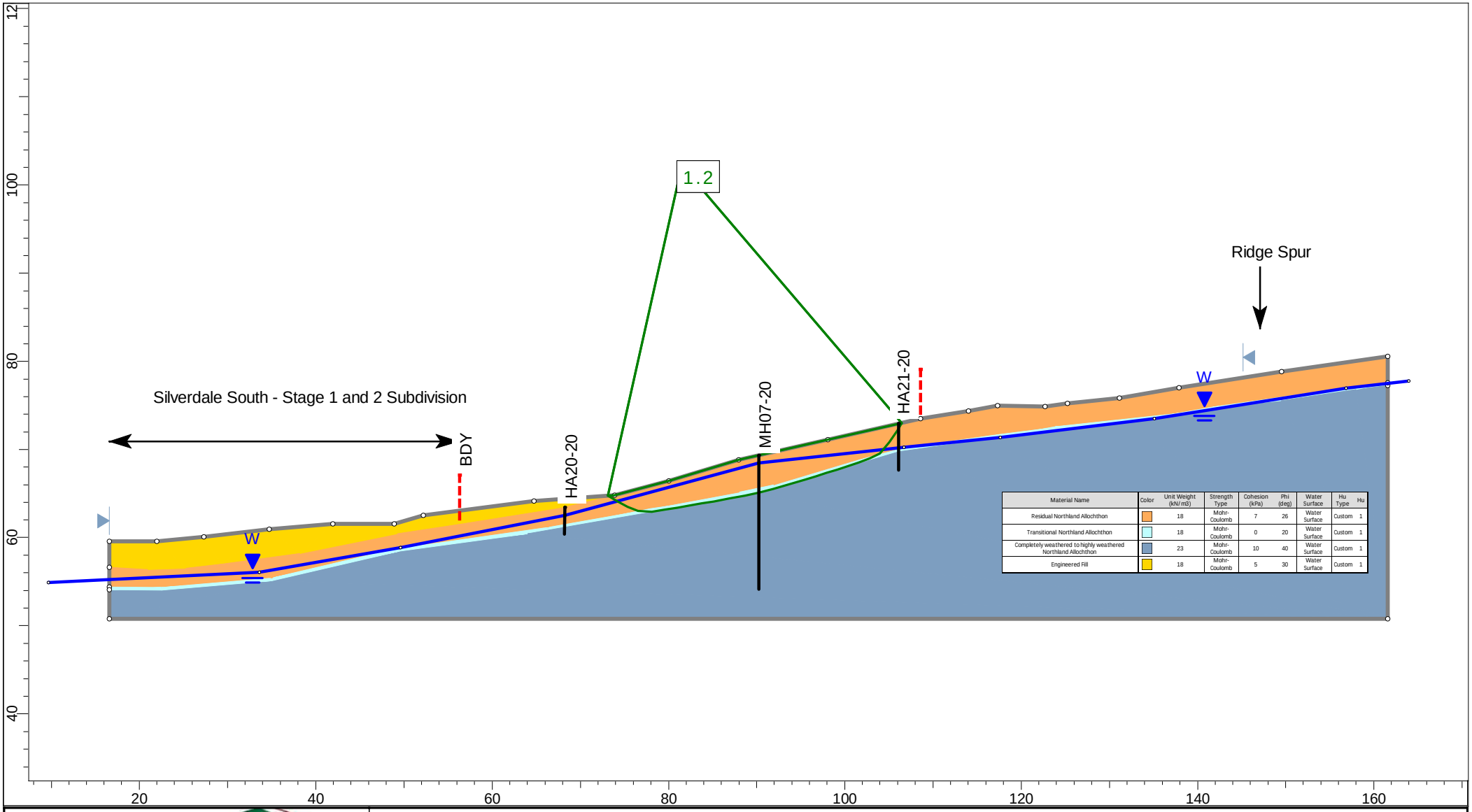

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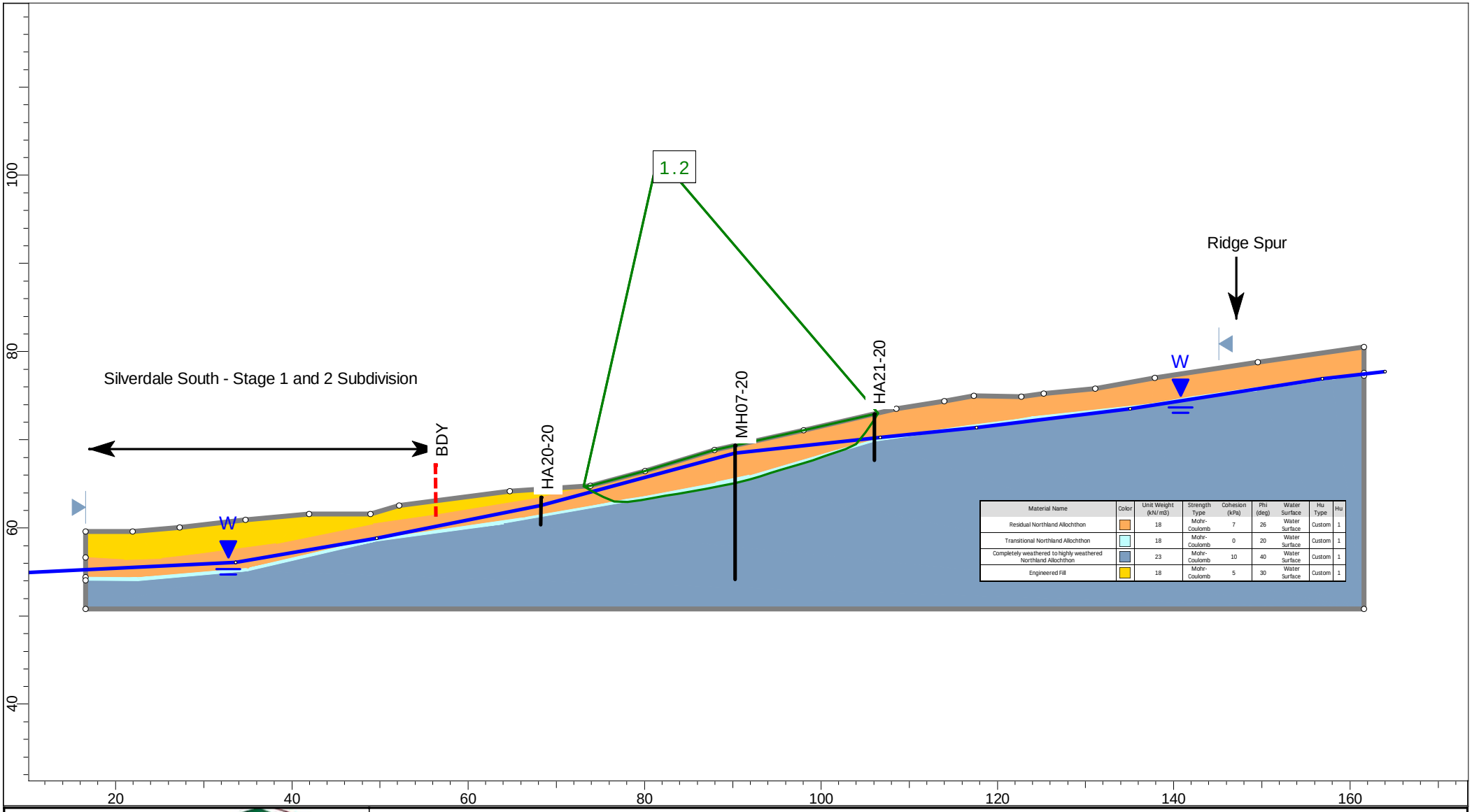
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Existing Profile, Normal Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
			File Name	AKL2020-0125 Section G 20082021 SP.slmd



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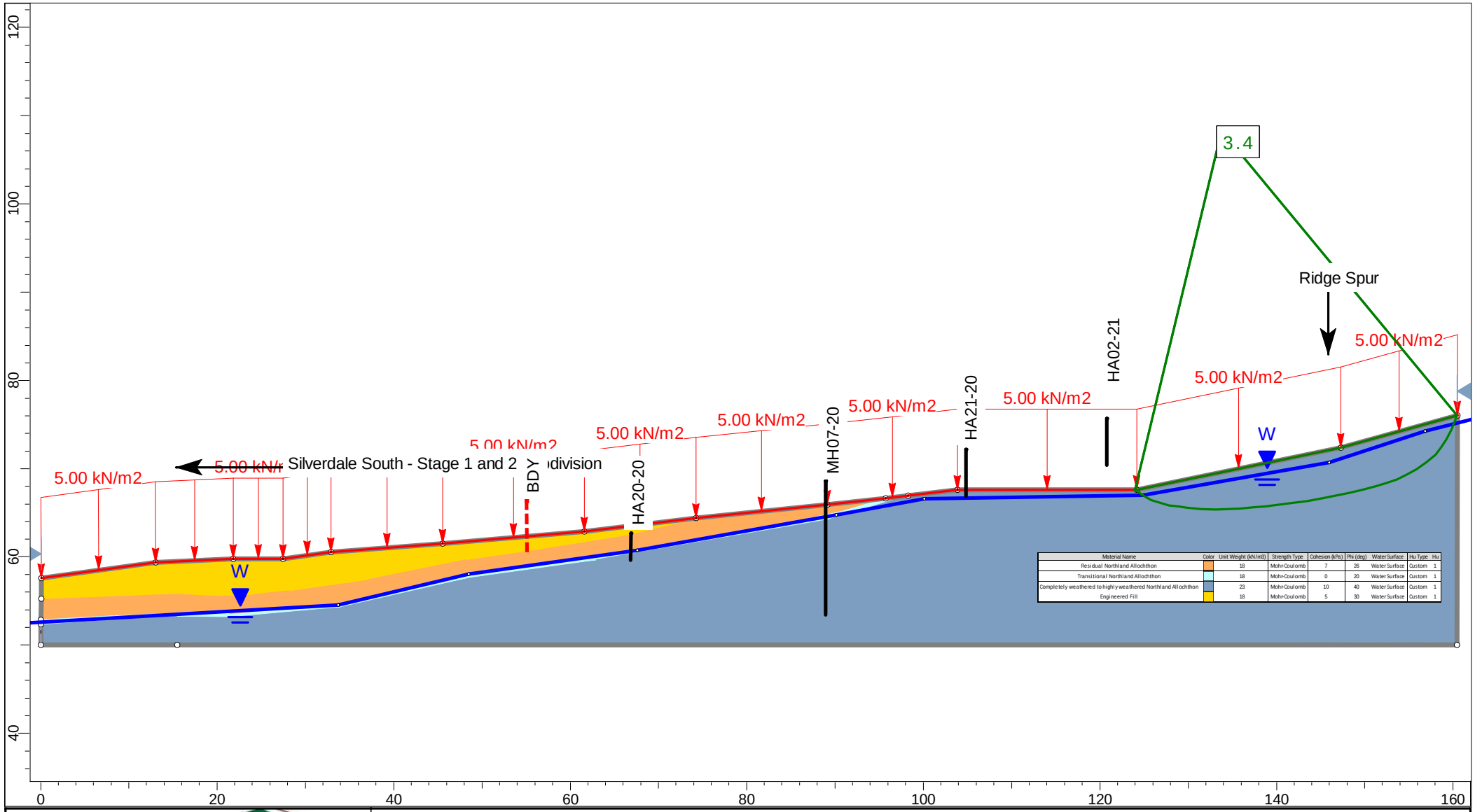
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Existing Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
			File Name	AKL2020-0125 Section G 20082021 SP.slmd



CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Proposed Profile, Normal Groundwater			
Drawn By: SP	Date: 6/09/2021	Scale 1:600	Company	Build Rich
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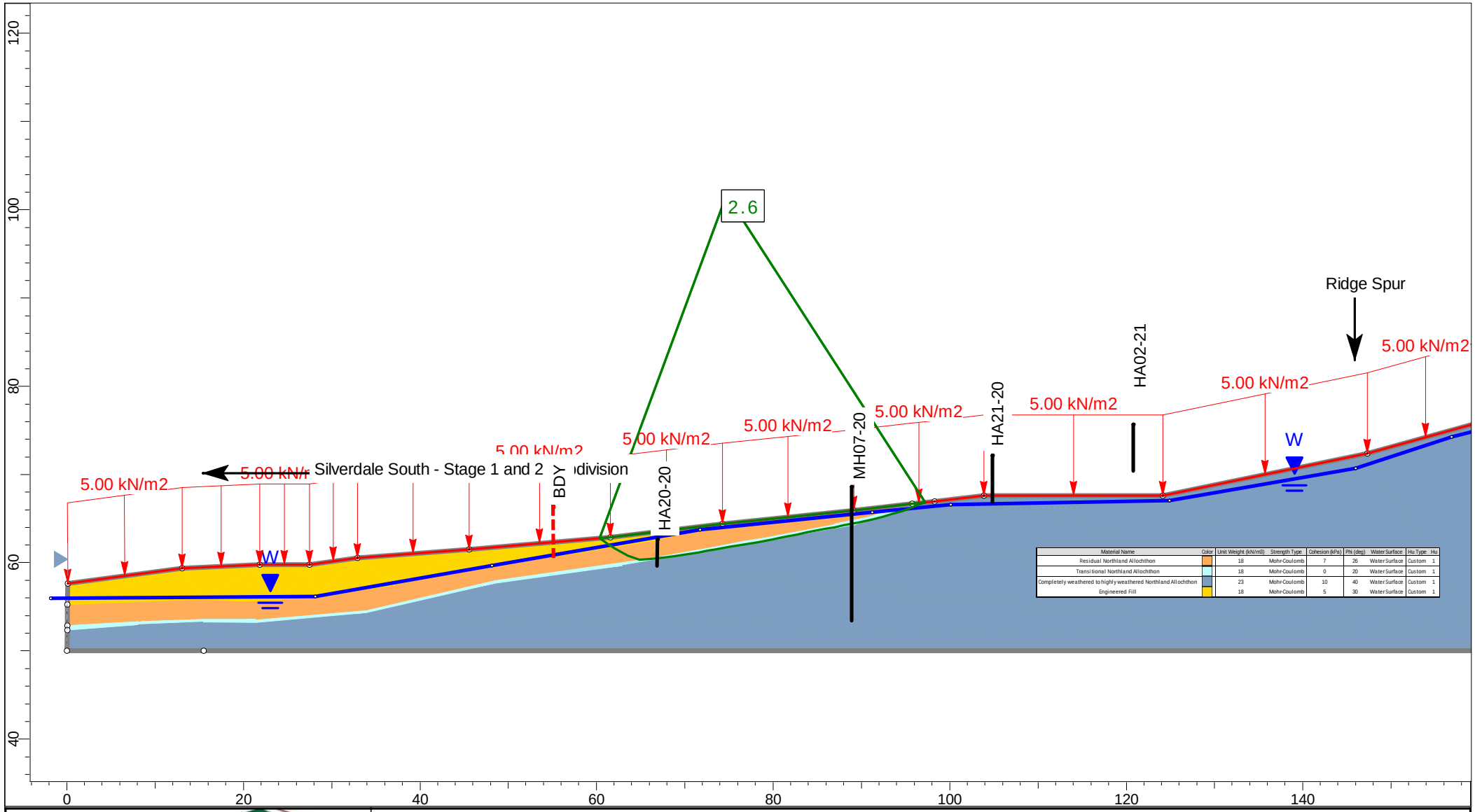
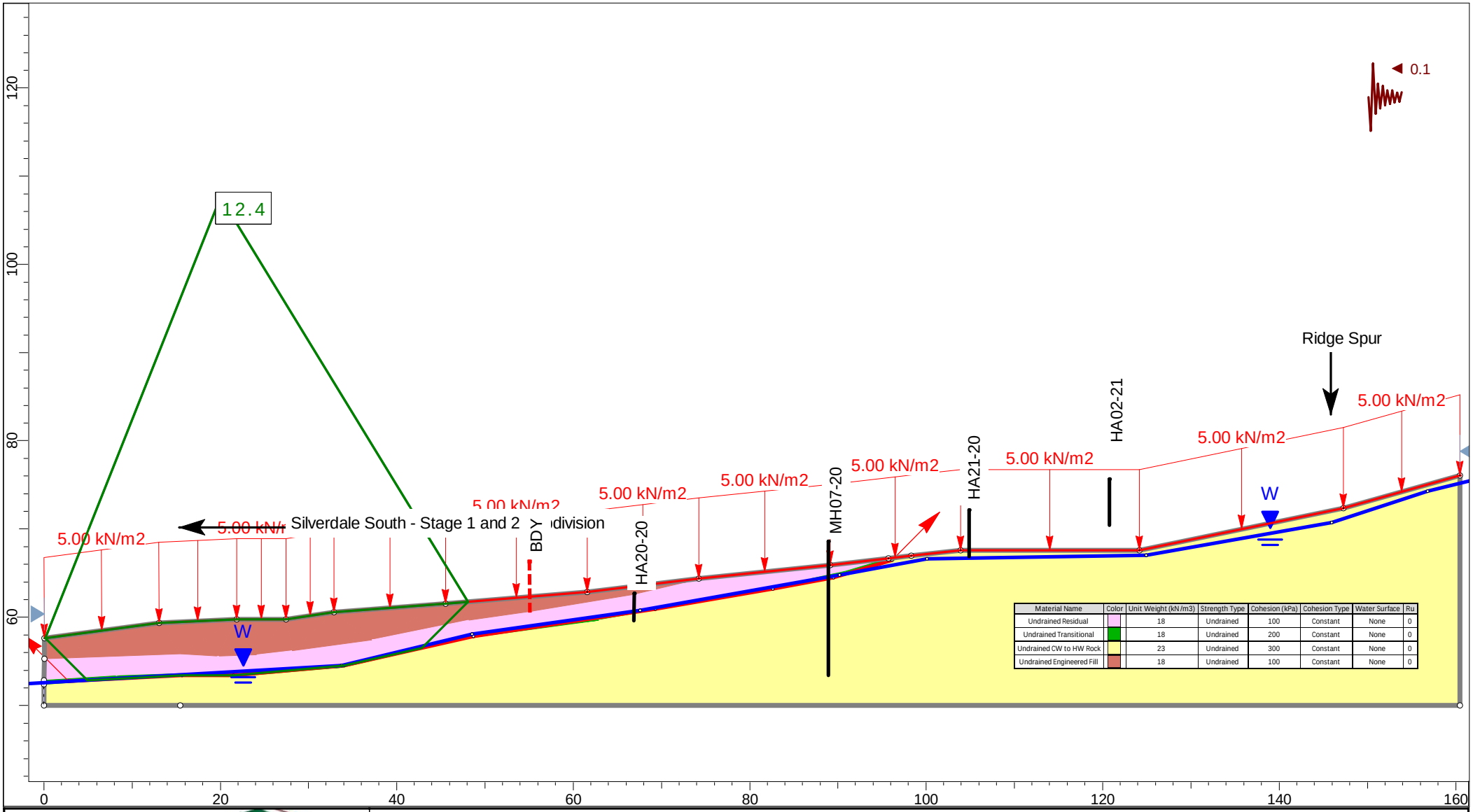


CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Proposed Profile, High Groundwater			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:600	*Company*	Build Rich
			File Name	AKL2020-0125 Section G 20082021 SP.slmd



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SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section G - Proposed Profile, Seismic			
Drawn By: SP	Date: 6/09/2021	Scale 1:600	Company	Build Rich
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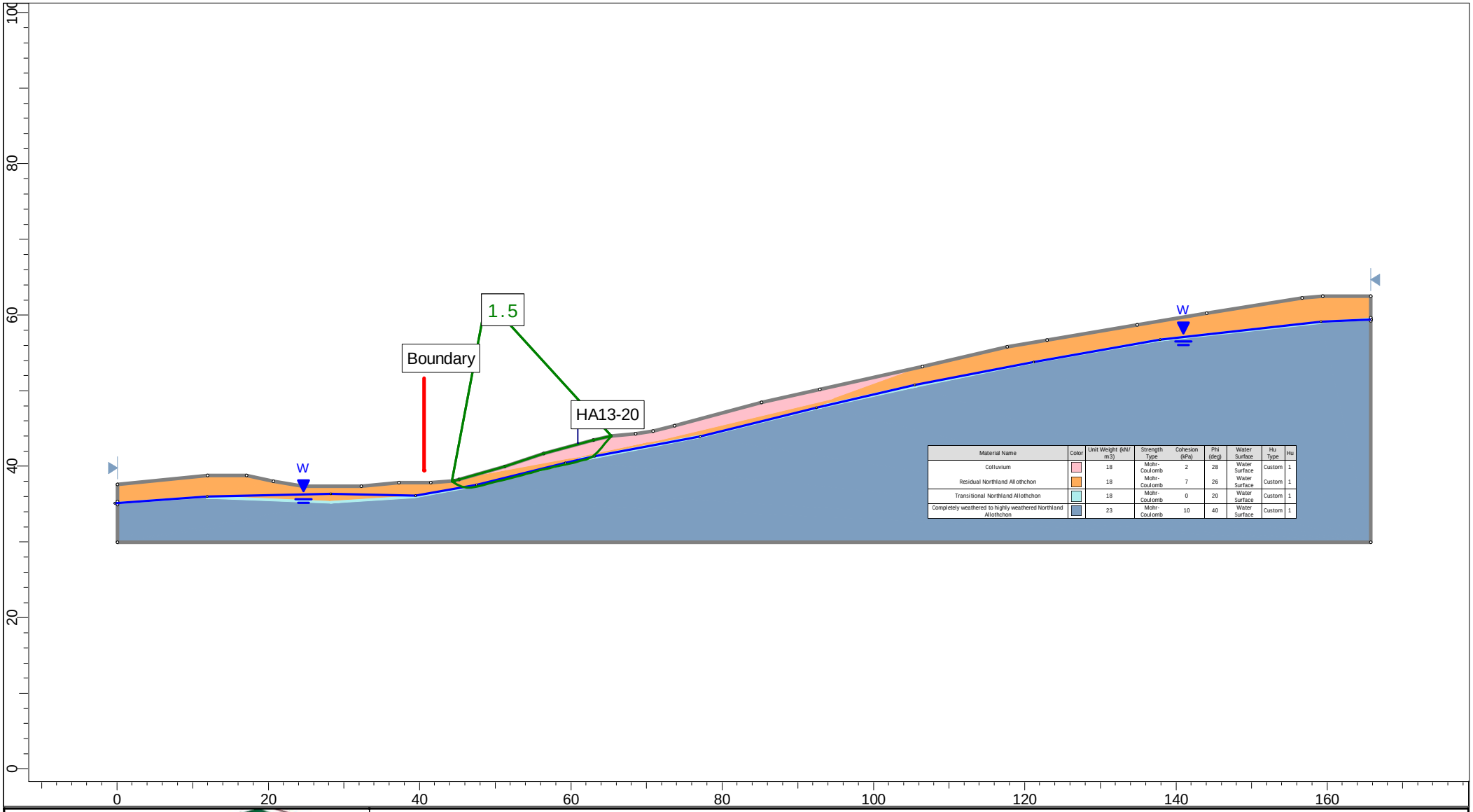

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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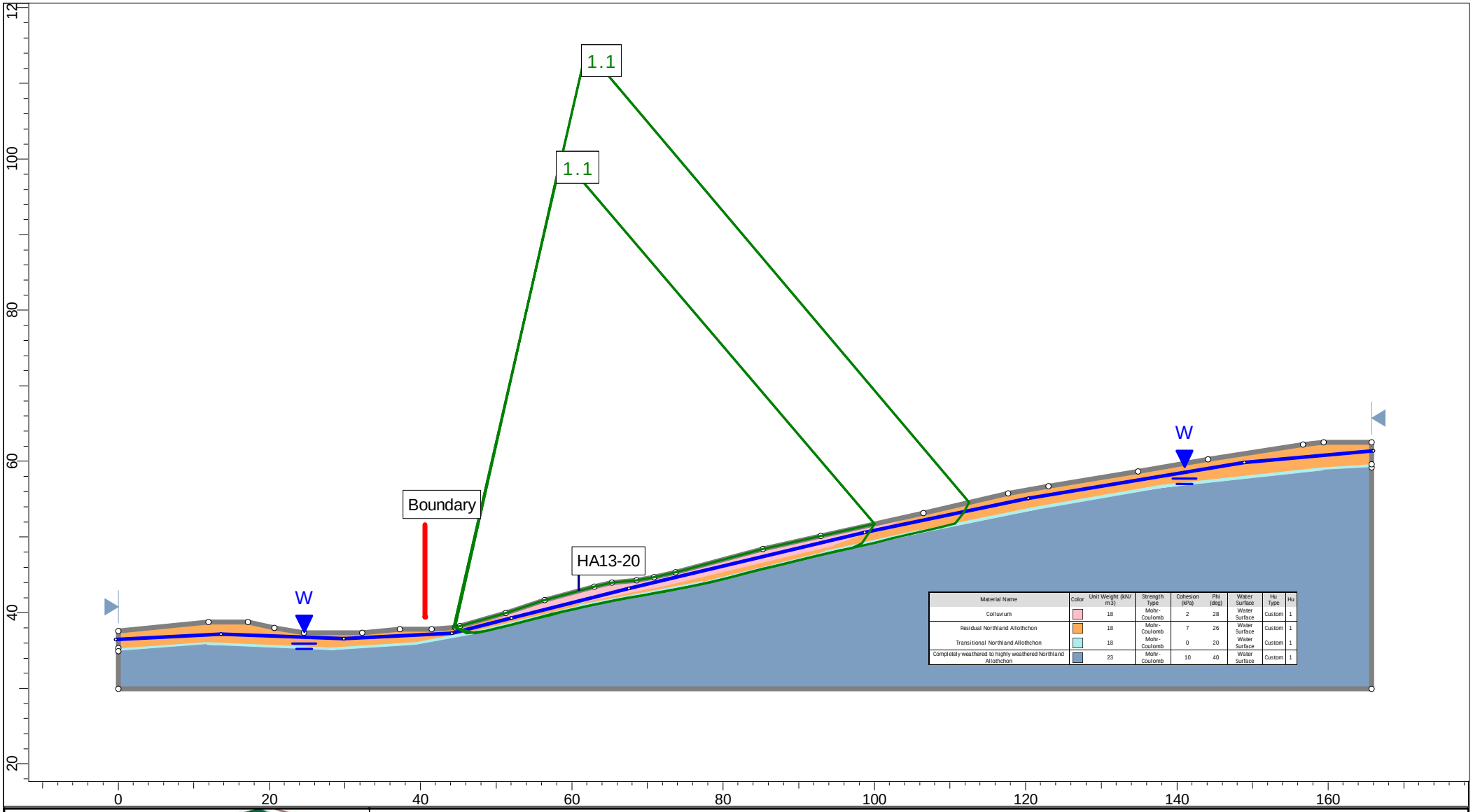
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Existing, NGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

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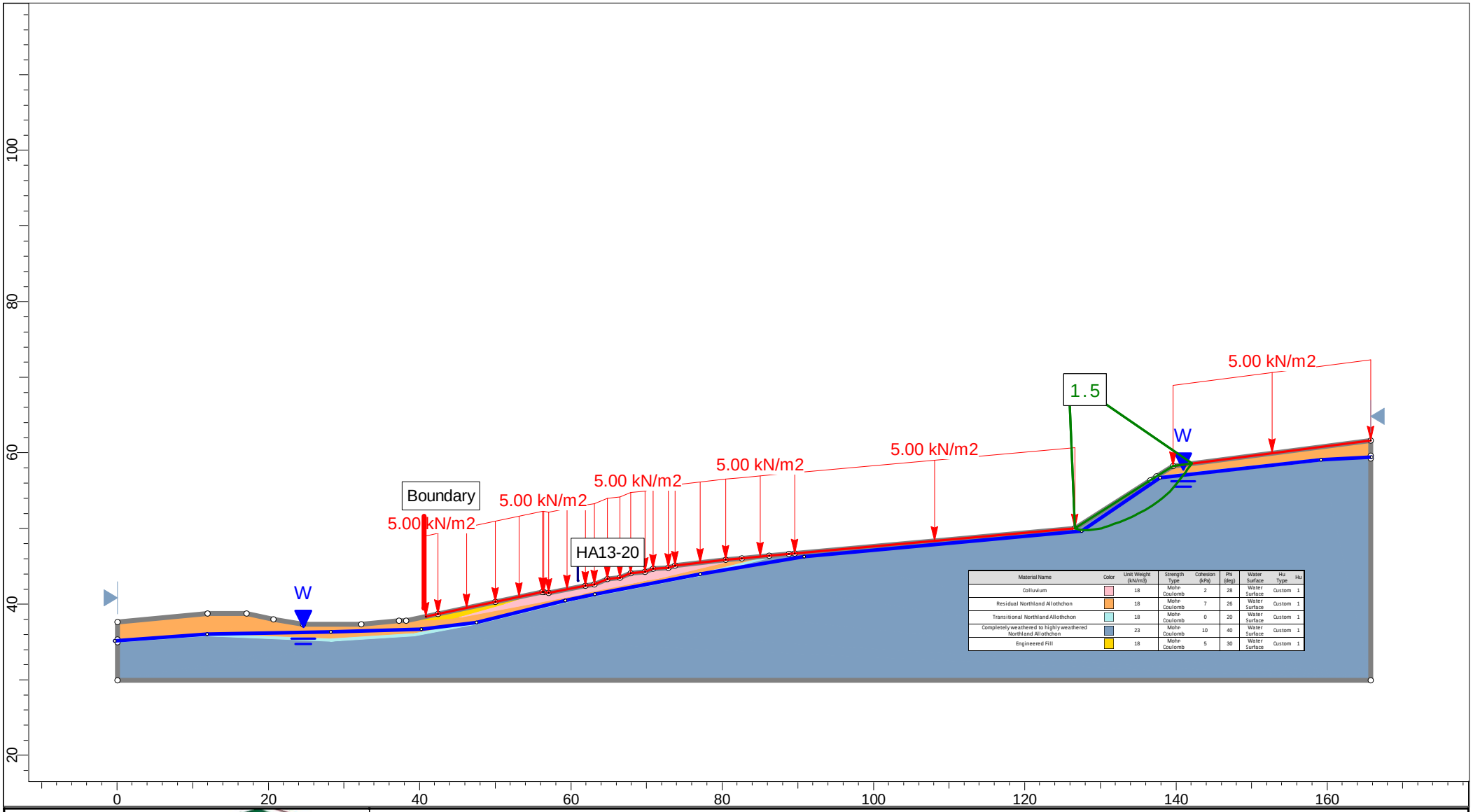
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Existing, HGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



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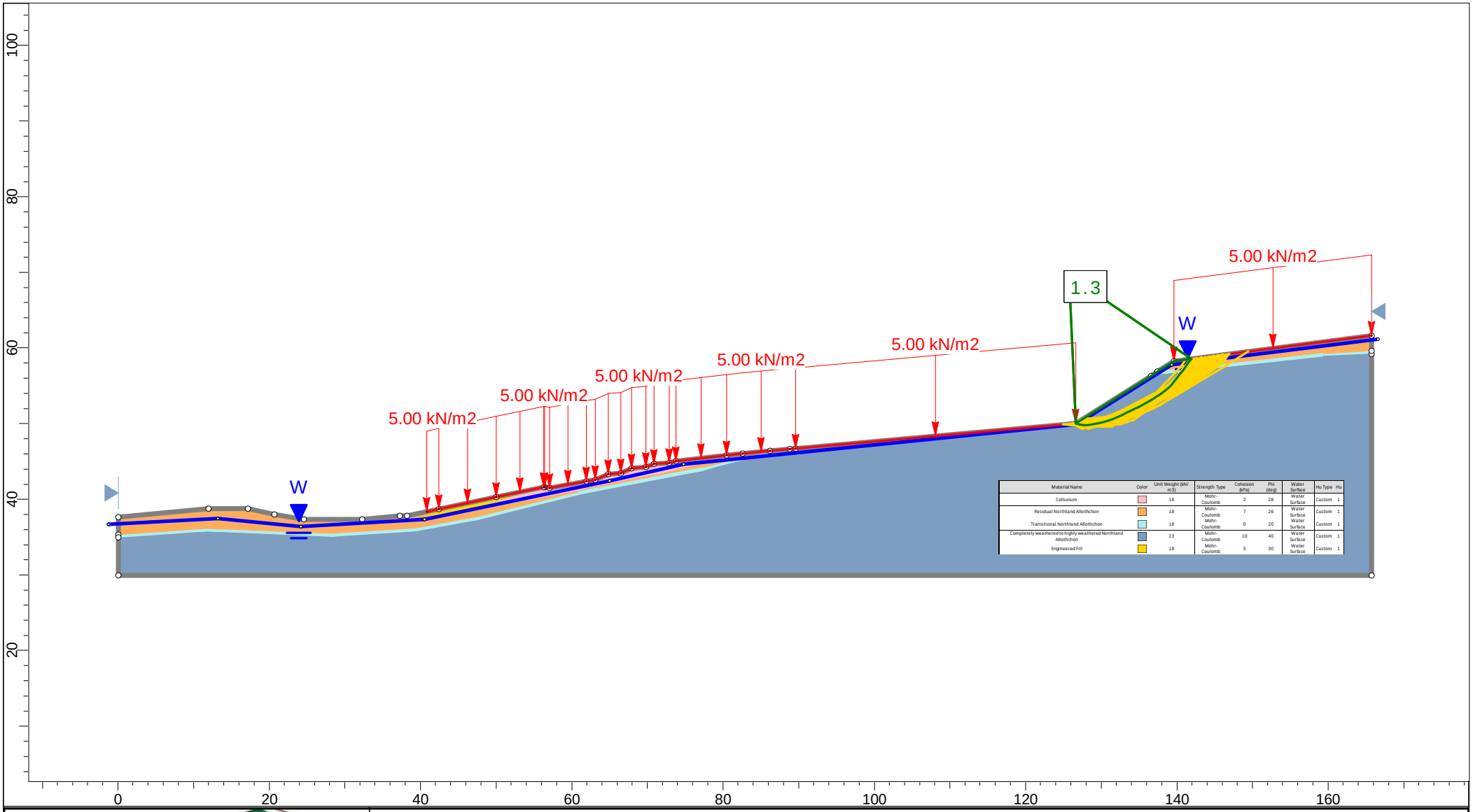
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Proposed, NGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



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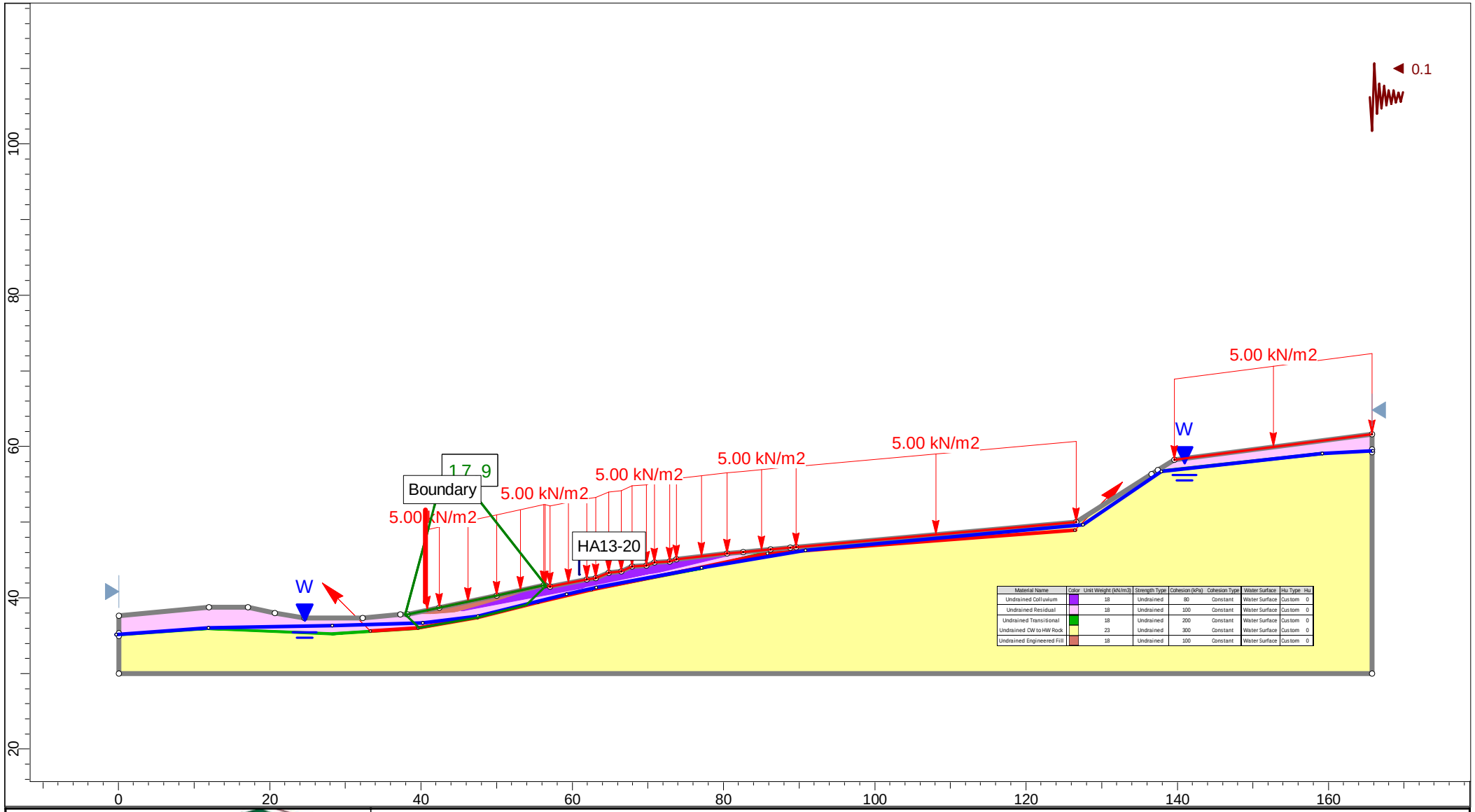
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Proposed, HGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



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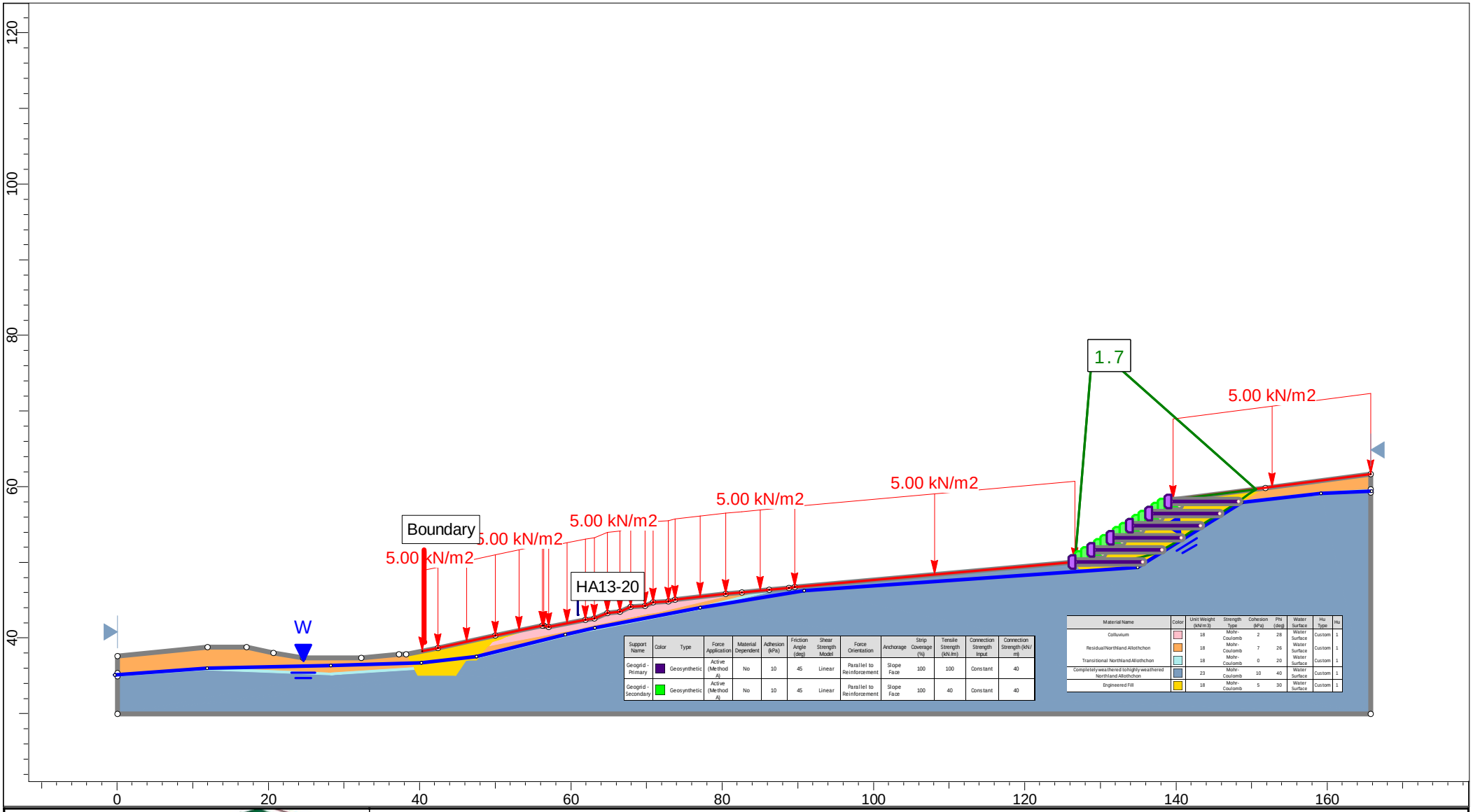
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Proposed, SEISMIC			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

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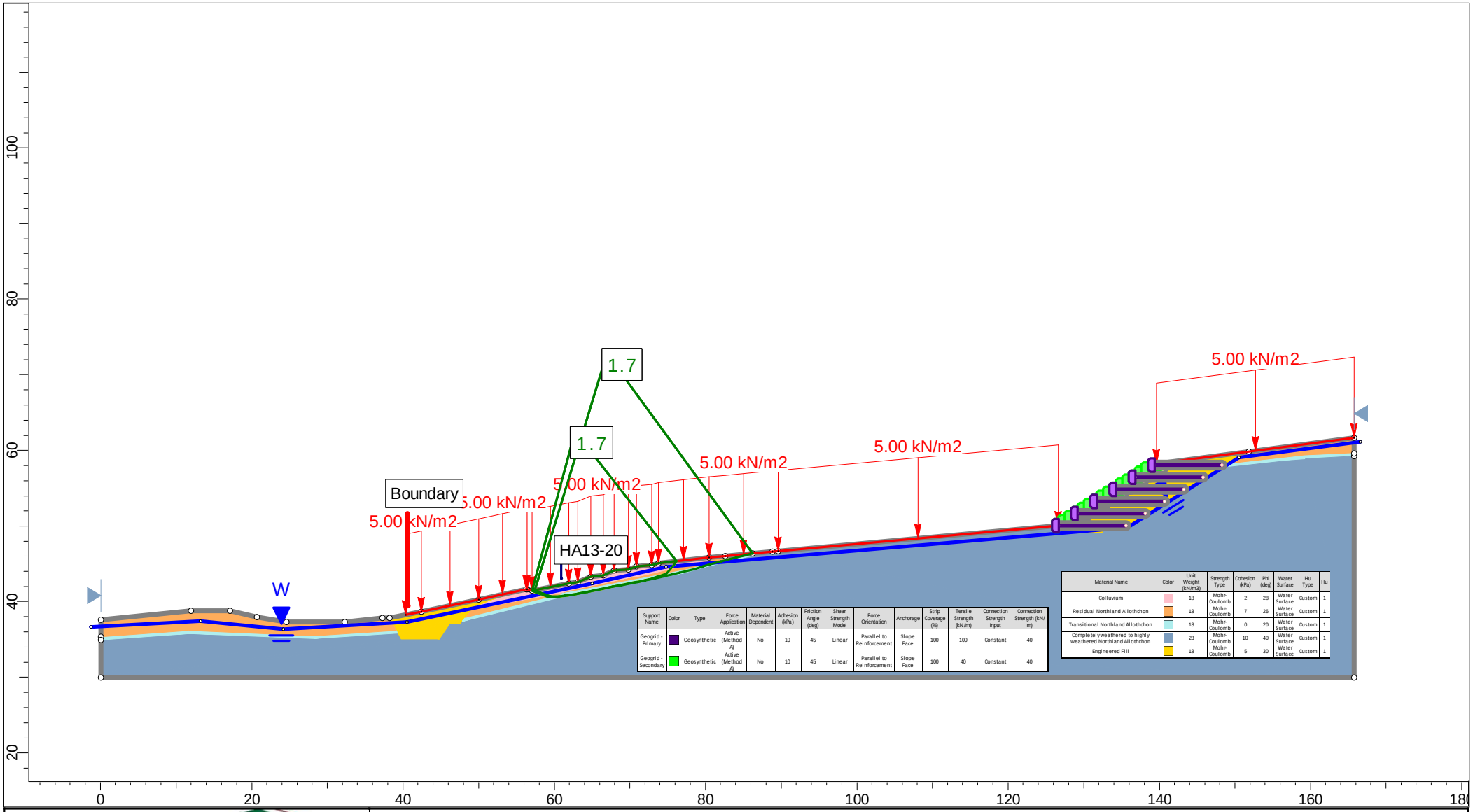
SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section H - Remediated, NGW		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company* Build Rich
			File Name Section H 31082021 SP.slmd



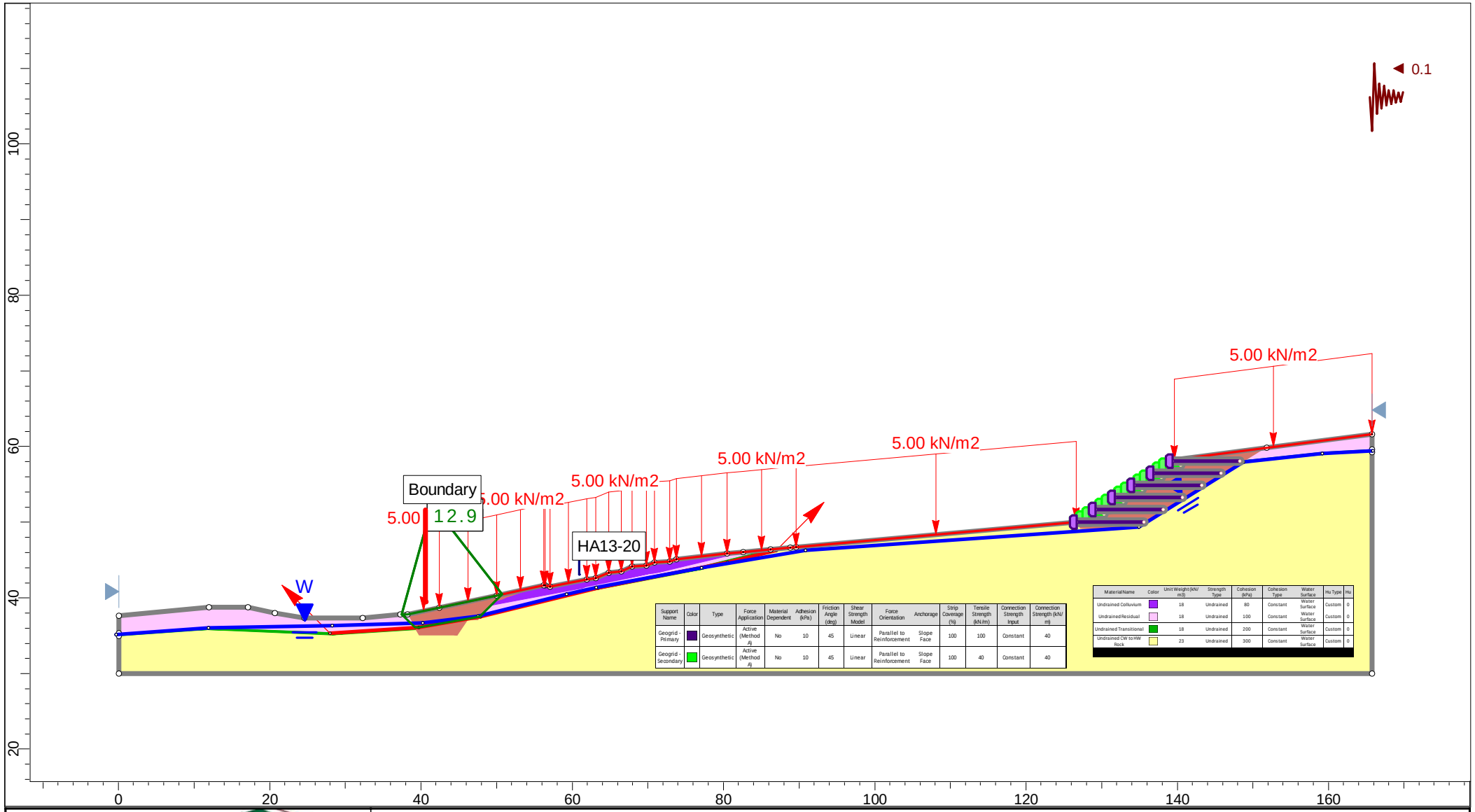
Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	2	28	Water Surface	Custom	1
Residual Northland Allothchon		18	Mohr-Coulomb	7	26	Water Surface	Custom	1
Transitional Northland Allothchon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely weathered to highly weathered Northland Allothchon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4			
Analysis Description	Section H - Remediated, HGW			
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company*	Build Rich
			File Name	Section H 31082021 SP.slmd



Support Name	Color	Type	Force Application	Material Dependent	Adhesion (kPa)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (kN/m)	Connection Strength Input	Connection Strength (kN/m)
Geogrid - Primary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	100	Constant	40
Geogrid - Secondary		Geosynthetic	Active (Method A)	No	10	45	Linear	Parallel to Reinforcement	Slope Face	100	40	Constant	40

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Hu Type	Hu
Undrained Colluvium		18	Undrained	80	Constant	Water Surface	Custom	0
Undrained Residual		18	Undrained	100	Constant	Water Surface	Custom	0
Undrained Transitional		18	Undrained	200	Constant	Water Surface	Custom	0
Undrained CW to HW Rock		23	Undrained	300	Constant	Water Surface	Custom	0

CMW Geosciences

SLIDEINTERP 9.018

Project	Silverdale South Stage 3&4		
Analysis Description	Section H - Remediated, SEISMIC		
Drawn By SP	*Date:* 6/09/2021	*Scale* 1:700	*Company* Build Rich
			File Name Section H 31082021 SP.slmd

Appendix E: Groundwater Assessment

Project no:

AKL2020-0125

Project name:

Silverdale South - Stage 3/4

Assessment of geotechnical aspects of proposed development with respect to the Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.6. Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10

Condition		Geotechnical Interpretation of Compliance
	Non-Compliant	
1. The water take must not be geothermal water		1. Groundwater is not geothermal
2. The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock		2. There are no peat soils identified on this site. Impact Assessment: Subsoil drains are to be installed that will follow existing alignments of surface water channels etc. Any groundwater intercepted will be returned to stream and/or wetlands in the same locations as present.
3. The water take must only occur during construction		3. Refer to impact assessments within this document.

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.10. Diversion of groundwater caused by any excavation, (including trench) or tunnel

Condition		Geotechnical Interpretation of Compliance
1.All of the following activities are exempt from the Standards E7.6.1.10(2) – (6)	Non-Compliant	
a. pipes cables or tunnels including associated structures which are drilled or thrust and are less than 1.2m in external diameter		a. No pipes greater than 1.2m diameter are proposed.
b. pipes including associated structures up to 1.5m in external diameter where a closed faced or earth pressure balanced machine is used		b. Not proposed for this site.
c. piles up to 1.5m in external diameter are exempt from these standards		c. Not proposed for this site.
d. diversions for no longer than 10 days; or		d. Earthworks excavations will exceed 10 days. Impact Assessment: Significant cuts are proposed from the north-eastern corner of the site within the ridgeline and in the centre of the northern boundary that will exceed 10 days of operation. Overall groundwater levels will likely be lower in the northern elevated area as part of these operations.
e. diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised where the part of the trench that is open at any given time is no longer than 10 days		e. Service trenches are to be open no longer than 10 days.
2.Any excavation that extends below natural groundwater level, must not exceed:	Non-Compliant	
a. 1ha in total area; and		a. Area is greater than 1 ha (refer to cut to fill plan)
b. 6m depth below the natural ground level		b. Maximum cut depth of 12.5m proposed Refer to Impact Assessment at 1(d) above.
3.The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.	Non-Compliant	3. The proposed earthworks plan indicates an area adjacent to East Coast Road where significant cuts are proposed that could potentially lower the ground water by up to 1m at the boundary. However the proposed 11.0m cut here ties into the existing level of the road. Impact Assessment: No detrimental impact on the neighbouring property. Deep subsoil drains are proposed to be installed within this cut. The design of these however (depth/location) will ensure that they facilitate the ongoing, unimpeded progress of groundwater from the surrounding land. Termination of these subsoil drains no closer to the boundary then 10m to the boundary in these low permeability soils will ensure that they do not lower the groundwater across the boundary by 2m or more. Cut of approximately 5.0m is proposed along the western boundary. Impact Assessment: Groundwater was recorded in this area at 4.8m and therefore drawdown within this cut is not likely to be a risk along the boundary. The proposed cut is through a ridgeline and bare land is present on the extension of the ridgeline into the neighbouring property. The cut will be battered down into the site but due to the depth of recorded groundwater lowering of the groundwater table here is considered unlikely.
4.any structure, excluding sheet piling that remains in place for no more than 30 days, that physically impedes the flow of groundwater through the si must not:	Compliant	
a. impede the flow of groundwater over a length of more than 20m; and		a. No potentially groundwater impeding structures of this nature are proposed for this site
b.extend more than 2m below the natural groundwater level.		b. No potentially groundwater impeding structures of this nature are proposed for this site
5.The distance to any existing building or structu re (excluding timber fences and small structures on the boundary) on an adjoining site from the edge	Compliant	
a.trench or open excavation that extends below natural groundwater level must be at least equal to the depth of the excavation		a. Adjacent infrastructure offset at least the depth of the excavation
b.tunnel or pipe with an external diameter of 0.2 - 1.5m that extends below natural groundwater level must be 2m or greater; or		b. Adjacent infrastructure and strutures are offset at least 2m
c.a tunnel or pipe with an external diameter of up to 0.2m that extends below natural groundwater level has no separation requirement.		c. Noted
6.The distance from the edge of any excavation that extends below natural groundwater level, must not be less than:	Compliant	
a.50m from the Wetland Management Areas Overlay		a. Greater than 50m from any Wetland Management Overlay
b.10m from a scheduled Historic Heritage Overlay; or		b. Greater than 10m from any Historic Heritage Overlay
c.10m from a lawful groundwater take.		c. Greater than 10m from any groundwater take

29 September 2021

Project: Silverdale South Stage 3/4

Client: Build Rich Limited

Project No: AKL2020-0125

1 GROUND WATER DRAWDOWN CALCULATIONS

Assume ground water drawdown of 1.6m along the Eastern boundary.

Hmax = 1.6m (Excavation and GW @ 0.9mbgl)

$R_o = C*h*k^{0.5}$ (CIRIA 113, 1986)

C = 2000

K = 10^{-7}m/s

R_o = 2000 x 1.6 x $\sqrt{10^{-7}}$

= 1.01m

Groundwater in HA20-20 recorded at 0.9m. Excavations along the eastern boundary (approx.) from earthworks contours estimated at 2.5m.

Appendix F: Geotechnical Work Specifications

19 May 2021 Document Ref: AKL2020-0125AE Rev.0

Land Development Geotechnical Works Specification

For: Silverdale South, Stage 3 & 4

1 INTRODUCTION AND SCOPE

This specification covers the geotechnical remediation works and associated earthworks outlined in the CMW Investigation Report (GIR), referenced AKL2020-0125AB Rev.0. It supplements the information provided on the design drawings and GIR. It provides detail on the required specification for:

- Site clearance and preparation including topsoil stripping and stockpiling;
- Geotechnical stabilisation works such as shear keys and stability undercuts;
- Subsoil drainage installation;
- Cut to fill earthworks operations;
- Fill materials and testing requirements;
- Earthworks finishing and respread of topsoil; and,
- As-built records.

Excluded from the scope are geotextile reinforced slopes with a face and steeper than 30 degrees or retaining structures covered by a building consent. Such works will be carried out in accordance with an independent structure specific specification.

Unless varied onsite by the Geotechnical Engineer, the following specification requirements must be met in order for CMW Geosciences (CMW) to provide a Geotechnical Completion Report for the works.

2 RELEVANT DOCUMENTS

2.1 Standards, Guidelines and Consents

The works shall comply with the relevant sections of the following standards, guidelines and consents:

1. Health and Safety at Work Act 2015 and Regulations 2016;
2. All Project Resource Consent Conditions and Engineering Works Approvals;
3. The applicable Council Infrastructure Design Standard;
4. The Auckland Council, Erosion and Sediment Control Guidelines – Guidance document 2016/005;
5. NZS 4431:1989 Code of Practice for Earth Fill for Residential Development;

6. NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes; and,
7. NZS 4404: 2010 Code of Practice for Urban Land Subdivision.
8. WorkSafe NZ – Excavation Safety Good Practice Guidelines, July 2016.

2.2 Geotechnical Investigation Report

Details of the geotechnical investigation, soil and rock conditions encountered, and the design of the geotechnical remedial works are contained in the CMW report AKL2020-0125AE Rev.0. The contractor should be aware of the contents and recommendations contained in that report.

The works shall comply with the recommendations contained in that report.

2.3 Construction Drawings

The works shall comply with the following geotechnical design drawings and standard details:

- Aspire Consulting Engineers, 2182 East Coast Road, Silverdale (Stage 3 & 4) – Drawing number 1625 – RC – PG103 to 104 and EW201 to 202, dated March 2021.

2.4 Conflicting Information

Where there is any conflict or discrepancy in the requirements of this specification and the documents listed above the matter shall be referred to the Geotechnical Engineer (CMW) for clarification.

3 GEOTECHNICAL OBSERVATION REQUIREMENTS

The following items form hold points in the construction works that require observation, testing and approval by the Geotechnical Engineer (CMW):

1. Foundations for filling once topsoil and unsuitable materials have been stripped prior to fill placement;
2. Shear key excavations and undercuts to confirm depth and extents prior to backfilling;
3. Subsoil drain excavations prior to placement of aggregate;
4. Any imported soil fill materials prior to placement on site;
5. Drainage aggregate quality prior to placement;
6. Geotextile layers once in place and prior to backfilling;
7. Filling placed at regular intervals to comply with the fill test frequency requirements below;
8. Compaction of backfilling in critical service trenches;
9. Flushing of the subsoil drainage system at the completion of earthworks;
10. Any unforeseen ground conditions that may impact on the construction works or future land use; and,

It is the contractor's responsibility to ensure that the Geotechnical Engineer is given reasonable notice and opportunity to observe the above works and that the works do not proceed until approval has been gained from the Geotechnical Engineer.

24 hours is considered reasonable notice.

4 SAFETY IN DESIGN

The design landform requires site excavations that may include geotechnical works such as undercuts, temporary excavations, steep fill batters, shear key excavations, deep and shallow subsoil drains as specified in the Geotechnical report and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent part in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

Our SiD risk assessment is presented in ***Appendix G*** to our report referenced AKL2020-0125AB Rev.0. This risk assessment must be communicated with all affected parties involved with the project and dealt with through specific on-site risk assessment plans.

5 TEMPORARY BATTERS AND EXCAVATION STABILITY

The temporary stability of the works is the responsibility of the main contractor. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Slope instability during construction is a significant risk where earthworks may cause changes to slope geometry or groundwater conditions.

The causes of instability during earthworks may include:

- Removal of toe support due to excavation;
- Over steepening of slope angles in temporary batters;
- Geological defects in the soil or rock mass, particularly where these are exposed in excavation faces;
- Elevated groundwater levels following rainfall, perched groundwater or rapid recharge due to the reduced distance to an impermeable layer (i.e. undisturbed rock) due to cut operations; and,
- Additional loading upslope of excavations. i.e. construction equipment or stockpiles.

To help mitigate these risks the contractor should consider:

- Staging excavations which reduce support to slopes or create temporarily over steepened slopes, to ensure large areas are not left unsupported. The allowable length of excavation to have open at any one time will vary and is dependent on a number of factors such as, local ground conditions, groundwater, length of time the excavation will be open, weather, depth of excavation, geological defects present and the earthworks equipment and methodology used;
- Ceasing works in excavations during rainfall and assessing stability of excavations following rainfall events prior to resuming work;
- Benching or battering back of excavation faces;
- Ensuring good control of surface water runoff above excavations and batters;
- Covering steep batters with impermeable covers where they may be left without support for any significant period of time;
- Avoiding loading the crests of slopes and excavations (including loading with working plant);
- Putting in place comprehensive risk identification and management procedures and work methodologies for temporary excavation stability;
- Carrying out regular inspections upslope of excavations and of the excavation slope to look for signs of instability such as ground displacement and the development or propagation of cracks; and,

- Seeking advice from the Geotechnical Engineer where there is doubt as to the stability of a slope or excavation.

6 CONSTRUCTION SPECIFICATION

6.1 Site Preparation

The Contractor shall remove all vegetation from the site of the earthworks except for trees indicated for preservation either by marking on the site or noted on the drawings, and clear the remainder of the site.

Clearing shall mean the felling of all trees, except those indicated, removal of all growth other than grass and weeds, extraction of tree stumps, demolition of fences and other minor items remaining in the way of site stripping, and the complete disposal of all items. Stumping shall mean the removal of all roots greater than 25mm in diameter.

Cleared areas shall be stripped to remove all turf and organic topsoil to depths designated by the Engineer ahead of or during the stripping operations. Stripping shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the course of the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

6.2 Erosion and Sediment Control

The works shall be carried out in accordance with the project Erosion and Sediment Control Management Plan and associated drawings.

The contractor shall ensure good control of surface water runoff at all times by shaping of the surface in cut and fill areas to prevent ponding during rainfall events.

The location of temporary Sediment Retention Ponds (SRP) on sloping ground shall be decided upon with input from the Geotechnical Engineer. Where comment of SRP stability is sought by Council then all fill materials used to form batters, must be placed as engineered fill and tested accordingly unless advised otherwise by the Geotechnical Engineer.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

6.3 Stockpiles

Topsoil stockpiles can add significant driving force for slope instability when placed at or near the crest of a slope. The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

6.4 Fill Foundations and Benching of Slopes

The foundation on which filling is to be placed must be observed by the Geotechnical Engineer following clearing and prior to the placement of any filling to confirm the strength of the underlying soils is sufficient.

Where it is found, after clearing and stripping operations as specified, that the foundation on which filling is to be placed is unstable, or in cuttings if it is found after the excavation has been cut down to the levels shown in the drawings that unstable ground is encountered, then the Engineer may direct that the soft, yielding or unstable materials causing such instability shall be removed to such depth as directed.

Benching of slopes prior to the placement and compaction of filling should be carried out in accordance with the normal requirements of NZS 4431 and related documents as mentioned above, especially on the steeper areas of the site, to ensure that the filling placed is keyed into the underlying natural ground.

This would involve the cutting of benches approximately the width of a bulldozer, with a slight reverse gradient back into the slope. The optimum depth of each bench is best confirmed by careful Engineering inspections during construction.

6.5 Shear Key, Fill Drainage Key and Buttress Fill Excavations

All shear keys, fill drainage keys and buttress fills required to improve long term stability conditions are to be constructed in accordance with the design drawings and standard details. The key/buttress base width, lateral extent and benching requirements need to be confirmed on site by the Geotechnical Engineer during construction. In most cases this requires detailed logging of the excavation faces by a geo-professional and may require trial pits to be dug in the base of the excavation. The contractor should make allowance for the time and plant required for these inspections in their work programme.

6.6 Fill Materials and Conditioning

6.6.1 Soil Fill, Rock Fill or Soil and Rock Mixed Fill

Site won materials used as engineered filling shall be free of topsoil, organic matter, rubbish and other unsuitable materials. The maximum particle size for soil and rock blended fill shall be 200mm and mixing and/ or crushing shall be carried in a manner that ensures that significant voids are not present in the filling between rock fragments.

For rock fill without soil blending, crushing is to occur to comply with the requirements for blended fills and needs to ensure that uniform compaction can occur without significant voids between particles in the absence of the soil fill.

6.6.2 Blending of Unsuitables

The blending of ‘unsuitables’ into structural fills may be undertaken only at the discretion of the Geotechnical Engineer following a request by the contractor and with sufficient time for appropriate consideration. Approval for any such blending must be sought from and provided by the Geotechnical Engineer in writing prior to the commencement of any blending.

In consideration of any such requests, the Geotechnical Engineer will need to be able to assess, et. al., the composition of the materials requested to be blended, the location on the site for the proposed fills, the fill depths and the elevation of the blended materials within the fills and any environmental constraints.

As a minimum, it is expected that any blended fills will be directed to comply with the following conditions:

- All significant, solid inorganics (such as roots and stumps) to be removed prior to blending; and,
- All inclusions of suitable man-made materials (e.g. concrete) and any excavated rock must comply with the normal compaction requirements specified herein in terms of size and ability for appropriate compaction to be achieved in close vicinity to the inclusions.
- All blended materials must be appropriately mixed/ blended normal fill materials to the specified ratio. Un-mixed interlayering of normal engineered filling with unsuitables will not be accepted.
- As a preliminary indication, it is expected that the ratio of unsuitables to suitable fill will not exceed 1 in 10 by volume.

It is expected that the Geotechnical Engineer will also need to apply limits to the location/ depth of blended fills within any specified fill area.

6.6.3 Hardfill

Hardfill used as structural filling shall be a graded, unweathered, durable, crushed rock product approved by the Geotechnical Engineer, with a grading suitable for compaction.

6.6.4 Material Conditioning

The cut materials on site may require some drying prior to compaction to achieve the required specification. This may be done by harrowing (such as with discs) and air drying when conditions permit or by the addition of hydrated lime.

The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.

All additives such as lime or cement proposed for use in backfill materials for Reinforced Earth Slopes or other materials in contact with geosynthetics must be approved and monitored by the Geotechnical Engineer.

6.7 Fill Placement, Compaction and Testing Requirements

6.7.1 Soil Fill

Soil placed in fills shall be conditioned and compacted until the following conditions are satisfied. Alternative methods based on specified compaction techniques may be selected by the Geotechnical Engineer if the method below is considered inappropriate due to the granular nature of the materials.

There are three classes of filling defined:

1) General Fill: Structural engineered fill which does not fall into either of the other two classes below;
2) High Strength Fill: Where specified on the drawings or GDR. Typically used for critical batter faces, shear keys and road subgrades;
3) Landscape Filling: Lower strength filling (than General Filling) may be specified on a case by case basis by the Geotechnical Engineer where the strength and properties of General fill is not required and such filling is approved by the client and regulatory authorities.

It should be noted that the surface of the fill area prior to placement of subsequent fill lifts should be in a state so as not to create a break in the consistency of the fill material between lifts. For example, if surfaces are left to dry out, or rolled to seal them from rainfall infiltration then the surface must be broken up and scarified with rippers or by other means to ensure a good bond between fill lifts.

The maximum lift of filling placed before compaction is dependent on the size and nature of the compaction equipment. Typically, 300mm loose depth is considered the maximum for a Cat 815/820 type compactor. In any event the contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/lift.

The test criteria and frequency for cohesive materials (Clays & Silts) are set out in Table 1 and 2 below. If non cohesive soils (i.e. Sands) are to be placed as engineered fill the matter should be referred to the Geotechnical Engineer to define the testing requirements.

Table 1 – Cohesive Materials (soil fill and soil/ rock blended fill) Compaction Test Criteria for Engineered Filling:

	Air Voids [1]		Vane Shear Strength [2]		Moisture Content[3]	Dry Density[3]
	Average	**Maximum Single Value**	**Average**	**Minimum Single Value**	**Maximum**	**Minimum**
General Fill	10%	12%	140 kPa	110 kPa	40%	1.25 t/m^3
High Strength Fill	8%	10%	150 kPa	120 kPa	40%	1.3 t/m^3
Landscape Fill	TBC by Geotechnical Engineer of case by case basis					

[1] Air Voids Percentage (as defined in NZS 4402:1986)

[2] Undrained Shear Strength (Measured by hand shear vane – calibrated using NZGS 2001 method)

[3] Moisture content and minimum dry density non-compliance may be accepted on site by the Geotechnical Engineer on a case by case basis depending on the nature of the material and the other criteria results.

Table 2 – Cohesive Materials (soil fill and soil/ rock blended fill) Compaction Testing Frequencies for Engineered Filling:

	Field Density & Air Voids %	Vane Shear Strength	Solid Density	Compaction Curve
General Fill	1 test per 1500m^3 of fill placed with not less than 1 test per 500mm lift of filling for each area.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling for each fill area.	1 test per material type per 50,000m3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m3 or at least 1 test every 5 weeks.
High Strength Fill	1 test per 1000m^3 of fill placed with not less than 1 test per 500mm lift of filling and for each 50m length of shear key excavation.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling per 25m of shear key excavation.	1 test per material type per 50,000m3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m3 or at least 1 test every 5 weeks.
Landscape Filling	TBC by Geotechnical Engineer of case by case basis			

The test criteria and/or frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.7.2 Site Won Rock Fill

A compaction specification is to be determined by the Geotechnical Engineer based on site trials.

6.7.3 Compaction Testing Reporting Requirements

1 All test location coordinates to be recorded by hand held GPS with reference to the NZTM projection. Test location coordinates, with date and test number reference are to be provided to the Geotechnical Engineer in electronic (excel) format on a weekly basis). Alternatively the Geotechnical Engineer may approve the use of site plans to mark the location of tests in lieu of GPS location.

2. The volume of filling placed for each progress claim month (typically ending 20th of the month) including all filling placed (undercut and cut to fill) to be provided to the Geotechnical Engineer monthly by the contractor or Engineer to the Contract to allow assessment of test frequency adequacy.

3. Interim fill test summaries are to be provided to the Geotechnical Engineer for review on a regular basis.

6.7.4 Hardfill

A plateau compaction test shall be carried out on site under the supervision of the Geotechnical Engineer, for each type of hardfill placed to determine the achievable maximum dry density (MDD) with no more than 20% total voids unless a laboratory derived MDD can be provided. The Geotechnical Engineer shall be given the opportunity to approve the size and type of compaction equipment to be used prior to any plateau testing.

Hardfill shall be placed and compacted to 95% of the MDD determined from the plateau test or laboratory MDD. If these conditions are not able to be met then appropriate adjustment of the moisture content or compaction equipment will be required.

In all cases, the dry density of the compacted fill at any one test site shall be not more than 5% below the minimum and the average of the dry densities of any ten consecutive test sites shall not be less than the specified minimum.

The Geotechnical Engineer may at their discretion, alter the compaction specification to a method compaction specification based on the plateau test result for materials with a maximum particle size greater than 65mm.

The test frequency shall be 1 test per 500m^3 of hardfill placed with not less than 1 test per 500mm lift of filling for each fill area.

The test frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.8 Subsurface Drainage

6.8.1 General

Drainage for shear keys, fill drainage keys, buttress fills, underfill gully drains and counterfort drains shall be constructed in accordance with the design drawings and standard details.

6.8.2 Materials

6.8.2.1 Pipes

Drainage pipes used in subsoil drainage shall be 160mm diameter highway grade drain coil. Drain coil walls shall be perforated or solid as detailed in the design drawings or directed by the Geotechnical

Engineer on site. Drain coils shall not have a geofabric filter sock unless requested by the Geotechnical Engineer on site.

6.8.2.2 Aggregate

Auckland Council now generally require that subsoil drainage has a 100-year design life and is essentially maintenance free, unless there is an entity such as body corporate or residents association that maintenance responsibility can be transferred to. Maintenance by individual owners is not practical as the subsoil drainage systems usually cross over, and generally benefit, multiple lots.

This requires a high quality drainage aggregate with the following properties:

- Self-filters against the soils present on site preventing loss of permeability over time; or, able to be practically wrapped in a suitable geofabric filter;
- High permeability, which translates to a low fines content; and
- Stable and not subject to crushing, weathering, internal erosion or piping, or significant loss of volume (settlement) over time.

Ideally the drainage aggregate should be a well graded self-filtering material such as a clean (free of significant cohesive fines) scoria SAP50 product or Transit F/2 specification filter media.

Alternatively, for shear key drainage, blanket drains, underfill drainage and all applications where full encapsulation with a geofabric filter cloth can be relatively simply and safely achieved, an open graded product, preferably 27/7 Scoria may be used. Care will need to be taken to ensure that the cloth fully encapsulates the aggregate. Observation of the cloth wrap should form an inspection hold point prior to backfilling over the drain. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is not critical to maintaining slope stability then a SAP20 or SAP50 may be used without a filter cloth wrap. Drains which fall into this category must be defined and confirmed as such by the Geotechnical Engineer. Additionally, where such materials are used, regular visual inspections and approval of the aggregate quality and laboratory grading curves is required. This is to comprise visual inspection of each site stockpile prior to material being placed in the trench. One wet sieve grading curve from each site stockpile per week is required while material is being imported to site to monitor the fines content. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is critical to maintaining slope stability then a TNZ/F2 or (approved) modified F2 aggregate must be used. In conjunction with this an approved high specification drainage pipe with filter cloth surround such as the Megaflo products may be specified.

Light compaction (i.e. tamping with back of excavator bucket) only is to be applied to drainage aggregates.

6.8.2.3 Filter Cloth

Any filter cloth surround specified on the drawings shall meet the requirements of Transit Specification TNZ/F7, Filtration Class 2 and Strength Class B unless otherwise specified on the drawings.

6.8.2.4 Trench Backfill in Service Trenches

It is important on all sloping land that service trenches running parallel to contours are avoided where possible as they can permit the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage, help develop tension cracks and possibly lead to slope and building instability.

Backfilling of all trenches should be to the general fill standard above unless specifically varied in writing by the Geotechnical Engineer and where possible the pipe bedding in all trenches on steep ground should contain a 50mm diameter perforated drain coil that is connected into each manhole on the line. This is to

help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

The subdivision drain laying contractor must be made aware of these requirements and of the need to contact us when trench backfilling is to take place.

6.8.3 Depth and Extent

The location, extent and depth of the drainage shown on the design drawings may be varied on site by the Geotechnical Engineer in response to the ground conditions encountered.

6.8.4 Drainage Outlets and Inspection Points

Outlets for subsurface drainage shall be provided at regular intervals shown on the drawings or as determined on site by the Geotechnical Engineer. Pipe outlets shall be specifically formed structures with adequate protection such as a headwall and/or rock rip rap. The position of all outlets shall be recorded on the asbuilt drawings.

Where possible it is good practice to include additional inspection and/or flushing points in the subsoil drainage system in the event that their performance needs to be confirmed in the future.

In any event, at least one temporary flush point is required for each subsoil drainage system to enable flushing of the system once the earthworks are substantially complete.

The flushing of the subsoil drainage system must be witnessed by the Geotechnical Engineer.

6.9 Finishing Works and Topsoil Respread

6.9.1 Overcut

All areas cut to below finished level should be reinstated with engineered filling to the satisfaction of the Geotechnical Engineer.

6.9.2 Topsoil Depth

Topsoil respread depth should be between 100mm and 300mm, or as directed by the Engineer to the contract. On ground steeper than 1V:3H the surface should be roughened under the supervision of the Geotechnical Engineer prior to topsoil placement.

6.9.3 Unsuitable Materials

At the conclusion of earthworks all surplus unsuitable materials should be removed from site or placed in designated permanent stockpiles. The size and location of such stockpiles must be approved by the Geotechnical Engineer and recorded on the asbuilt drawings.

6.9.4 Road Subgrades

Testing and formation of road subgrades will be carried out as part of the subdivision civil works package.

7 MONITORING

7.1 Settlement

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for residential building development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is to be agreed with the Geotechnical Engineer during construction.

It is the contractor's responsibility to ensure the integrity of the monitoring points is maintained during the works.

To ensure appropriate quality settlement data is collected for analysis, the following principles and procedure for the works must be adhered to:

Instrument Installation:

- Instruments must be installed on the stripped surface prior to the commencement of surcharge filling to capture the full effects of the surcharging. Partial placement of surcharge and excavation back down to install an instrument is not acceptable.
- Upon installation, the instrument locations are to be fixed with GPS.
- The RL must be recorded by precise levelling at that time.

Surcharge Loading

- Unless instructed otherwise by the Geotechnical Engineer to avoid bearing capacity failure, it is important that surcharge filling is placed to its design height and full lateral extents in its entirety in a single, rapid operation to allow for measurement of a single settlement curve.

During construction:

- It is important that the surcharge surface RL is recorded and reported together with the instrument data.
- Readings must be taken monthly or per 1m fill or pre-load lift height, whichever is more frequent.
- GPS level readings can be taken during fill and pre-load construction.

Preload height:

- Within 48 hours of full preload height being achieved, the RL must be recorded by precise levelling and the full extent of the surcharge must be surveyed and provided to the Geotechnical Engineer as soon as possible.
- Fortnightly monitoring must be undertaken unless advised otherwise by the Geotechnical Engineer.

7.2 Groundwater

The assumptions made in the design of the slope stabilising works with regard to long term groundwater levels are important. It is therefore considered prudent to reinstall several of the groundwater monitoring piezometers removed during construction in key areas to confirm the assumption made in the design and the performance of the subsoil drainage network.

The location of these will be determined by the Geotechnical Engineer at the completion of the earthworks.

8 ASBUILT INFORMATION REQUIREMENTS

In order to provide a Geotechnical Completion Report (GCR) certain as-built information must be provided to CMW. It is the contractor's responsibility to ensure that all of the following items are surveyed prior to placing filling. The survey of these items should therefore form a hold point in the construction sequence.

1. The location and invert of all sub surface drainage; and,
2. The depth of filling placed including all benching, undercuts, shear or fill drainage keys and temporary ponds which have been backfilled.

CMW require the following as-built information to be provided for the GCR:

1. Cut and fill depth plan (including undercuts and shear keys);
2. Final contour plan;
3. Drainage locations and inverts (surface and subsurface);
4. Drainage outlet locations (surface and subsurface);
5. Details of any defined overland flow paths;
6. Location and heights of any retaining walls and Mechanically Stabilised Earth (MSE) structures;
7. Position and extent of any geogrid layers (in plan view);
8. Material data for imported products used such as draincoils, aggregates and geofabrics as well as confirmation that products installed comply with the requirements of the project drawings and this specification; and,
9. Any settlement Monitoring Data.

Appendix G: SiD Risk Assessment

CMW Safety in Design Risk Assessment

AKL20200-0125, Silverdale Sout, Stage 3 & 4 - 19 May 2021

Design Element	Hazard	Description	Assessed Risk			Controls Incorporated in Design	Residual Risk		
			Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Earthworks	Falling from height	Injury to construction staff while constructing steep temporary or permanent earthworks cut or fill faces.	4	3	12	Temporary barrier fence or other means to be used to ensure persons cannot access to the edge of steep excavations	4	2	8
	Striking underground services	Injury to construction staff if live services are struck.	5	3	15	All sites cleared for services prior to site investigations and earthworks construction	5	1	5
	Moving Machinery	Injury to construction staff.	4	3	12	Separate moving machinery from light vehicles and person movements with fencing and/or safe distances from exposed construction staff operations.	4	2	8
	Working at edges of excavations	Injury to construction staff.	3	3	9	Install safety barriers, exclusion zones, signage as necessary to warn of hazard.	3	2	6
	Trench excavation collapse	Injury to construction staff or persons due to crushing/impact injury.	4	3	12	Follow Worksafe requirements, trench shields or benching of excavations to be used. No staff to enter the trench without appropriate and approved measures already in place.	4	2	8
	Cut / fill batter collapse	Injury to construction staff during construction.	4	3	12	Safe distances and appropriate temporary slope gradients and heights to be assessed prior to construction and monitored during to confirm as appropriate, safe distances and barrier fencing to be used on site where deemed necessary.	4	2	8
	Excessive noise during construction	Damage to hearing of construction staff or persons adjacent to the site.	3	3	9	Comply with appropriate allowances for noise on site, ear protection to be worn where appropriate, setback distances from adjacent sites or notified working hours to avoid conflict with adjacent property inhabitants.	3	2	6
	Machinery rollover	Machinery trafficability over soft, wet or uneven ground.	4	3	12	Appropriate construction of temporary haul roads, implement drainage and geofabrics, appropriate driver training.	4	2	8
	Contaminated Soils	Airborne or in-ground contaminants affecting construction staff.	3	3	9	Perform an Environmental assessment of the site prior to construction.	3	2	6

NOTE: It is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect).

Safety in Design Assessment Framework

Risk Matrix		Consequence				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	Event Will Occur 5	Medium 5	High 10	High 15	Extreme 20	Extreme 25
	Event Almost Certain to Occur 4	Low 4	Medium 8	High 12	Extreme 16	Extreme 20
	Event May Occur 3	Low 3	Medium 6	High 9	High 12	High 15
	Event Not Likely to Occur 2	Low 2	Low 4	Medium 6	Medium 8	High 10
	Event Rarely Occurs 1	Low 1	Low 2	Low 3	Low 4	Medium 5

Appendix H: Natural Hazards Risk Assessment

NATURAL HAZARDS RISK ASSESSMENT FOR LAND SUBDIVISION SILVERDALE SOUTH, STAGE 3 & 4

A. CONTEXT

Section 106 of the Resource Management Act (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land, other land or structures (consequence).

Section 2 of the RMA defines natural hazards as any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

This appendix to CMW report reference AKL2020-0125AH Rev.0 sets out the criteria for and presents the results of an assessment of the geotechnical-related natural hazards associated with this proposed subdivision development. The remaining hazards, i.e. tsunami, wind, drought, fire and flooding hazards are not covered by this assessment.

B. BASIS OF ASSESSMENT

B.1. Risk Classification

The occurrence of natural hazards and their potential impacts on the proposed subdivision development is assessed in terms of risk significance, which is based on likelihood and consequence factors. A risk table is used to help assess the likelihood and consequence factors, the form of which used by CMW for this project is presented in Table B1.

Table B1: Natural Hazard Risk Classification

Risk Matrix		Consequence				
		Insignificant 1	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
Likelihood	**Almost Certain 5**	Medium 5	High 10	Very high 15	Extreme 20	Extreme 25
	Likely 4	Low 4	Medium 8	High 12	Very high 16	Extreme 20
	Moderate 3	Low 3	Medium 6	Medium 9	High 12	Very high 15
	Unlikely 2	Very low 2	Low 4	Medium 6	Medium 8	High 10
	Rare 1	Very low 1	Very low 2	Low 3	Low 4	Medium 5

B.2. Likelihood

With respect to assessing the likelihood or chance of the risk occurring, the qualitative definitions used by CMW for this project are provided in Table B2 for each likelihood classification.

Table B2: Qualitative Natural Hazard Likelihood Definitions		
1	Rare	The natural hazard is not expected to occur during the design life of the project
2	Unlikely	The natural hazard is unlikely, but may occur during the design life
3	Moderate	The natural hazard will probably occur at some time during the life of the project
4	Likely	The natural hazard is expected to occur during the design life of the project
5	Almost Certain	The natural hazard will almost definitely occur during the design life of the project

B.3. Consequence

In terms of determining the consequence or severity of the natural hazard occurring, the qualitative definitions used by CMW for this project are provided in Table B3 for each consequence classification.

Table B3: Qualitative Natural Hazard Consequence Definitions		
1	Insignificant	Very minor to no damage, not requiring any repair, no people at risk, no economic effect to landowners.
2	Minor	Minor damage to land only, any repairs can be considered normal property maintenance no people at risk, very minor economic effect.
3	Moderate	Some damage to land requiring repair to reinstate within few months, minor cosmetic damage to buildings being within relevant code tolerances, does not require immediate repair, no people at risk, minor economic effect.
4	Major	Significant damage to land requiring immediate repair, damage to buildings beyond serviceable limits requiring repair, no collapse of structures, perceptible effect to people, no risk to life, considerable economic effect.
5	Catastrophic	Major damage to land and buildings, possible structure collapse requiring replacement, risk to life, major economic effect, or possible site abandonment.

B.4. Risk Acceptance

It is recognised that the natural hazard risk assessment provided herein is qualitative and, due to the wide range of possible geohazards that could occur, is somewhat subjective. Other methods are available to quantitatively assess an acceptable level of geotechnical related natural hazard risk, such as defining an acceptable factor of safety with respect to slope stability or acceptable differential ground settlements with respect to recommended building code limits.

Therefore, to give this qualitative natural hazard risk assessment some relevance to more commonly adopted numerical or quantitative geotechnical assessment techniques, a residual risk rating of very low to medium (risk value = 1 to 9 inclusive) is considered an acceptable result for the proposed subdivision development.

A risk rating of high to extreme (risk value ≥ 10) is considered an unacceptable result for the proposed subdivision development.

C. RISK ASSESSMENT

The natural hazards relevant to this proposed subdivision development and adjacent, potentially affected land have been assessed with respect to the criteria outlined above.

Assessment is based on proposed post development ground conditions with and without any geotechnical controls. The latent risk was first assessed with the site in its proposed developed state to consider the risks to the development and surrounding land, including assessment of land modifications from the pre-existing natural state, without any implemented geotechnical controls. The specific geotechnical mitigation measures and engineering design solutions outlined in the table below and CMW report, where relevant, were then considered to determine the natural hazard residual risk remaining after the proposed controls have been implemented.

Results of this assessment are presented in Table C1 below.

Table C1: Natural Hazard Risk Assessment Results

RMA S2 Hazard	Description	Proposed Site Latent Risk of Damage to Land / Structures			Comments and Geotechnical Control	Proposed Site Residual Risk of Damage to Land / Structures OR Acceleration/ Worsening of Hazard with Geotechnical Controls Implemented		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
Earthquake	Fault Rupture	2	3	Medium 6	48km from closest active fault (Waikapua fault, Whitford)	2	3	Medium 6
	Liquefaction Induced Flooding and/ or Subsidence	2	2	Low 4	Shallow cohesive soils not susceptible to liquefaction	2	2	Low 4
	Lateral Spread	2	3	Medium 6	Shallow cohesive soils not susceptible to lateral spread	2	3	Medium 6
Volcanic Activity	Ash & Pyroclastic Falls	1	5	Medium 5	No active volcanic activity	1	5	Medium 5
	Lava flows & Lahars	1	5	Medium 5	No active volcanic activity	1	5	Medium 5
Geothermal Activity	Formation of geysers, hot	1	5	Medium 5	No geothermal activity. Closest geothermal	1	5	Medium 5

	springs, fumaroles, mud pools				location 10km north at Waiwera			
Erosion	Cut Batters	5	2	High 10	Max 1:3 gradient	2	2	Low 4
	Fill Batters	5	2	High 10	Surface water controls applied on batters and restrict gradients to 1:3. Geogrids to be used to construct MSE wall	2	2	Low 4
Landslip	Global Slope Instability	4	5	Extreme 20	Due to steep slope gradients and depth of fills, shear keys, palisade walls, shear piles and drainage are required to control global stability	1	5	Medium 5
	Soil Creep	5	4	Extreme 20	Batter gradients max 1:3. Geogrids to be used to construct MSE wall. Palisade walls and drainage.	2	4	Medium 8
	Bearing Capacity Failure	2	4	Medium 8	Undercut and replace and shear key	1	4	Low 4
	Cut & Fill Batter Instability	2	5	High 10	Surface water control, geogrids, facing system on MSE wall	1	5	Medium 5
Subsidence	Expansive Soils	4	3	High 12	Foundation design	2	4	Medium 8
	Soft Soils	5	3	Very High 15	Undercut and remove	2	3	Low 4
	Effects of Dewatering	3	3	Medium 9	Dewatering likely to occur in rock. Neighbouring dwellings far enough away not to be impacted	1	3	Low 3
Sedimentation	Rockfall, Debris Inundation	4	4	Very High 16	Palisade wall / barrier wall	2	4	Medium 8

Notes:

- Assessments include the impact of the proposed subdivision works on adjacent properties.
- The following reference(s) contain information on the hazards contained in this assessment and the non-geotechnical hazards that have not been included:
    - **Auckland**
      https://aucklandcouncil.maps.arcgis.com/apps/MapSeries/index.html?appid=81aa3de13b114be9b529018ee3c649c8

CMW Geosciences
Great People | Practical Solutions

ATTACHMENT 3

AKL2022-0128AB Preliminary Geotechnical Investigation Report

7 October 2022

SMALL ROAD DEVELOPMENT

53 SMALL ROAD, SILVERDALE

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

Build Rich Limited

AKL2022-0128AB Rev. 0

AKL2022-0128AB		
Date	**Revision**	**Comments**
7 October 2022	A	Initial draft for internal review
11 October 2022	0	Final issue

	Name	**Signature**	**Position**
Prepared by	Henry Nagel		Project Engineering Geologist
Reviewed by	Sam Gibb		Principal Geotechnical Engineer CMEngNZ, CPEng
Authorised by	Richard Knowles		Principal Geotechnical Engineer CMEngNZ, CPEng

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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Build Rich Limited to carry out a geotechnical investigation of a site located at 53 Small Road, Silverdale, which is being considered for the construction of a residential subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2022-0128AA Rev. 0, dated 12 July 2022.

This report is to support preliminary design of the subdivision.

1.2 Scope of Work

As detailed in our proposal letter, the agreed scope of work to be conducted by CMW was defined as follows:

- Desktop study of available information relevant to the proposed development.
- Geotechnical site investigation, comprising the drilling of hand auger boreholes and excavation of test pits.
- Evaluate and develop an appropriate geological and geotechnical model.
- Identify any geohazards to the proposed development, including instability, groundwater issues, and provide strategies to mitigate.
- Compile all of the above detail into a concise geotechnical investigation report, incorporating relevant plans, field investigation data, laboratory test data and calculations.

2 SITE DESCRIPTION

2.1 Site Location

The site, legally described as Lot 2 DP 554131 comprises an area of approximately 25,419m^2 and is located at 53 Small Road, Silverdale, as shown on Figure 1 below. The proposed development area also includes a 1,000m^2 portion of 39 Small Road, legally described as Lot 3 DP 554131.

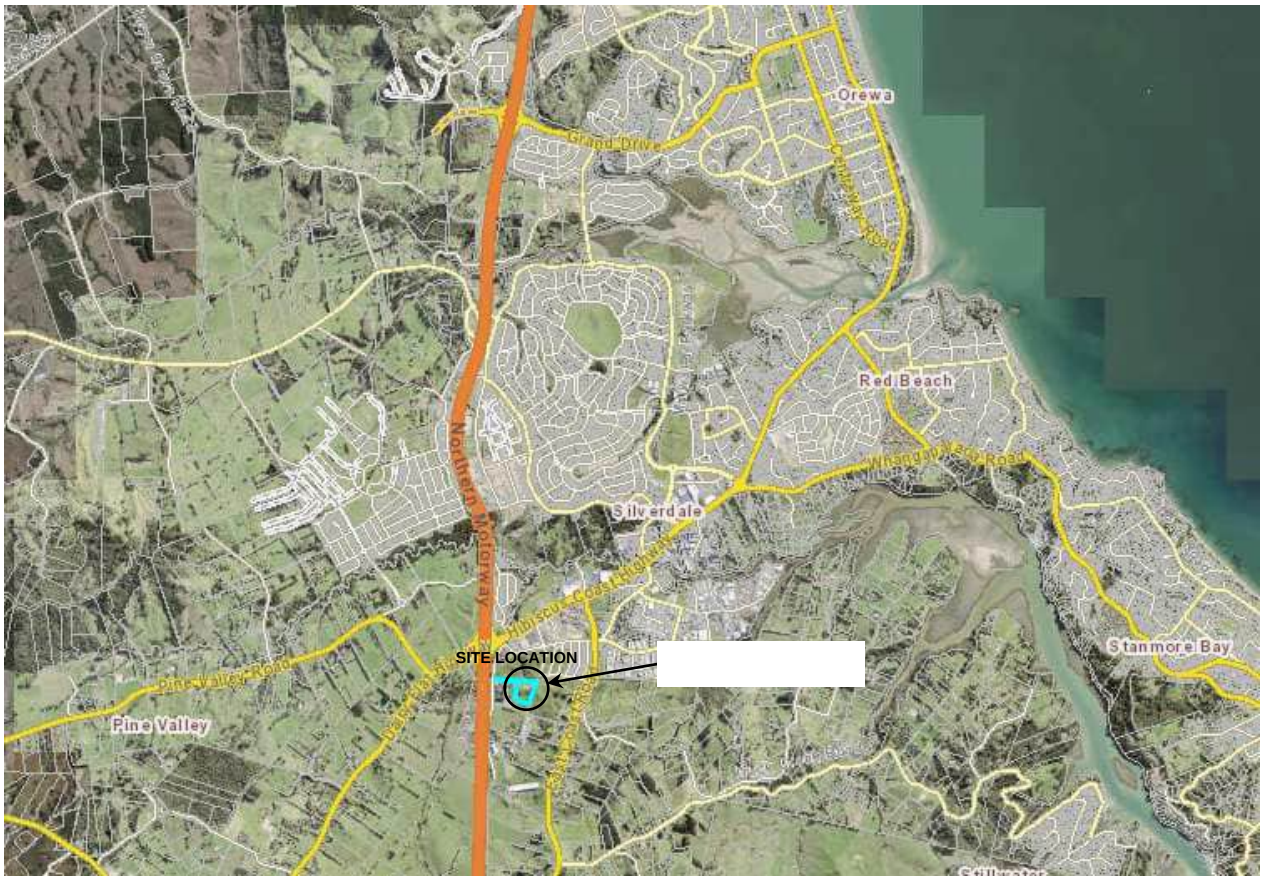


Figure 1: Site Location Plan (Reference Auckland Council GeoMaps[1])

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on the attached Site Plan as ***Drawing 01.***

Overall, the slope across the site slopes moderately towards the south-west. The southern portion of the site is generally the lowest lying area of the site and the gradient becomes gentler towards this area (1V:12H). The northern boundary the site follows the southern face of a ridgeline that trends east to west, where gradients are steepest (1V:5H). Elevations drop from approximately 40m RL to 20m RL from north to south.

A small gully feature/overland flow path is located at the south-east end of the site, which is fed from a larger gully feature beyond the eastern boundary of the site. Wetland marsh is present in this area.

Contours across the southern half of the site and within the portion of 39 Small Road, as well as historic aerial photographs, suggest that historic fills have been placed within this portion of the site, including a hardstand along the eastern boundary and farm pond backfills.

[1] Auckland Council GeoMaps <https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html>

The site is bound to the north by the Botanic Retirement Village, and to the south and east by rural properties. 43 Small Road is located west of the site, which has a series of man-made cut batter slopes down to a building and hardstand area. A recently developed church is located on the northern half of 39 Small Road.

The site is currently covered with grass.

3 PROPOSED DEVELOPMENT

At the time of undertaking this investigation and of writing this report the project was in the early stages of planning and it was anticipated that the geotechnical investigation would provide details of preliminary feasibility options for the site.

No architectural or engineering design drawings have been supplied to date and we have prepared this report on the basis that a future development will broadly comprise minor cuts and fills and associated retaining walls to form a terraced site supporting residential NZS3604 type buildings with shallow strip and pad foundations.

4 INVESTIGATION SCOPE

4.1 Desktop Study

A desktop study was carried out before commencing fieldwork. This included online research through Auckland Council Geo Maps, Dial Before You Dig, aerial photographs and review of previous investigation and reporting.

A review of historic and recent aerial photographs between 1940 and 2017 indicated the following activity:

- Largely pasture farmland until 1960;
- Track running west to east and hardstand east formed in 1963;
- Formation of a man-made pond on 39 Small Road area between 1963 and 1996. Appeared to have been created by formation of a bund. Hardstand area mostly grassed.
- Second pond formed in the eastern corner of 53 Small Road between 1996 and 1999.
- Formation and abandonment of a dirt bike track on 39 Small Road area east of the man-made pond between 2001 and 2006.
- Formation of a hardstand area within the western half of 53 Small Road between 2011 and 2017.
- Filling of both man-made ponds between 2017 and 2022.

4.2 Field Investigation

Following a dial before you dig search, and onsite service location, the field investigation was carried out between 8 August 2022 and 11 August 2022. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[2] and logged in accordance with NZGS guidance[3]. The scope of fieldwork completed was as follows:

- Undertook a walkover survey of the site to assess the general landform, site conditions and adjacent structures/infrastructure;
- Six test pits, denoted TP01-22 to TP06-22, were excavated using a 20-tonne hydraulic excavator fitted with a 2m wide blade bucket and 0.8m wide toothed rock bucket to depths of between 3.4m and 6m below existing ground levels. TP02-22 was terminated due to refusal while the remaining test pits were terminated at the maximum reach of the excavator. Engineering logs and photographs of the test pits are presented in ***Appendix B***;
- Eight hand auger boreholes, denoted HA01-22 to HA08-22, were drilled using a 50mm diameter auger to target depths of up to 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ vane shear strength testing. All hand augers refused at depths of 1.2m to 4.1m and Dynamic Cone Penetrometer (DCP) testing was carried out within the bases from refusal depth. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths are presented in ***Appendix B***;
- Groundwater monitoring was undertaken on one occasion during a further visit following the initial fieldwork to monitor the groundwater levels in HA03-22 and HA07-22.

The approximate locations of the respective investigation sites referred to above are shown on the Site Plan as ***Drawing 01***. Test locations were measured using handheld GPS. Elevations were inferred from Auckland Council GIS contours.

[2] NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification
[3] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

5 GROUND MODEL

5.1 Published Geology

Published geological maps[4] depict the regional geology for the area as comprising Hukerenui Mudstone (Mangakahia Complex) of the Northland Allochthon as illustrated in ***Figure 2*** below.

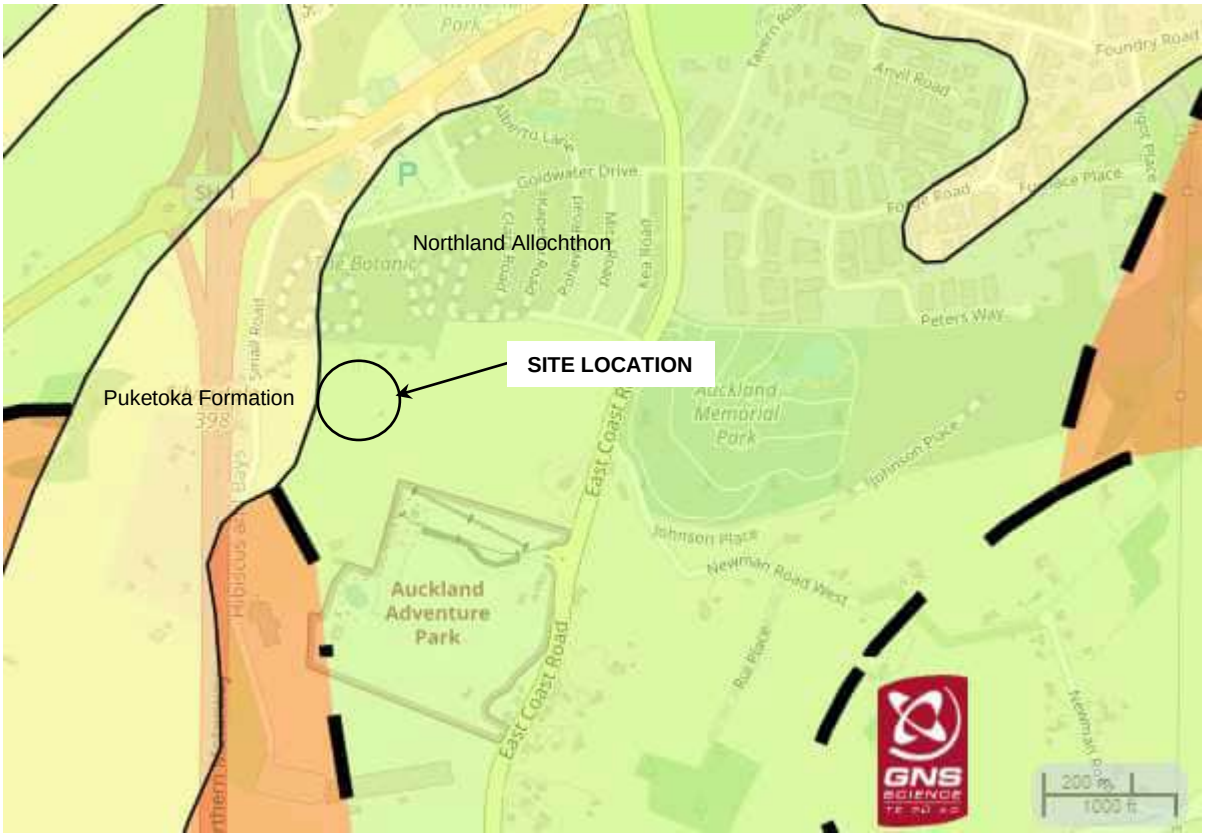


Figure 2: Regional Geology (GNS Sciences Geology Web Map)

This strata is part of an allochthonous (meaning removed from its formation location) mass of continental crust that had been peeled from the subduction zone north of New Zealand and emplaced through low angle thrust faulting onto areas of Northland and the Silverdale area.

Due to the nature of the faulting and emplacement, the materials which form the Northland Allochthon are highly fractured, variably weathered and often form a melange of strata including mudstones, siltstones, limestones, ultra-mafic rocks and shales. This geological formation is often unstable even on gentle slopes.

Two lithologies are present within the Northland Allochthon. Whangai Formation is described as cream to grey siliceous and locally calcareous mudstone while Hukerenui Mudstone is described as commonly sheared and deformed mudstone with small serpentine bodies.

Tauranga Group alluvial and colluvial materials generally fill the low-lying areas and gullies. These materials are described as clays and silts. The Tauranga Group contact is mapped near the western boundary of the site.

[4] Edbrooke, S. W. (complier) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3.1 sheet +74p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences

Based on the known history of the site and surrounding land levels, some depths of fill could be anticipated as a result of earthwork works operations and the filling of historic ponds.

5.2 Geomorphology

Geomorphology has been based on historical aerial photographs, a site walkover and our investigations on neighbouring sites.

The geomorphology reflects the underlying geology and associated slope processes. The dominant regional structure is evident in the subject and neighbouring sites in the form of features such as gullies and ridgelines.

This geology is typically known for its deformed, crushed and sheared nature and is notorious for instability even at gentle slopes. The combination of the existing elevation of the northern ridgeline and the shallow Northland Allochthon rock controls the geomorphology of the site.

A large west-trending gully feature was observed in the neighbouring site to the east, which continues towards the southern end of 53 Small Road. Where the gradient becomes shallower, an overland flow path is evident, which trends towards the west.

Minor head scarp features were observed on the southern face of the northern ridgeline, but the man-made hardstand and fills conceal the original geomorphology in the middle portion of the site. Gentler gradients are present towards the south-west and west, typical of Puketoka Formation alluvial processes.

Several mounds in the topography are present predominantly in the southern half of the site, indicating historical filling.

5.3 Stratigraphic Units

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area, apart from TP06-22, which encountered Tauranga Group Alluvium in an area that was mapped as Northland Allochthon. The ground conditions can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented in the appended Geological Plan/Geological Sections on ***Drawing 01***.

5.3.1 Topsoil

Topsoil was encountered in all boreholes and test pits apart from HA01-22, HA08-22, TP01-22, TP02-22, TP03-22 and TP06-22. The thickness ranged from 0.1m to 0.5m.

5.3.2 Uncontrolled Fill

Uncontrolled fill was encountered in HA08-22, and all test pits. The fill generally comprised clayey silts and silty clays with a maximum thickness of up to 4m depth. The majority of the fills are associated with the formation of the hardstands on site and also backfilling of the ponds. Vane shear strengths within the fill ranged from 46kPa to 160kPa and were inconsistent indicating non-engineered fill.

5.3.3 Colluvium

Colluvium was encountered in HA05-22. The colluvium generally had the appearance of residual Northland Allochthon soils, with evidence of rootlets mixed towards the base of the deposit. Vane shear strengths ranged from 50kPa to 147kPa and depth extended to 2.3m.

5.3.4 Puketoka Formation

Puketoka Formation (Tauranga Group) clayey silts and silty clays were encountered within HA07-22 and TP06-22, generally within the low-lying areas of the site. Vane shear strengths ranged from 99kPa to 174kPa and depth extended up to 5.8m.

5.3.5 Residual Northland Allochthon

Residual soils of the Northland Allochthon Formation were encountered in all hand auger boreholes and within all test pits apart from TP06-22. These soils generally consisted of stiff to hard, light grey mottled orange, bluish grey, light orange brown, clays silty clays and clayey silts with minor fine to medium sands. Vane shear strengths ranged from 87kPa to greater than 200kPa.

5.3.6 Transitional Northland Allochthon

The transitional unit is where the residual soils transition into completely weathered to highly weathered rock. This unit is typically highly sheared, with blocky fabric and has evidence of groundwater such as limonite staining.

5.3.7 Northland Allochthon Rock

Completely weathered to highly weathered Northland Allochthon Rock was encountered in TP04-22, TP05-22 and TP06-22. It was also inferred in all hand augers based on refusal depth. The rock consisted of extremely weak to weak siltstones and mudstones of the Whangai Formation encountered at depths between 1.2m and 5.8m.

5.3.8 Summary

The distribution of these units is illustrated on the appended Geological Sections A-A and B-B (***Drawing 03***) and presented below in Table 1.

Table 1: Summary of Strata Encountered

Unit	Depth to base (m)		Thickness (m)	
	Min	**Max**	**Min**	**Max**
Topsoil	0.2	0.4	0.2	0.4
Uncontrolled Fill	1	4	0.9	4
Colluvium	2.3	2.3	1.9	1.9
Puketoka Formation	1.8	5.8	1.6	4.3
Residual Northland Allochthon	1.2	5.5	1	4
*Northland Allochthon Rock	-	-	-	-

Notes: *Thickness only recorded where base of strata has been confirmed.

5.4 Groundwater

During the investigation, which was completed in mid-winter conditions (August 2022), groundwater was encountered within boreholes at the depths provided in Table 2, which also presents the results of groundwater monitoring undertaken following the investigation:

Table 2: Groundwater Monitoring Data			
Borehole	**Screen Depth (mbgl)**	**11 August 2022**	**27 September 2022**
		Depth (mbgl)	**Depth (mbgl)**
HA01-22	-	0.8	-
HA03-22	3.1	2.2	1.97
HA04-22	-	1.1	-
HA06-22	-	1.6	-
HA07-22	3.3	3.0	0.73
TP01-22	-	3.6	-
TP02-22	-	2.0	-
TP03-22	-	1.2	-
TP05-22	-	1.4	-
TP06-22	-	2.0	-

However, given the presence of a variable and clayey soil profile, it is possible that perched groundwater may occur during and following periods of rainfall. It should also be noted that while groundwater was not encountered across all investigation boreholes or test pits, it is typical in this geology for the groundwater to flow through the more permeable transition zone, which in this site is relatively shallow in depth.

6 GEOHAZARDS ASSESSMENT

6.1 Context

The following sections of this report provide an assessment of the geohazards relevant to this site.

6.2 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[5] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.1 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (for importance level 2)

f = site response factor subject to subsoil class (refer Section 7.1 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[6] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 3: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	$Magnitude_{eff}$
ULS	1/500	1.0	0.19	6.5
SLS	1/25	0.25	0.05	5.9
ACCOPS	1/150	0.58	0.10	5.75

Note: ULS = ultimate limit state; ACCOPS = Auckland Council seismic stability case[7], AEP = annual exceedance probability

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

In accordance with NZGS guidance[8] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency/density.

[5] NZ Geotechnical Society publication “Earthquake geotechnical engineering practice, Module 1: Overview of the standards”, (March 2016)
[6] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)
[7] Auckland Council Code of Practice for Land Development and Subdivision, version 1.6, 24 September 2013, Table 2.C.1
[8] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards”, (May 2016)

6.3.2 Geological Age

The vast majority, and nearly all, case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[9] [10]. Pleistocene aged alluvium (>12,000 years) is also considered to have a very low to low risk of liquefaction[10].

The Puketoka Formation alluvium (river and hill slope), found within the low-lying areas of the site are of middle to late Pleistocene geological age and therefore, in terms of geological age, are considered to be low risk of liquefaction.

Across the elevated terraces, soils below the water table comprise Northland Allochthon deposits. These soils are defined as having a dated age of 37.0 million to 98.9 million years old. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance[5] sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

PI < 7: Susceptible to Liquefaction

7 ≤ PI ≥ 12: Potentially Susceptible to Liquefaction

PI ≥ 12: Not Susceptible to Liquefaction

The natural soils beneath the site comprise silts and clays of low plasticity. The presence of silts within the soil profile also has a significant impact on the liquefaction susceptibility.

6.3.4 Discussion

Across the site, the subsoils generally comprised deposits the Northland Allochthon, with Puketoka Formation present in the low-lying areas. Auckland Council GeoMaps depict these deposits to be of very low liquefaction vulnerability.

Although the soils contain varying silt contents, the mapped risk level, geological age, as well as our investigation findings (stiff to very stiff soils), we do not consider liquefaction to be a risk to the proposed development. Liquefaction has therefore not been considered further.

6.4 Slope Stability

6.4.1 Design Criteria

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment as set out in the Auckland Council Code of Practice for Land Development and Subdivision (residential subdivision/development):

[9] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[10] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

Table 4: Slope Stability Factor of Safety Criteria	
Condition	**Required Factor of Safety**
Normal Groundwater Condition	1.5
Extreme (worst credible) groundwater condition	1.3
Seismic condition with 150 yr event	1.2

6.4.2 Shear Strength Parameters

6.4.2.1 Effective Stress Parameters

Drained shear strength parameters for the various geological units that underlie the site were inferred from the field investigation, laboratory test data and experience in similar ground conditions within the neighbouring sites and across the Northland and Auckland regions. CMW have undertaken extensive work in the area and on adjacent sites and have gained considerable knowledge in the behaviour of these materials and their properties.

Table 5: Summary of Effective Stress Shear Strength Parameters			
Geological Unit	**Unit Weight (kN/m^3)**	**Effective Stress Shear Strength Parameters**	
		c' (kPa)	**Ø' (deg)**
Colluvium	18	4	26
Puketoka Formation	18	3	26
Residual Northland Allochthon	18	5	26
Transitional Northland Allochthon	18	0	20
Completely Weathered to Highly Weathered Northland Allochthon	23	10	40
Note: Where c' = effective cohesion, Ø' = effective friction angle			

6.4.2.2 Total Stress Parameters

The soils that underlie the site comprise predominantly cohesive silts and clays that will behave in an undrained state during short term seismic loading. Undrained soil shear strengths (Su), used for assessing the stability of slopes during seismic loading, were taken from the hand-held shear vane results and are summarised as follows:

Table 6: Summary of Undrained Shear Strength Parameters	
Geological Unit	**Design Su (kPa)**
Colluvium	50
Alluvium	90
Residual Northland Allochthon	100
Transitional Northland Allochthon	20

6.4.3 Slope Stability Analyses

As proposed development plans have not been provided, we have only assessed the prevailing stability conditions of the existing contours (derived from Auckland Council GIS). Stability conditions for the proposed levels should be assessed when plans are available.

Slope stability analyses were undertaken using the proprietary software SLIDE Version 6. Analysis was undertaken using the Morgenstern-Price method of slices under the translational failure mechanism which is the anticipated failure mechanism in this geology.

Selected stability printouts are attached in ***Appendix C*** and summarised as follows:

Table 7: Slope Stability Analyses Results

Location	Slope Stability Factor of Safety (Existing Contour)		
	Prevailing	Transient	Seismic
Geological Section A-A	2.4	1.6	1.8
Geological Section B-B	2.3	1.8	2.0

Results show that the slope stability factor of safety criteria are achieved for the existing landform and assessed ground model conditions described above.

6.5 Erosion

Earthworks involving cuts, particularly on ridges, may expose erodible rock layers which were once capped and create the potential for consequential piping/tunnelling erosion and slope failure.

Erosion of cut and fill batters during earthworks is considered to be a high-risk natural hazard and easily addressed during construction. Erosion around batters may subsequently contribute to slope instability and falling debris. This hazard is typically controlled during the design phase by limiting batters to a maximum of 1(V):3(H) gradients and during earthworks via benches, erosion control blankets, geotextiles and stormwater control.

6.6 Load Induced Settlement

Deep fills may be subject to ongoing settlement for a period following completion of works. Our experience indicates that with appropriate gully preparation and drainage, settlements are typically complete soon after the earthworks are finished.

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for the proposed development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is be agreed with the Geotechnical Engineer during construction.

6.7 Uncontrolled Fills

Due to the unknown history of the uncontrolled fills encountered on site there is risk of potential settlement within these fills or lower available bearing capacities.

6.8 Expansive Soils

Seasonal shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have

returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011[11] excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870[12]. for foundation design advice. However the November 2019 update of Acceptable Solution B1/AS1[13] provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

Nevertheless, there is evidence[14] indicating that the use of the B1/AS1 method of assessment of expansiveness may be inaccurate. Accordingly, our assessments herein have been made in line with our experience, BRANZ Report SR120A[15] and AS2870.

6.9 Groundwater Impact Assessment

As we have not been provided with proposed earthworks plans, we have not undertaken a groundwater impact assessment. However, due to the recorded groundwater measurements, it is anticipated that an impact assessment will be required if cuts are proposed. This should be addressed at detailed reporting stage.

[11] Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard
[12] Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW
[13] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/AS1, Amendment 19
[14] Rogers, N., McDougall, N., Twose, G., Teal, J. & Smith, T. (2020) The Shrink Swell Test: A Critical Analysis, *NZ Geomechanics News,* Issue 99, pages 66-80.
[15] Fraser Thomas Limited (2008) - Addendum Study Report (BRANZ SR120A), Soil Expansivity in the Auckland Region – Final Report

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

Based on the findings of our investigation, including the presence of hard deposits at relatively shallow depths, the seismic site subsoil category defined in Section 3.1.3 of NZS 1170.5 is assessed to be C (shallow soil site).

7.2 Slope Stability Management

Specific slope stability analysis of the proposed contours should be undertaken once plans are available.

Typical remediation methods to provide adequate factors of safety in this geology include construction of shear keys and/or palisade walls, retaining walls, installation of subsoil drainage within gullies and counterfort drains.

7.3 Earthworks

7.3.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431[16] and the requirements of the Auckland Council Infrastructure Development Code under the guidance of a Chartered Professional Geotechnical Engineer. Geotechnical Works Specification should be addressed in the detailed report.

The following sections provide general earthworks recommendations for the site based on our experience in this geology.

7.3.2 Site Stripping

Prior to earthworks commencing topsoil should be stripped and uncontrolled fills undercut. Additionally, soft deposits within gullies should be cleaned out.

Locations of any stockpiles should be carefully considered as to not compromise stability conditions.

7.3.3 Excavatability

Rock is likely to be encountered at shallow depths close to ridgelines if cuts are to be made in these areas. Given the highly fractured/completely weathered nature of the rock, it is expected that excavation of these materials will be readily achieved with normal earthworks plant, such as scrapers and bulldozers with scoops.

7.3.4 Underfill Drainage

Underfill drains will need to be installed beneath any new fills within low lying tributaries and gully inverts. Effective drainage is a key factor required for maintaining slope stability and reducing the geotechnical hazards across the site.

Drain positions should be determined once earthworks plans are available.

7.3.5 Capping Layer

Exposure of the rockmass within cuts is susceptible to rapid weathering and infiltration of surface water that could comprise stability conditions. Rock could be encountered as shallow as 1.2m, particularly on ridgelines.

[16] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

Typical mitigation of this risk is to over-excavate these deposits to a depth of 1m and cap with engineered filling.

7.4 Civil Works

7.4.1 Service Trenches

Services trenches excavated along contour in areas of steep ground may need to be backfilled with engineered filling and if in natural ground, may require a drain coil in the base of the trench connected to the stormwater system. Identification of critical service lines must be made once drawings are available.

8 FOUNDATIONS

8.1 Shallow Foundations

Based on the assumption that the development will comprise the construction of standard NZS3604-type structures we anticipate that a preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 2.5m in plan.

There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms.

8.2 Expansive Soils

On this basis of our visual tactile assessment, results of laboratory testing and reference to BRANZ Report SR120A, we have assessed the AS2870 Site Class to be M (moderate) with an anticipated characteristic surface movement of up to 40mm. Foundation design may be selected in accordance with appropriate solutions for this Class from AS2870 or may be undertaken by specific engineering design.

9 FURTHER WORK

This report has been undertaken to assess the preliminary feasibility of the site for residential development. Further reporting, analyses and/or investigation will be required once proposed development plans are available.

10 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Build Rich Limited in relation to the Small Road Development at 53 Small Road, Silverdale in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Build Rich Limited seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report 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 and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Appendix A: Drawings

Drawing 01:	Site Investigation Plan
Drawing 02:	Geology Plan
Drawing 03:	Geological Section A-A and B-B

LEGEND:

- HA01-22 — HAND AUGER (HA) LOCATION
- TP01-22 — TEST PIT (TP) LOCATION
- 53 SMALL ROAD BOUNDARY
- 39 SMALL ROAD BOUNDARY

NOTES:

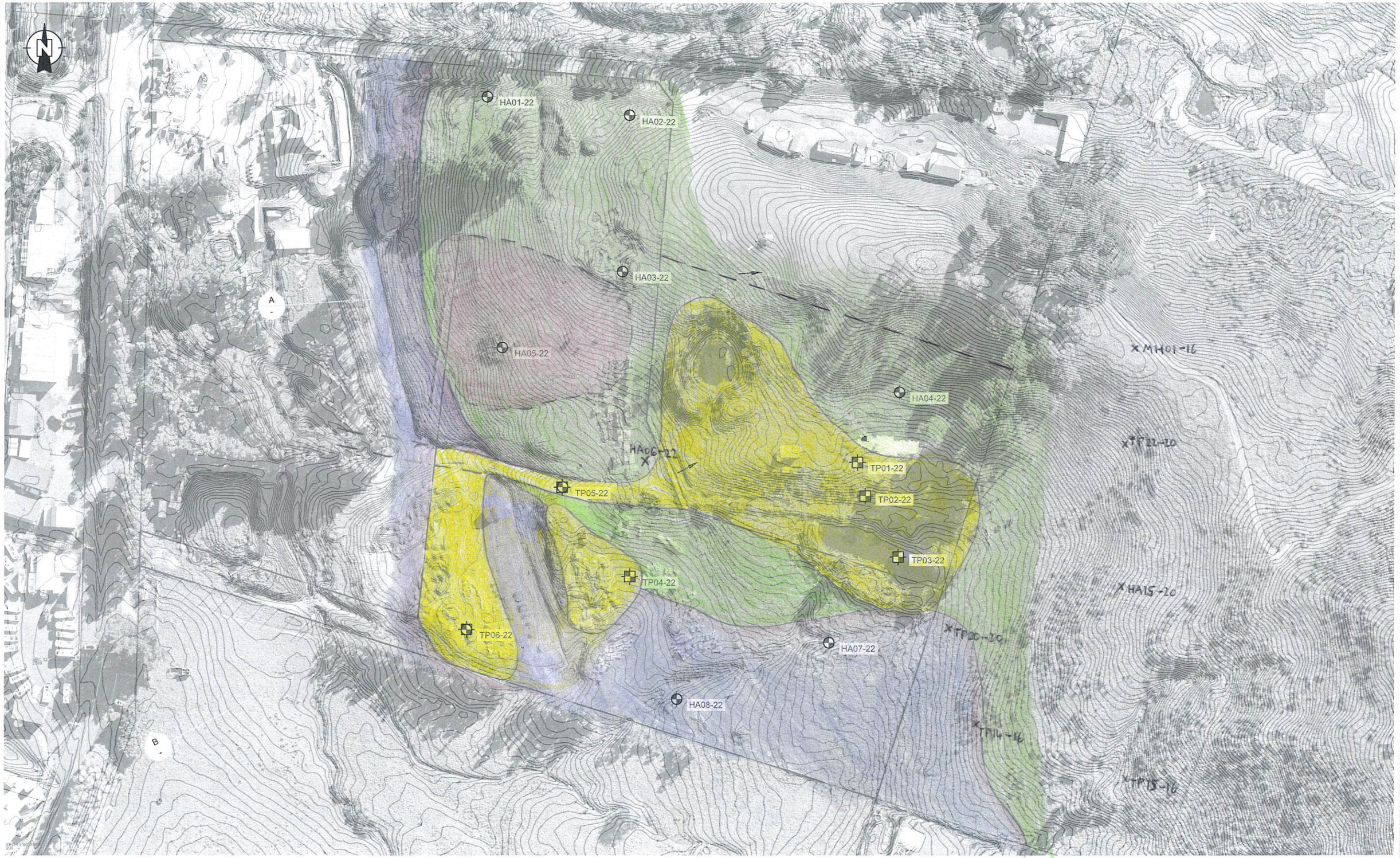
1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS MAP.
2. CONTOURS ARE IN 0.25m INTERVALS.

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH LTD		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: HN	DRAWING: 01
		REVISION: 0	SCALE: 1:1250
TITLE: SITE INVESTIGATION PLAN		DATE: 03/10/2022	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL2022-0128 SITE INVESTIGATION PLAN.DWG



LEGEND:

- HA01-22 HAND AUGER (HA) LOCATION
- TP01-22 TEST PIT (TP) LOCATION
- SITE BOUNDARY

- Uncontrolled Fill
- Colluvium
- Puketoka Formation
- Northland Allochthon

NOTES:

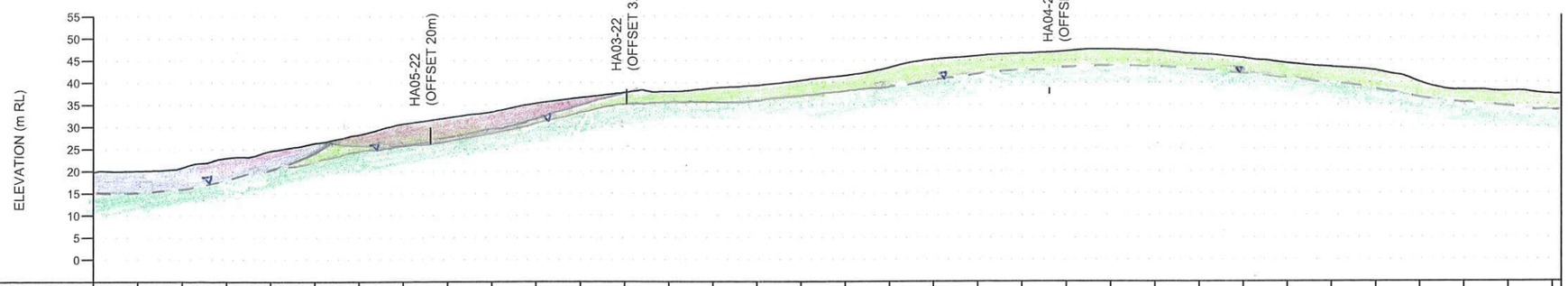
1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS MAP.
2. CONTOURS ARE IN 0.25m INTERVALS.

1:1250 0 12.5 25 37.5 50 62.5 m

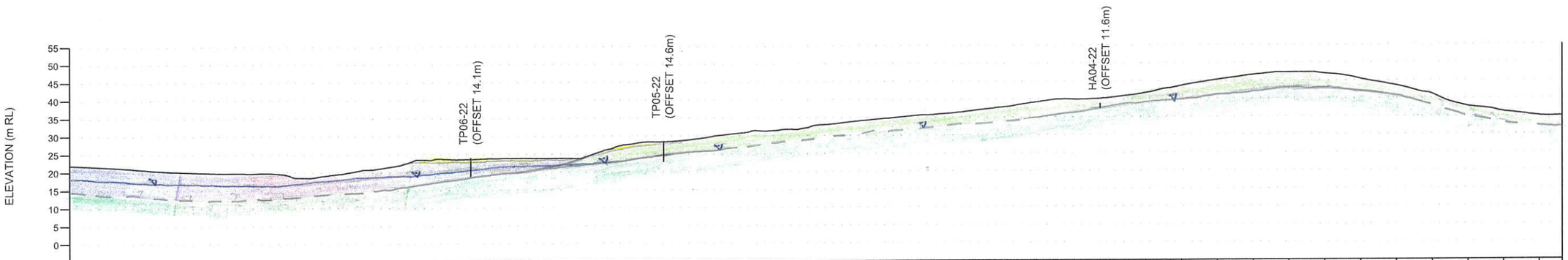
CMW Geosciences

CLIENT: BUILD RICH LTD		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: HN	DRAWING: 01
		REVISION: 0	SCALE: 1:1250
TITLE: GEOLOGY PLAN		DATE: 07/09/2022	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL 2022-0128 SITE INVESTIGATION PLAN.DWG


ELEVATION (m RL)
55
50
45
40
35
30
25
20
15
10
5
0
HA05-22 (OFFSET 20m)
HA03-22 (OFFSET 3.6m)
HA04-22 (OFFSET 46m)

| | | |



DISTANCE (m)	EXISTING GROUND (m RL)
10	21.50
20	20.79
30	20.16
40	19.83
50	19.68
60	19.39
70	18.96
80	20.42
90	21.67
100	23.43
110	23.62
120	23.81
130	23.82
140	23.75
150	26.28
160	28.29
170	28.65
180	30.03
190	31.43
200	31.75
210	33.05
220	34.04
230	34.93
240	35.69
250	36.59
260	37.76
270	39.25
280	39.92
290	40.34
300	41.67
310	43.64
320	45.28
330	46.64
340	47.26
350	46.94
360	45.42
370	43.55
380	41.16
390	37.75
400	36.26
410	35.09
416	35.00

SECTION-B

- Uncontrolled Fill
- Puhetoha Formation
- Residual Northland Allochthon
- Northland Allochthon Rock

LEGEND:

EXISTING SURFACE

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH LTD		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: HN	DRAWING: 03
		REVISION: A	SCALE: 1:1250
TITLE: SECTION-B		DATE: 07/09/2022	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL 2022-0128 SITE INVESTIGATION PLAN.DWG

Appendix B: Hand Auger Borehole and Test Pit Logs

HAND AUGER BOREHOLE LOG - HA01-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1748879.4mE; 5945117.6mN Projection: NZTM
Elevation: 29.20m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			29.2			MH: Clayey SILT: Orange brown mottled grey. High Plasticity. (Northland Allochthon)			
			29.0			ML: Clayey SILT: Brownish grey. Low Plasticity. (Northland Allochthon)			
	0.4	Peak = 61kPa Residual = 32kPa					W	St	
▼	0.8	Peak = UTP		1		... at 1.00m, becoming SILT with some sand. Grey.			
	1.2	Peak = >203kPa							
	1.6	Peak = 131kPa Residual = 15kPa					S	VSt to H	
	2.0	Peak = 131kPa Residual = 58kPa		2		... at 2.00m, becoming Clayey SILT with minor fine sand. Grey mottled orange.			
	2.4	Peak = >203kPa							
	2.8	Peak = UTP				Borehole terminated at 2.8 m			20
				3					
				4					
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5, 10, 15

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 0.8m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA02-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: HN Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 1748930.0mE; 5945111.0mN Projection: NZTM
Elevation: 37.45m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			37.4			ML: SILT with trace clay : Dark brown with minor rootlets. Low plasticity (Topsoil)	M to W		
			37.2			CH: Silty CLAY: Light grey streaked light yellowish brown. High plasticity. (RS Northland Allochthon)			
	0.4	Peak = 154kPa Residual = 46kPa							
	0.8	Peak = 157kPa Residual = 64kPa						VSt	
			36.6	1		ML: SILT with minor clay : Greyish white streaked yellowish brown Low plasticity. (RS Northland Allochthon)			
	1.2	Peak = 141kPa Residual = 64kPa	36.2			CH: Silty CLAY : Light grey with minor yellowish brown streaks. High plasticity. (RS Northland Allochthon)			
	1.6	Peak = 77kPa Residual = 40kPa						St	
			35.6			ML: Clayey SILT : Light grey with minor yellowish brown streaks. Low plasticity. (RS Northland Allochthon)	M		
	2.0	Peak = 172kPa Residual = 61kPa	35.4	2		ML: SILT with trace clay : Light grey with minor yellowish brown streaks. Low plasticity. (RS Northland Allochthon)			
						... at 2.00m, becoming SILT with trace clay			
	2.4	Peak = >200kPa				*... at 2.40m, becoming light grey streaked yellowish brown with minor dark grey streaks.*			
	2.8	Peak = >200kPa						VSt to H	
				3		*... at 3.00m, becoming Clayey SILT. Light grey, dark grey, and orange brown.*			
	3.2	Peak = >200kPa				*... at 3.20m, becoming SILT. Grey with orange brown stains. Friable.*			
						... at 3.50m, becoming SILT with minor clay. Grey streaked dark grey.	D to M		
						Borehole terminated at 3.6 m			
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1702 DCP No: 01
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 11/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1748927.6mE; 5945055.5mN Projection: NZTM
Elevation: 38.32m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			38.3			OL: Organic SILT: Dark brown. Low Plasticity. (Topsoil)			
			38.1			ML: Clayey SILT with some fine sand: Orange grey. Low Plasticity. (Northland Allochthon)	M		
	0.4	Peak = >203kPa				... at 0.40m, becoming brownish grey mottled orange.			
	0.8	Peak = >203kPa		1					
	1.2	Peak = UTP					W		
						... at 1.40m, becoming SILT with some fine sand. Grey mottled orange.			
	1.6	Peak = UTP						H	
						... at 1.80m, becoming Sandy SILT with minor clay. Whitish grey mottled orange with limonite staining.			
	2.0	Peak = UTP		2					
	2.4	Peak = UTP					S		
	2.8	Peak = >203kPa				... at 2.80m, becoming SILT with some sand. Bluish grey with brown streaks.			
				3					
						Borehole terminated at 3.1 m			17
									20
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 2.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA04-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 11/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749026.5mE; 5945012.6mN Projection: NZTM
Elevation: 38.62m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			38.6			OL: Organic SILT: Dark brown. Low Plasticity. (Topsoil)	M		
			38.4			ML: Clayey SILT with some fine sand: Whitish grey mottled orange. Low Plasticity. (Northland Allochthon)			
	0.4	Peak = 133kPa Residual = 15kPa					W	VSt	
	0.8	Peak = UTP		1				H	
▼	1.2	Peak = UTP					S		
						Borehole terminated at 1.2 m			20
				2					
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 1.1m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA05-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: HN Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 1748885.0mE; 5945028.5mN Projection: NZTM
Elevation: 29.76m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			29.8			OL: Clayey SILT : Dark brown with minor rootlets. Low plasticity. (Topsoil)	M to W		
	0.4	Peak = 147kPa Residual = 55kPa	29.4			CH: Silty CLAY: Light yellowish brown with minor light orange brown streaks. High plasticity. (Colluvium)		St to VSt	
	0.8	Peak = 77kPa Residual = 40kPa		1					
						... at 1.00m, becoming CLAY with trace silt.		F	
	1.2	Peak = 50kPa Residual = 20kPa				... at 1.20m, becoming light grey streaked light yellowish brown. Trace rootlets.			
	1.6	Peak = 63kPa Residual = 20kPa					M		
	2.0	Peak = 89kPa Residual = 20kPa		2		... at 2.00m, becoming silty CLAY, light brown to light grey with with minor grey blocky silt clasts. Trace rootlets.		St	
			27.5			ML: Clayey SILT: Dark grey streaked light grey. Low plasticity. (Northland Allochthon)			
	2.4	Peak = >200kPa							
	2.8	Peak = >200kPa				... at 2.90m, with trace blackish grey shear planes.			
				3		... at 3.00m, becoming friable.		H	
	3.2	Peak = >200kPa					D to M		
						Borehole terminated at 3.6 m			20
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1702 DCP No: 01
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749014.9mE; 5944995.1mN Projection: NZTM
Elevation: 31.50m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			31.5			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)			
	0.4	Peak = 136kPa Residual = 29kPa	31.1			ML: Clayey SILT with minor fine sand: Grey mottled orange. Low Plasticity. (Northland Allochthon)			
						... at 0.50m, becoming Clayey SILT with some gravel. Gravel is fine to coarse, subangular, derived from siltstone clasts.			
	0.8	Peak = UTP					W		
			30.5	1		CH: Silty CLAY: Grey mottled orange. High Plasticity. (Northland Allochthon)			
	1.2	Peak = 162kPa Residual = 17kPa						VSt to H	
▼	1.6	Peak = >203kPa	29.9			ML: Clayey SILT with minor fine sand: Grey mottled orange. Low Plasticity. (Northland Allochthon)			
							S		
	2.0	Peak = UTP		2		*... at 2.00m, becoming Sandy SILT with trace gravel. Gravel is coarse, subangular, derived from siltstone clasts.*			
						Borehole terminated at 2.2 m			16
									20
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 1.6m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA07-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 11/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749001.7mE; 5944923.4mN Projection: NZTM
Elevation: 29.23m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			29.2			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)			
			29.0			CH: Silty CLAY: Grey mottled orange streaked dark grey. High Plasticity. (Tauranga Group)			
	0.4	Peak = 96kPa Residual = 55kPa	28.8			ML: Clayey SILT with some fine sand: Grey mottled orange. Low Plasticity. (Tauranga Group)		St	
	0.8	Peak = 133kPa Residual = 49kPa		1					
	1.2	Peak = 177kPa Residual = 67kPa				... at 1.20m, becoming orange grey	M		
	1.6	Peak = >203kPa							
			27.4			ML: Sandy SILT with trace gravel: Blue with minor grey mottles. Low Plasticity. Gravel is coarse, subangular siltsone clasts. (RS Northland Allochthon)			
	2.0	Peak = 148kPa Residual = 87kPa		2				VSt	
	2.4	Peak = 145kPa Residual = 102kPa					W		
	2.8	Peak = 148kPa Residual = 104kPa							
				3					
	3.2	Peak = UTP					S		
						Borehole terminated at 3.3 m			20
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 3.0m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA08-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: HN Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 1748947.4mE; 5944903.6mN Projection: NZTM
Elevation: 26.10m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			26.1			ML: SILT with minor clay : Dark brownish grey with trace brown mottles. Low plasticity. (Alluvium)			
	0.4	Peak = 50kPa Residual = 15kPa					M to W	F	
			25.5			ML: SILT with minor clay: Blackish brown with trace light grey mottles. Low plasticity. Minor sub-angular light grey silt clasts. (Fill)			
	0.8	Peak = 46kPa Residual = 12kPa		1					
			25.0			CH: Silty CLAY : Light grey with minor light orange brown streaks. High plasticity. (Tauranga Group)			
	1.2	Peak = 104kPa Residual = 9kPa							
	1.6	Peak = 141kPa Residual = 6kPa						VSt	
	2.0	Peak = >200kPa		2		... at 2.00m, becoming CLAY. Greyish white streaked light orange brown.			
	2.4	Peak = 98kPa Residual = 58kPa					M		
			23.4			ML: SILT with some clay: Light grey. Low plasticity. Homogeneous. (RS Northland Allochthon)			
	2.8	Peak = >200kPa		3				VSt to H	
	3.2	Peak = 172kPa Residual = 80kPa				... at 3.20m, relict blocky structure.			
	3.6	Peak = >200kPa							
	4.0	Peak = >200kPa		4		... at 4.00m, becoming with trace blackish grey shear planes.			
						Borehole terminated at 4.1 m			
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1702 DCP No: 01
Remarks: Groundwater not encountered. Overland flow at 1.0m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP01-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP01-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1
Position: 1749011.6mE; 5944987.6mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 35.62m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			35.6			ML: Clayey SILT with minor gravel and trace cobbles: Grey streaked white. Low Plasticity. (Fill)				
	0.4	Peak = 87kPa Residual = 35kPa						St		
	0.8	Peak = 160kPa Residual = 58kPa	34.8			ML: Sandy SILT: Orange brown. Low Plasticity. (Fill)				
			34.6	1		ML: Clayey SILT with minor gravel and trace cobbles: Grey streaked white. Low Plasticity. (Fill)				
	1.2	Peak = >203kPa				*... from 1.20m to 1.30m, becoming brown*				
	1.4	Peak = 148kPa Residual = 58kPa					W			
				2				VSt		
	2.3	Peak = 160kPa Residual = 58kPa				*... at 2.30m, becoming brownish grey*				
						... at 2.40m, becoming purplish brown mottled orange				
	2.6	Peak = 119kPa Residual = 35kPa								
						... at 2.80m, becoming whitish grey mottled orange				
				3						
	3.2	Peak = 160kPa Residual = 49kPa						St		
▼	3.6	Peak = 84kPa Residual = 44kPa								
	4.0	Peak = 151kPa Residual = 73kPa	31.6	4		ML: Sandy SILT: Whitish grey mottled orange. Low Plasticity. (Northland Allochthon)				
						... at 4.00m, Transition to rock bucket	S			
	4.4	Peak = 133kPa Residual = 44kPa	31.2			CH: Silty CLAY with minor fine sand: Whitish grey mottled orange. High Plasticity. (Northland Allochthon)		VSt		
	4.8	Peak = 139kPa Residual = 41kPa								
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 3.6m. Changed to rock bucket at 4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP02-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP02-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749014.4mE; 5944975.6mN Projection: NZTM
Elevation: 33.75m Datum: AUCKHT1946

Pit Dimensions: 4.0m by 2.0m
Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			33.8			ML: Clayey SILT with trace gravel: Brown mottled orange. Low Plasticity. Gravel is coarse, subangular. (Fill)				
	0.4	Peak = 58kPa Residual = 29kPa				... at 0.40m, becoming Clayey SILT with minor fine sand and trace gravel. Orange grey. Gravel is coarse, subangular.		St		
	0.8	Peak = 99kPa Residual = 67kPa		1			W			
	1.2	Peak = 102kPa Residual = 29kPa								
	1.6	Peak = 116kPa Residual = 20kPa								
▼	2.0	Peak = 99kPa Residual = 20kPa	31.8	2		OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)		VSt		
	2.4	Peak = 107kPa Residual = 29kPa	31.4			MH: Clayey SILT: Whitish grey mottled orange. High Plasticity. (Northland Allochthon)	S			
	3.0	Peak = 162kPa Residual = 52kPa		3						
						Test pit terminated at 3.40 m				
				4						
				5						

Termination Reason: Hole collapsed despite benching
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 2.0m. Pit collapse.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 2

Position: 1749026.1mE; 5944953.9mN Projection: Pit Dimensions: 4.0m by 2.0m
Elevation: 31.75m Datum: Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			31.8			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				0.0-5.5m:
			31.6			CL: Silty CLAY with minor fine sand and trace gravel: Brown mottled orange and dark grey. Low Plasticity. Gravel is fine to medium, subangular. (Fill)				
	0.4	Peak = 87kPa Residual = 15kPa					W			
	0.8	Peak = 70kPa Residual = 26kPa						St		
			30.8	1		OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				
▼	1.2	Peak = 61kPa Residual = 15kPa				*... at 1.20m, groundwater pooling on surface.*				
			30.2			MH: Clayey SILT: Brownish grey mottled orange. High Plasticity. (Northland Allochthon)				
	1.6	Peak = 107kPa Residual = 29kPa								
	2.0	Peak = 131kPa Residual = 26kPa		2						
						... at 2.20m, groundwater seepage through walls and minor wall collapses.				
	2.4	Peak = 107kPa Residual = 49kPa						VSt		
	2.8	Peak = 104kPa Residual = 29kPa								
			28.8	3		ML: Sandy SILT: Whitish grey mottled orange. Low Plasticity. Sand is fine to medium grained. (Northland Allochthon)	S			
	3.2	Peak = 90kPa Residual = 29kPa								
	3.6	Peak = 61kPa Residual = 44kPa				*... at 3.60m, becoming bluish grey mottled orange.*		St		
	4.0	Peak = 61kPa Residual = 49kPa		4						
				5						

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 1.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 2 of 2

Position: 1749026.1mE; 5944953.9mN Projection: Pit Dimensions: 4.0m by 2.0m
Elevation: 31.75m Datum: Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			26.2			CH: Silty CLAY: Brownish grey streaked black. High Plasticity. (Northland Allochthon)			5 10 15 20	
				6		Test pit terminated at 6.00 m				
				7						
				8						
				9						
				10						

Material Description: Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 1.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP04-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP04-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1
Position: 1748930.5mE; 5944947.0mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 26.75m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			26.8			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				
	0.4	Peak = 174kPa Residual = 29kPa	26.4			CH: Silty CLAY: Grey mottled orange. High Plasticity. (Fill)				
	0.8	Peak = 133kPa Residual = 44kPa		1				VSt to St		
	1.2	Peak = 87kPa Residual = 46kPa								
	1.6	Peak = 104kPa Residual = 46kPa								
	2.0	Peak = 133kPa Residual = 46kPa		2				VSt		
	2.4	Peak = 189kPa Residual = 58kPa	24.4			ML: Sandy SILT with minor gravel: Brownish grey mottled orange. Low Plasticity. Sand is fine to coarse grained. Gravel is coarse, subangular, siltstone clasts. (Northland Allochthon)	W			
	3.0	Peak = 160kPa Residual = 55kPa		3						
	3.4	Peak = >203kPa								
	4.0	Peak = UTP		4		... at 4.00m, transition to rock bucket		H		
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater not encountered. Changed to rock bucket at 4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP05-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP05-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1
Position: 1748906.4mE; 5944978.7mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 28.47m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
			28.5			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				
	0.5	Peak = 102kPa Residual = 17kPa	28.0			CH: Silty CLAY: Whitish grey mottled orange. High Plasticity. (Fill)	W	VSt		
	0.8	Peak = 116kPa Residual = 44kPa								
			27.5	1		ML: Clayey SILT: Bluish grey mottled orange. Low Plasticity. (Northland Allochthon)		St		
▼	1.4	Peak = 87kPa Residual = 58kPa								
	1.6	Peak = 90kPa Residual = 58kPa								
			26.5	2		CH: Silty CLAY with trace fine sand: Whitish grey mottled orange. High Plasticity. (Northland Allochthon)		St to VSt		
	2.4	Peak = 148kPa Residual = 58kPa								
	2.8	Peak = 174kPa Residual = 44kPa						VSt		
	3.0	Peak = 160kPa Residual = 38kPa	25.5	3		ML: Sandy SILT: Blue. Low Plasticity. Sand is fine to medium grained. Blue highly weathered SILTSTONE present. Extremely weak. Blocky fabric with randomly oriented microfractures. (Northland Allochthon)	S			
	3.5	Peak = >203kPa								
	4.0	Peak = UTP		4				H		
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 1.4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 2

Position: 1748872.6mE; 5944928.3mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 22.90m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			22.9			CH: Silty CLAY with minor fine sand and gravel: Orange grey. High Plasticity. Gravel is coarse, subangular, siltstone clasts. (Fill)				
	0.4	Peak = 99kPa					M	St		
	0.8	Peak = 75kPa				*... at 0.80m, becoming bluish grey streaked dark grey with minor wood/bark fragments.*				
				1						
	1.2	Peak = 148kPa	21.7			ML: Clayey SILT with minor gravel: Bluish grey mottled dark grey and white. Low plasticity. Gravel is coarse, subangular, siltstone clasts. (Fill)				
			21.4			CH: Silty CLAY: Brownish grey mottled orange. High Plasticity. (Puketoka Formation)				
	1.6	Peak = 128kPa Residual = 12kPa								
▼	2.0	Peak = 174kPa Residual = 41kPa	20.9	2		ML: Clayey SILT with minor fine sand: Whitish grey mottled orange. Low Plasticity. Blocky fabric is siltstone clasts. (Puketoka Formation)	W	VSt		
	2.7	Peak = >203kPa				*... at 2.60m, becoming whitish grey with trace light orange brown stains.*				
			19.9	3		CL: Silty CLAY: Brownish grey with trace organic staining. Low Plasticity. Organic odour. (Puketoka Formation)				
	3.2	Peak = 102kPa Residual = 29kPa				*... at 3.00m, minor pit collapse.*				
	3.5	Peak = 99kPa Residual = 29kPa	19.4			ML: SILT with minor fine sand: Whitish grey. Low Plasticity. Blocky fabric. (Puketoka Formation)				
			19.1			CH: Silty CLAY with minor fine sand: Whitish grey mottled orange. High Plasticity. (Puketoka Formation)				
				4			S	VSt to H		
			17.9	5		ML: Clayey SILT: Dark grey mottled orange. Low Plasticity. Trace organics present. (Puketoka Formation)				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 2.0m. Changed to rock bucket at 3.5m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 2 of 2

Position: 1748872.6mE; 5944928.3mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 22.90m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			17.4			ML: Sandy SILT: Bluish grey. Low Plasticity. Sand is fine to medium grained. Derived from completely weathered to highly weathered SANDSTONE. Extremely weak. Includes SILT. Blue mottled orange. Low Plasticity. Trace organics. (Puketoka Formation)			5 10 15 20	
			17.1			ML: SILT: Blue streaked purplish brown. Low Plasticity. Derived from completely weathered to highly weathered SILTSTONE. Blocky fabric with randomly oriented microfractures. (Northland Allochthon)				
				6		Test pit terminated at 6.00 m				
				7						
				8						
				9						
				10						

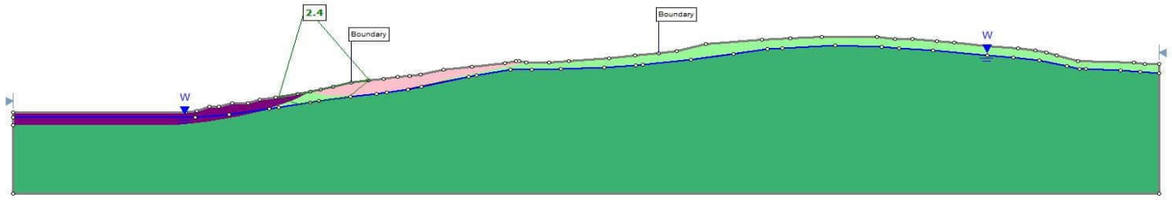
Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 2.0m. Changed to rock bucket at 3.5m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

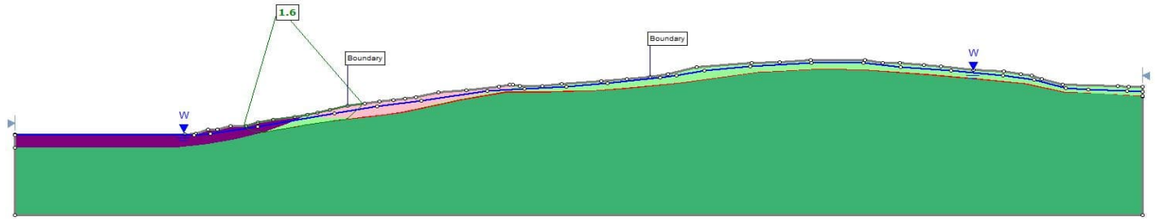
Appendix C: Slope Stability Printouts

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

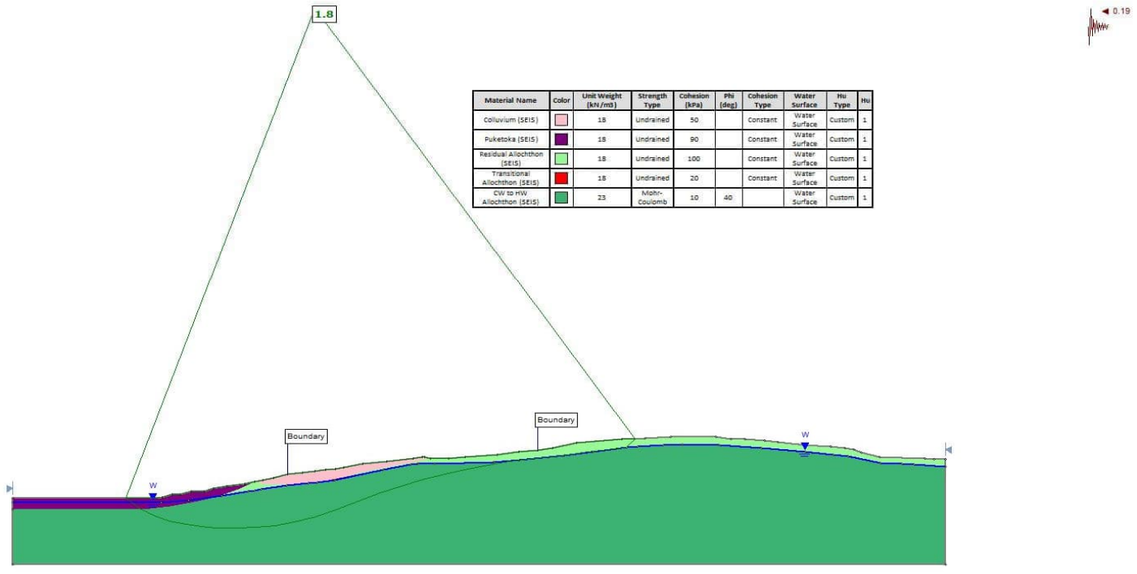


Normal Groundwater Conditions

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1



Transient Groundwater Conditions



Seismic Event

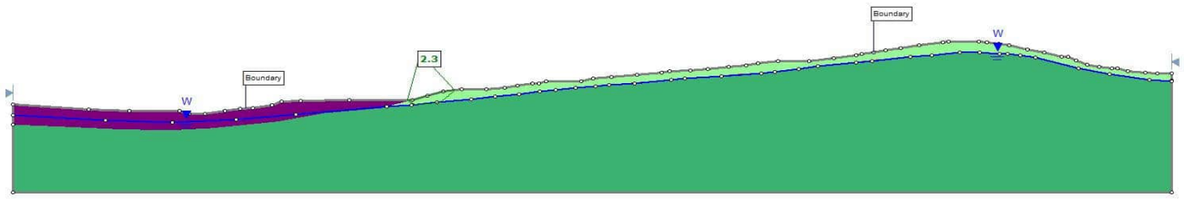
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Colluvium (SEIS)		18	Undrained	50		Constant	Water Surface	Custom	1
Puketoka (SEIS)		18	Undrained	90		Constant	Water Surface	Custom	1
Residual Allochthon (SEIS)		18	Undrained	100		Constant	Water Surface	Custom	1
Transitional Allochthon (SEIS)		18	Undrained	20		Constant	Water Surface	Custom	1
CW to HW Allochthon (SEIS)		23	Mohr-Coulomb	10	40		Water Surface	Custom	1

Parameters

CMW Geosciences

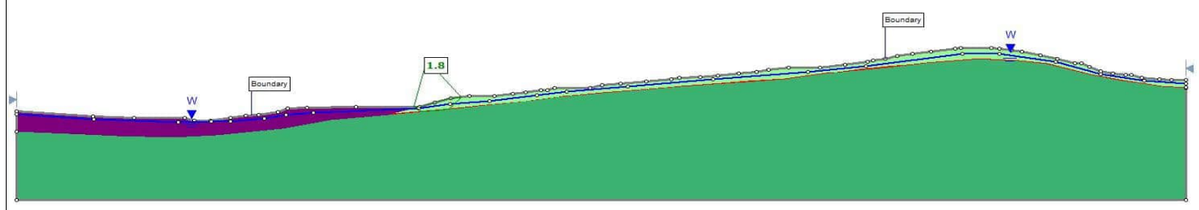
Project 53 Small Road, Silverdale	*Analysis* Cuckoo	*Project No.* AKL2022-0128
Title Section A - Existing	*Date* 3/10/2022	*Drawing* STAB 01

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

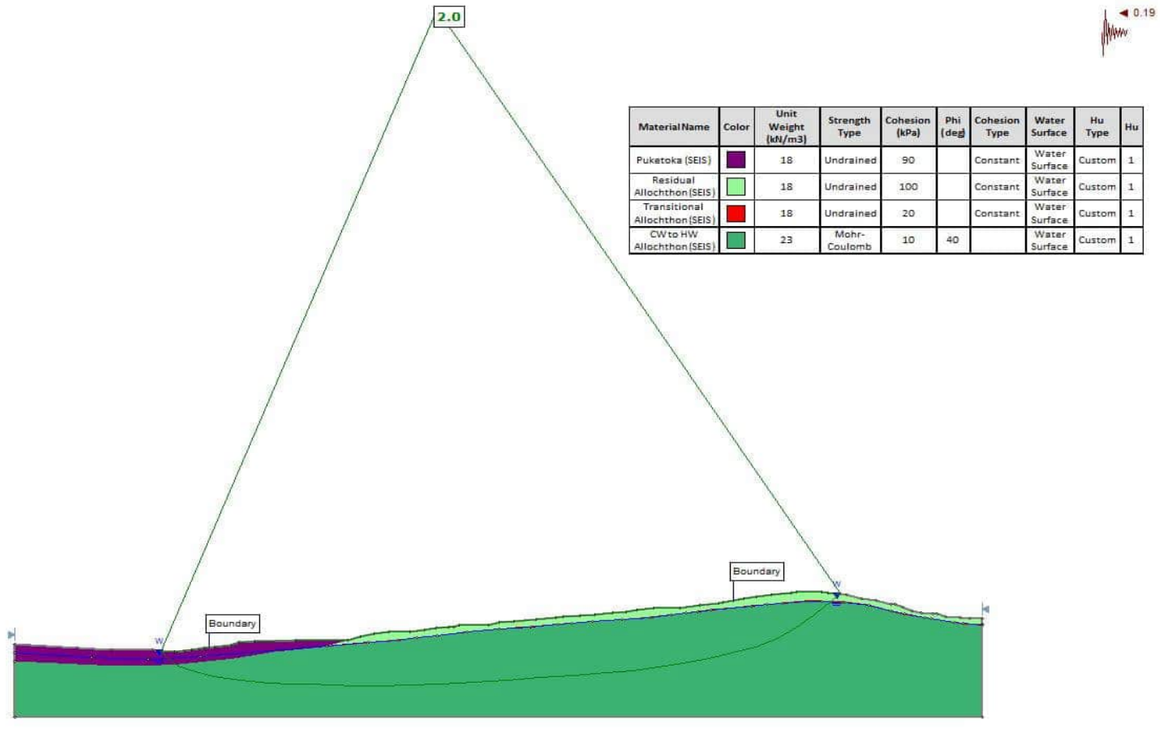


Normal Groundwater Conditions

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1



Transient Groundwater Conditions



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Puketoka (SEIS)		18	Undrained	90		Constant	Water Surface	Custom	1
Residual Allochthon (SEIS)		18	Undrained	100		Constant	Water Surface	Custom	1
Transitional Allochthon (SEIS)		18	Undrained	20		Constant	Water Surface	Custom	1
CW to HW Allochthon (SEIS)		23	Mohr-Coulomb	10	40		Water Surface	Custom	1

Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Colluvium (SEIS)		18	Undrained	50		Constant	Water Surface	Custom	1
Puketoka (SEIS)		18	Undrained	90		Constant	Water Surface	Custom	1
Residual Allochthon (SEIS)		18	Undrained	100		Constant	Water Surface	Custom	1
Transitional Allochthon (SEIS)		18	Undrained	20		Constant	Water Surface	Custom	1
CW to HW Allochthon (SEIS)		23	Mohr-Coulomb	10	40		Water Surface	Custom	1

Parameters

CMW Geosciences

Project 53 Small Road, Silverdale	*Analysis* Cuckoo	*Project No.* AKL2022-0128
Title Section B - Existing	*Date* 3/10/2022	*Drawing* STAB 02

Appendix D: Laboratory Test Results

ROADTEST LTD

Revision: 1

DETERMINATION OF THE WATER CONTENT, CONE PENETRATION LIMIT & LINEAR SHRINKAGE
TEST METHOD NZS 4402 : 1986 TEST 2.1, 2.5 & 2.6

Project Name :	**53 Small Road**		
		Project No :	22 0001 75
Client :	CMW Geosciences	Page :	1 of 1
Address :	PO Box 300206 Albany, Auckland 0754	Date of Order :	30.09.22
		Sample Method :	Hand auger
Attention :	Henry Nagel	Sample Date :	30.09.22
		Sampled By :	CMW Geosciences

Test Details :

Test performed on :	Whole Sample
History :	Natural

Sample No.	Location	Depth (m)	Cone Penetration (CPL)	Linear Shrinkage (LS)	Natural Water Content (%)
636N	Expansive 2	0.4 - 0.8	83	17	37.5
637N	Expansive 1	0.4 - 0.8	71	16	37.0

Comments :

Tested By:	RS	Date :	03 to 05.10.22
Calculated By :	AS	Date :	06.10.22
Checked By :	EC	Date :	06.10.22

CMW Geosciences
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ATTACHMENT 4

AKL2022-0128AD Geotechnical Earthworks Design Report

4 October 2023 Document Ref: AKL2022-0128AD Rev. 1

Build Rich Limited
32 Henwood Road, Taupaki
Auckland 0782

Attention: Liang

RE: GEOTECHNICAL EARTHWORKS DESIGN REPORT
53 SMALL ROAD, SILVERDALE

1 INTRODUCTION

CMW Geosciences (CMW) was engaged by Build Rich Limited to prepare a geotechnical report for a site located at 53 Small Road, Silverdale, which is being considered for the construction of a commercial subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2022-0128AC Rev. 0, dated 25 August 2023.

This report is to support a land use (earthworks) resource consent application to Auckland Council.

This report is intended to supplement our Preliminary Geotechnical Investigation Report referenced below, including assessment of the relevant additional geohazards associated with the proposed earthworks.

2 PREVIOUS REPORTING

CMW completed a Preliminary Geotechnical Investigation Report (GIR) referenced AKL2022-0128AB Rev. 0, dated 7 October 2022. That report is appended to this report and its findings and recommendations remain applicable where the sections below do not supersede them.

The investigation completed for the preliminary GIR comprised eight hand auger boreholes to depths of up to 5m and six test pits to depths of up to 6m, and included installation of two standpipe piezometers.

3 PROPOSED DEVELOPMENT

The supplied Earthworks Design Report prepared by Aspire Consulting Engineers, referenced 1782-1, dated August 2023, depicts the construction of a terraced site to form a series of building platforms. Bulk earthworks to form these contours involves cuts of up to 6m and fills of up to 5m, with total cut and fill volumes of 33,200m^3 and 30,350m^3 respectively. A fill batter up to 5m in height is proposed to be constructed along the western boundary.

The proposed contours include several near-vertical retaining wall cuts, and although no retaining wall plans have been supplied to date, we have prepared this report based on the assumption that cantilever retaining walls will be constructed to support these cuts.

Lot layout plans are not yet available, but we have assumed combined floor loads of 20kPa will be applied across the near-level finished subgrades supporting commercial buildings.

A wetland pond up to 3m deep is proposed to be excavated in the south-west corner of the site.

4 SUPPLEMENTARY GEOHAZARDS ASSESSMENT AND RECOMMENDATIONS

4.1 Slope Stability Analysis

We have assessed slope stability of four cross sections across the site (B, C, D and E) which were selected to capture areas of deepest cuts (including batters), areas of deepest fills, and permanent pond stability.

4.1.1 Design Criteria

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment:

Table 1: Slope Stability Factor of Safety Criteria

Condition	Required Factor of Safety
Normal Groundwater Condition	1.5
Extreme (worst credible) groundwater condition	1.3
Seismic condition for ULS PGA (calculated as 0.19g)	1.0

4.1.2 Design Parameters

Design parameters for each geological unit underlying the site are presented below, which have been extracted from our preliminary GIR and were based on the investigation findings and previous analysis of other stages in similar geology.

Table 2: Geotechnical Design Parameters				
Unit Description	**γ (kN/m³)**	**c´ (kPa)**	**ϕ´ (deg)**	**S_u (kPa)**
Engineered Fill	18	5	30	100
Existing Fill	18	2	26	50
Colluvium	18	4	26	50
Puketoka Formation	18	3	26	90
Residual Northland Allochthon	18	5	26	100
Transitional Northland Allochthon	18	0	20	20
Highly Weathered Northland Allochthon	23	10	40	N/A

Notes: γ = soil unit weight
c´ = effective cohesion
ϕ´ = effective friction angle
S_u = undrained shear strength

4.1.3 Methodology

- Slope stability analyses were undertaken using the Morgenstern-Price method of slices under translational failure mechanisms using the proprietary software SLIDE Version 6.
- Groundwater levels were based on available monitoring information including those from nearby sites. Elevated groundwater conditions were assumed at approximately 1m below ground surface.
- Micro-piles were used where proposed contours are vertical/near-vertical (i.e., future retaining walls) to isolate slip-circles to global stability.
- A 20kN uniformly distributed vertical load was applied across the building platform areas for commercial buildings.

4.1.4 Initial Results

Slope stability analyses were undertaken on Sections B-B to E-E inclusive (see ***Figure 1)***, which were assessed as the critical sections across the site.

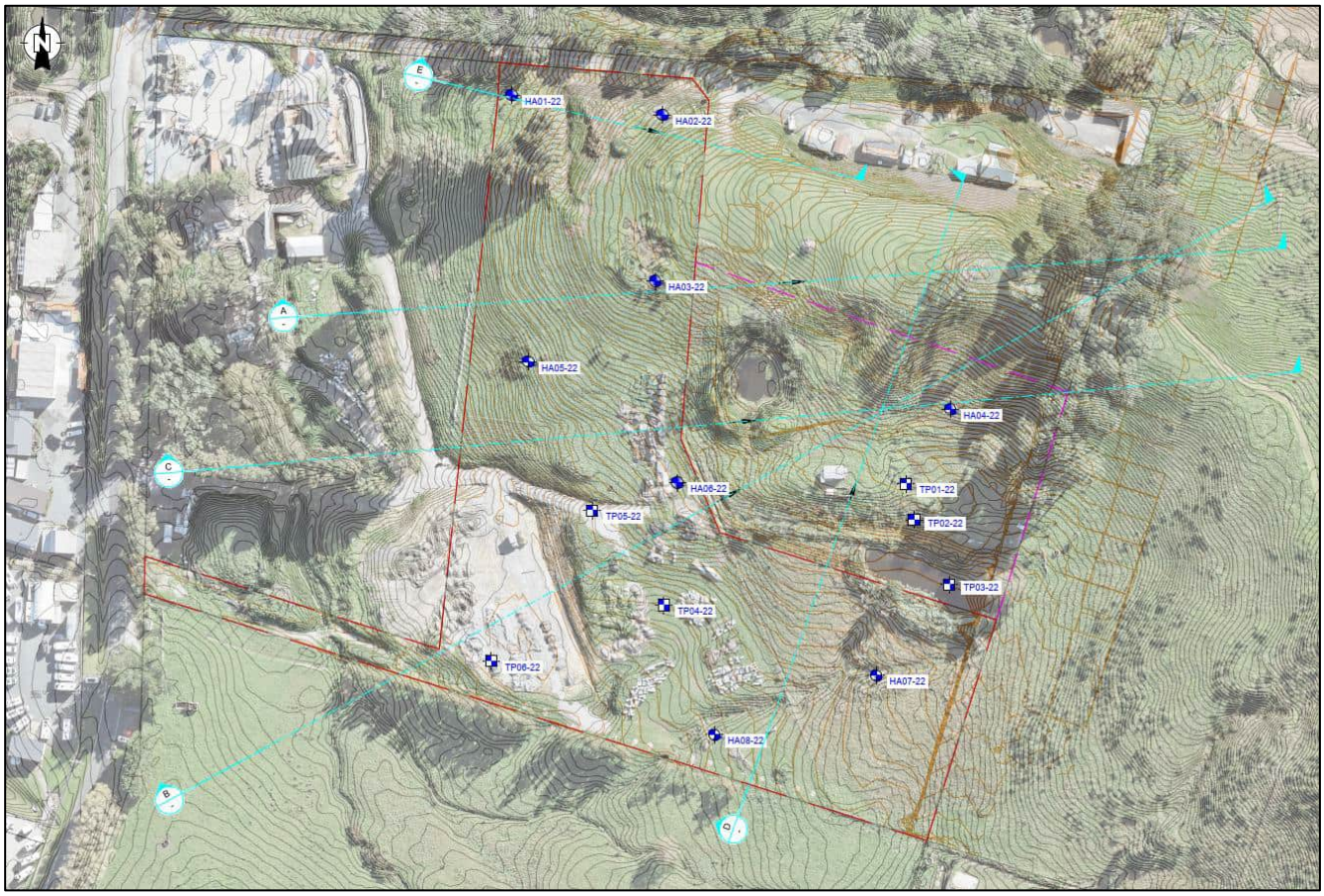


Figure 1: Slope Stability Sections

Stability printouts are appended to this report and are summarised below for the proposed landform.

Table 3: Slope Stability Analysis Results			
Section	**Slope Stability Minimum Factor of Safety**		
	Prevailing	**Transient**	**Seismic**
B-B	1.6	1.0	1.9
C-C	1.2	1.0	2.0
D-D	1.5	1.4	1.5
E-E	1.2	1.2	1.9

4.1.5 Slope Stability Management

Slope stability results indicate that remediation along the western boundary fill batter in the form of either a shear key/MSE slope or a palisade wall with integrated retaining wall is required. For the wetland pond (Section B), an engineered fill buttress is required on the upslope batter. In all cases, subsoil drainage is required to control groundwater levels, which are implemented as either underfill drains or integrated into the retaining structure/shear key designs. Details of the shear key (critical case) are presented in ***Drawing 07*** appended. MSE wall design or palisade wall design is to be undertaken at detailed design stage.

Results of these analyses are presented below:

Table 4: Slope Stability Analysis Results – Post Remedial Works				
Section	**Remedial Works**	**Slope Stability Minimum Factor of Safety**		
		Prevailing	**Transient**	**Seismic**
B-B	Engineered fill buttress in pond (10m width from toe of pond batter[1])	1.6	1.3	2.0
C-C	Shear key/MSE slope[2] (5m wide base, 1m key into HW rock) or palisade wall[2]	1.5 (Shear Key) 1.5 (Palisade)	1.3 (Shear Key) 1.3 (Palisade)	2.0 (Shear Key) 1.0 (Palisade)
D-D	None required	1.5	1.4	1.5
E-E	Shear key/MSE slope[2] or palisade wall[2]	1.6 (MSE) 1.6 (Palisade)	1.3 (MSE) 1.4 (Palisade)	1.9 (MSE) 1.9 (Palisade)
Notes: [1] **Refer to *Drawing 08*.** [2] **MSE slope or palisade wall to be designed at detailed design stage. Conceptual design information provided below. Refer to *Drawing 07* for shear key dimensions.**				

Preliminary conceptual information for both the MSE and palisade options are as follows. These will require detailed design.

MSE Slope

- Geogrid length: 8m
- Geogrid vertical spacing: 0.5m
- Minimum geogrid unfactored biaxial ultimate tensile strength (kN/m): 35/35

Palisade Wall

- Minimum shear capacity: 265kN/m (approximately equivalent to a 500mm SED normal density timber pole)
- Minimum embedment: 1m into highly weathered rock (approximately 5m below existing ground level)
- Slope above wall (surcharge slope) should not exceed 30°

Specific Design Zones will be implemented at completion stage to protect the function of the retaining structures and subsoil drainage.

The shear key or palisade wall should be constructed prior to excavation of the pond.

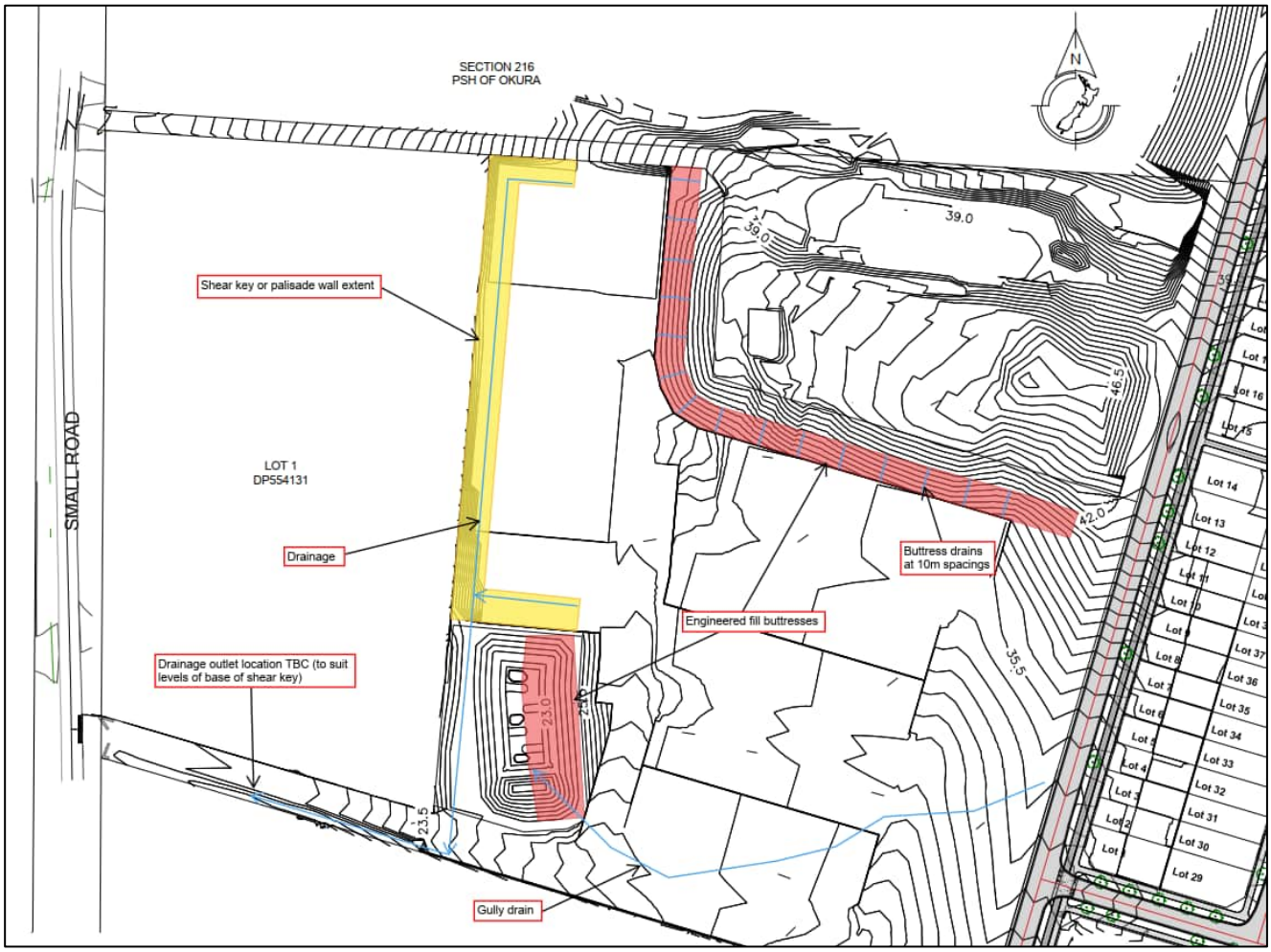


Figure 2: Remediation Plan

4.1.6 Cuts Exposing Transition Zone

Portions of the proposed cut batter above the inner northern and eastern boundary may expose the transition zone, which presents an instability risk on the finished batter. The zones outlined on ***Figure 2*** above depict the anticipated zones where engineered fill buttresses should be benched into the slope. These benches should be undercut a minimum 0.5m into highly weathered rock, and underfill drains installed as depicted in ***Drawing 08***.

4.2 Boundary Effects

We have undertaken an assessment of boundary effects due to groundwater drawdown associated with excavations of up to 6m near the site boundary and deflection induced settlement associated with proposed cantilever retaining walls of up to 4m high.

Assessment of the northern boundary (yellow boundary on ***Figure 3*** below), eastern boundary (green boundary on ***Figure 3*** below) and northern driveway boundary (red boundary on ***Figure 3*** below) have been undertaken due to their proximity to infrastructure at 39 Small Road. The proximity of these structures to the boundary of the 53 Small Road development and zone of deepest cut is summarised in ***Table 5*** below and presented on ***Figure 3***.

Table 5: Geotechnical Effects Cases					
Location	**Maximum Cut**	**Maximum Cut Offset from Boundary**	**Boundary Effected**	**Distance from Maximum Cut to Nearest Structure**	**Distance from Top of Batter (on Boundary) to Nearest Structure**
Section D	6m	15m	Inner northern	30m (carpark), 60m (church)	15m (carpark), 45m (church)
Section E	6m	17m	Inner eastern	40m (church)	23m (church)
Northern Driveway	3.5m	3.75m	Northern driveway	3.75m (driveway)	0m

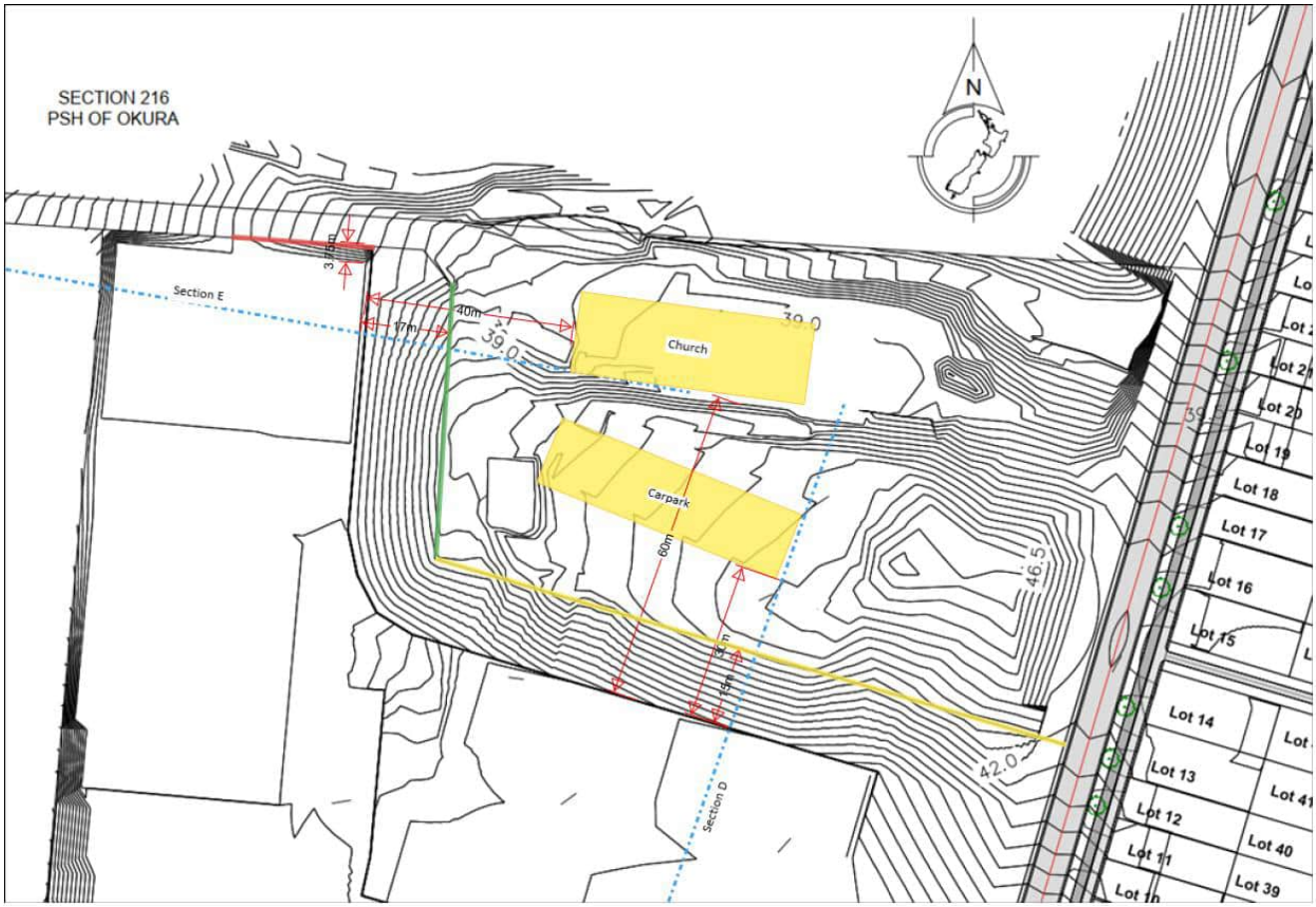


Figure 3: Nearest Infrastructure

4.2.1 Groundwater Monitoring Results

CMW groundwater monitoring results to-date are compiled in the preliminary GIR referenced above. HA03-22 (closest to the area of deepest cut) recorded a groundwater level of 2m below existing ground level on 27 September 2022, which has been used as the lowest recorded groundwater level in the area.

4.2.2 Assessment of Effects

The assessment of effects at any location is considered to be the sum of:

- Groundwater-induced settlement due to draw-down from the lowest historic level (i.e. where the ground experiences new stress changes).
- Deflection-induced settlement due to lateral movement behind a retaining structure.

Figure 4 below depicts the proposed earthworks levels (black line) relative to the existing topography and groundwater table.

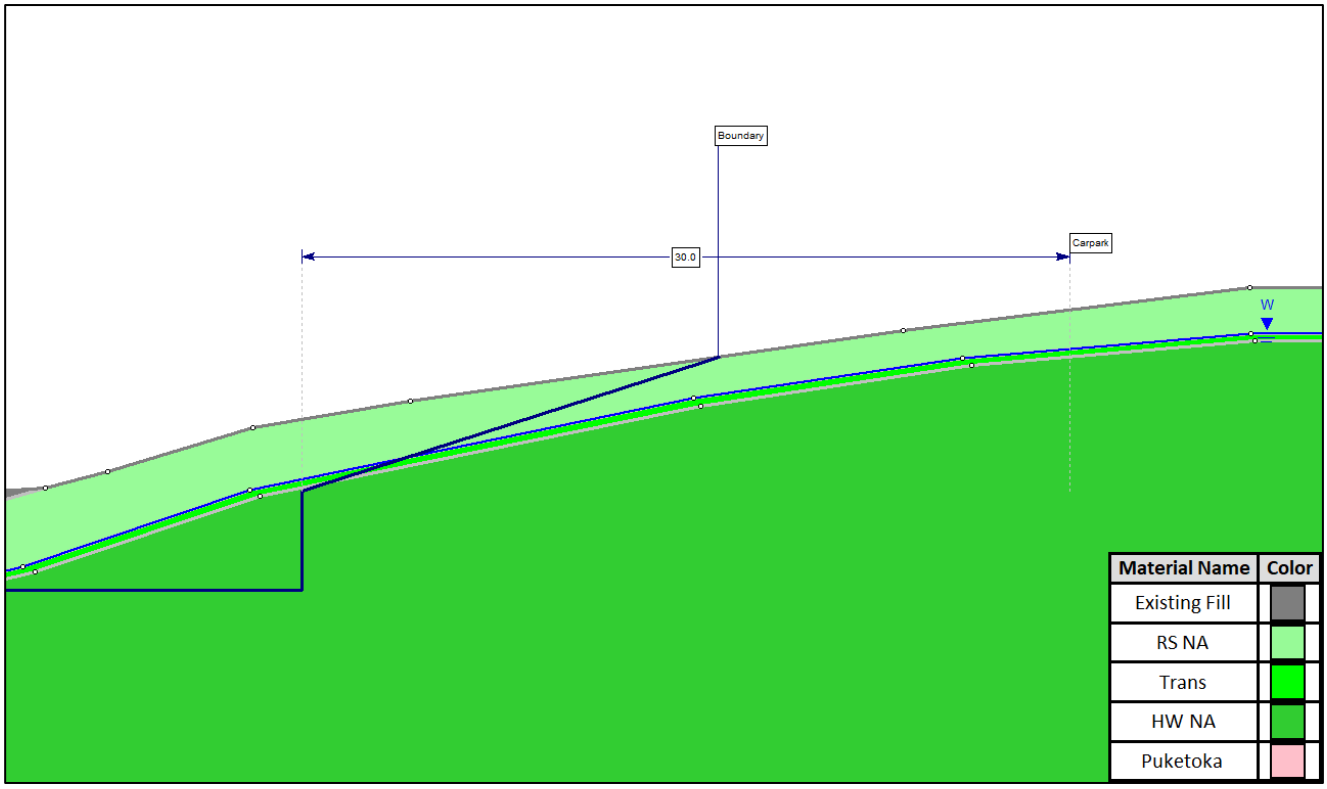


Figure 4: Section D Boundary

4.2.3 Settlement Effects

4.2.3.1 Groundwater Drawdown

Groundwater drawdown has been assessed by a review of geometry and groundwater records using CIRIA Guide C515[1] for plane flows as appended (Groundwater Drawdown Calculation).

Drawdown induced settlements have been calculated using the following equation: $\delta = \Delta\sigma * \frac{1}{E} * H$

Where:

δ	=	Settlement (mm)
E	=	Young's modulus (MPa)
Δσ	=	Change in effective stress (kPa)
H	=	Thickness of compressible layer

4.2.3.2 Deflection

Settlements associated with deflection of the retaining wall(s) have been assessed assuming a deflection of 0.35% of wall height and using empirical methods for settlement behind the wall as described in CIRIA C760[2].

[1] CIRIA, C515 (2000) Groundwater control: design and practice

[2] CIRIA, C760 (2017) Guidance on embedded retaining wall design

CIRIA C760 also recommends that vertical settlement will be negligible (<5mm) at 3.5x the excavated height from the wall.

4.2.3.3 Summary of Effects

Table 6: Geotechnical Effects		
Item	**Section D**	**Northern Driveway**
General		
Distance to boundary[1] (m)	15m	3.75m
Distance to nearest structure / infrastructure[1] (m)	30m	3.75m
Maximum excavation (m)	6m	3.5m
Groundwater		
Depth to lowest measured previous groundwater level[2] (m)	2m	2m
Maximum groundwater drawdown (m)	4m	1.5m
Groundwater drawdown zone of influence, Lo (m)	13m	5m
Change in stress (kPa)	40kPa	15kPa
Maximum settlement due to groundwater drawdown (mm)[3] – at max drawdown level	13mm	5mm
Maximum settlement due to groundwater drawdown (mm)[3] – nearest structure	0mm	5mm
Groundwater inflow rate, Q (m^3/day)[3]	9.4	3.5
Retaining Wall		
Deflection-induced settlement directly behind retaining wall (mm)[4]	21mm	12mm
Deflection-induced settlement at nearest structure (mm)[4]	0mm	12mm
Combined		
Combined groundwater and retaining wall settlement at nearest structure/infrastructure (mm)	0mm	17mm
Differential settlement underneath nearest structure/infrastructure[5]	0	1:300

Notes: [1]Measured from location of maximum groundwater drawdown / retaining wall location
[2]Feasible maximum
[3]Calculated using CIRIA C515, assuming a 5m thickness of residual soil with lower bound 15MPa stiffness
[4]Calculated using CIRIA C760
[5]Expressed as a ratio of width of structure effected over total settlement

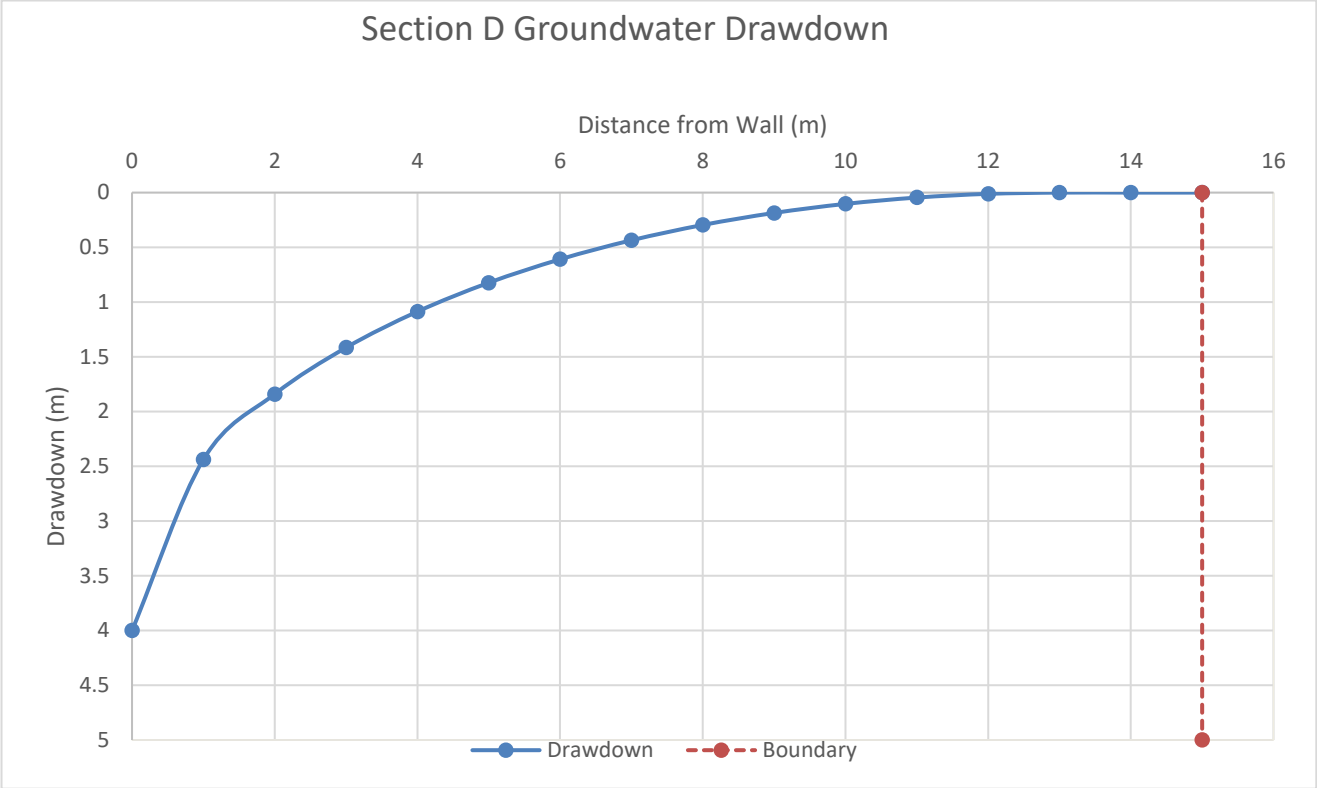


Figure 5: Section D drawdown curve extracted from spreadsheet in *Appendix E*

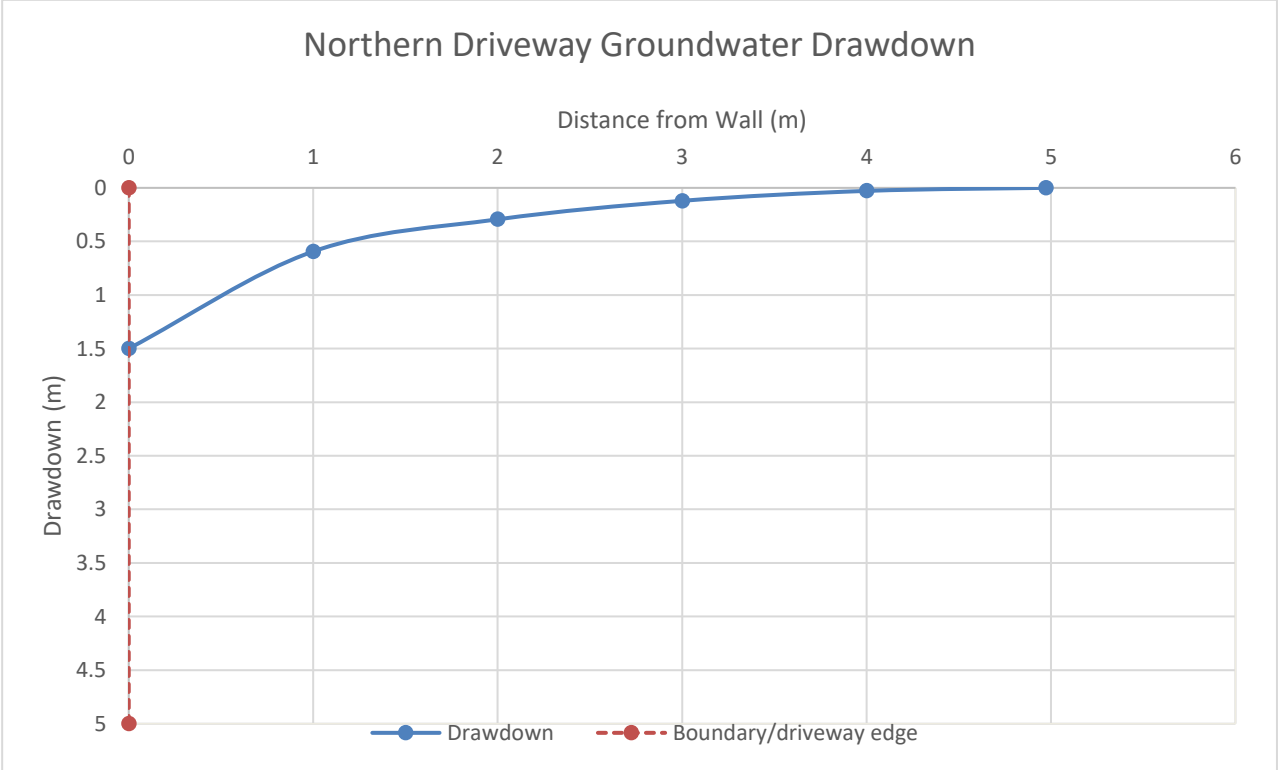


Figure 6: Northern driveway drawdown curve extracted from spreadsheet in *Appendix E*

4.2.4 Results

The results above indicate that the only neighbouring structure subject to drawdown and deflection induced settlement is the northern driveway due to its proximity to the proposed cut. Based on the combined

settlement value presented above (17mm), the building damage degree according to Burland (2012)[3] is classified as having slight effect. However, an existing slope up to approximately 10m in height is present beyond the northern edge of the driveway due to earthworks completed as part of the neighbouring retirement village development as part of a proposed 10m high retaining structure. Therefore, the drawdown settlements calculated above are considered conservative, as a drawdown greater than that caused by the proposed 3.5m cut has already occurred in this area.

The deflection induced settlement is not considered to worsen the current state of the driveway (minor cracks already present on the driveway).

4.3 Groundwater Consenting

An assessment has been made of the impact of the proposed works on groundwater conditions in accordance with the requirements of Section E7 of the Auckland Unitary Plan (AuP).[4] The assessment has considered the impacts of the proposals for taking, using, damming/diversion and drilling activities and the results are contained in the appended table (***Appendix F***).

Our assessment has indicated that the main cut areas are non-compliant according to the following standards:

1) *E7.6.1.6(2)* — *The water take must not be for a period of more than 30 days where it occurs in soil or rock*
2) *E7.6.1.10(1d)* — *Groundwater diversions must be no longer than 10 days*
3) *E7.6.1.10(2a)(2b)* — *Excavations below natural groundwater level must not exceed 1ha in total area; and 6m depth below the natural ground level*
4) *E7.6.1.10(3)* — *The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site*
5) *E7.6.1.10(4a)* — *Any structure that physically impedes the flow of groundwater through the site must not impede the flow of groundwater over a length of more than 20m*

The project planner is to confirm the consenting requirements regarding the AuP rules for groundwater take and diversion.

The assessment of groundwater drawdown impacts on neighbouring structures/infrastructure above has indicated a minimal effect from drawdown, therefore we do not propose to undertake additional groundwater monitoring during or post construction.

4.4 Uncontrolled Fills

The uncontrolled fills identified in our preliminary investigation should be undercut and replaced with engineered fills if not already removed due to bulk earthworks operations. As further discussed in the Geotechnical Works Specification in ***Appendix G*** the uncontrolled fill material may be blended into suitable fill at a ratio of no greater than 1 in 10 by volume.

Indicative locations of uncontrolled fills based on investigation findings is appended in the Geology Plan in the preliminary GIR.

4.5 Temporary Stability

The engineered fill buttresses discussed in Section 4.1.6 above must be completed prior to excavation of the retaining wall cuts.

[3] Burland (2012) Building response to ground movements, *ICE Manual of Geotechnical Engineering*, Vol 1

[4] Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

The contractor should consider temporary stability of exposed cuts during construction and construction should be staged so that an exposed length of no greater than 20m is open at any given time and the retaining wall fully constructed as soon as practicably possible prior to excavation of the next section. If bulk earthworks in front of the wall are to be completed prior to retaining wall excavations, then a 1(V):1(H) batter should be left in place.

Due to the proximity of the northern cut below the northern driveway, a top-down construction methodology should be considered here to maintain boundary stability conditions during construction of this wall.

Further details should be provided at detailed design stage.

4.6 Wetland Pond

Areas of the pond outside the buttress discussed in Section 4.1.5 above that have rock exposed in the cut should have an engineered fill liner to minimise water ingress into the underlying fractured rock. The liner should have a minimum thickness of 1m (perpendicular to surface). Testing on the fill material within the embankment will be undertaken as per the earthworks specification for the subdivision works. Samples will also be tested from the finished pond liner to ensure a minimum permeability of 10^{-7}m/s.

The outlet location of the pond should be carefully considered to maintain appropriate stability conditions. Outlet details and emergency spillway erosion protection will be reviewed at detailed design stage.

As noted in Section 4.1.5 above, the shear key or palisade wall should be constructed prior to excavation of the pond.

5 FURTHER WORK

We intend to undertake additional site investigation comprising five hand auger boreholes to supplement our initial investigation. The purpose of this additional investigation is to:

- Assess conditions of existing ground underlying areas of deepest fills;
- Further refine extents and depths of existing uncontrolled fills;
- Additional groundwater monitoring in areas of deepest cuts;
- Refining rock levels along the western boundary where the shear key or palisade wall is required.
- Detail design of remediation structures.

Following completion of the additional site investigation, we will review this report and update if necessary.

6 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Build Rich Limited in relation to the 53 Small Road, Silverdale project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Build Rich Limited seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

For and on behalf of CMW Geosciences

Prepared by:	Reviewed and authorised by:
Henry Nagel	Sam Gibb
Project Engineering Geologist	Principal Geotechnical Engineer

Distribution: 1 electronic copy to Liang via email
Original held at CMW Geosciences

Attachments:
Shear Key and Underfill Drain Typical Details
Slope and Pond Buttress Typical Details
Remediation Plan
Supplied Earthworks Design Report
CMW Preliminary Geotechnical Investigation Report
Slope Stability Printouts
Groundwater Drawdown Calculations
Groundwater Impacts Assessment
Geotechnical Works Specification

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report 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 and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

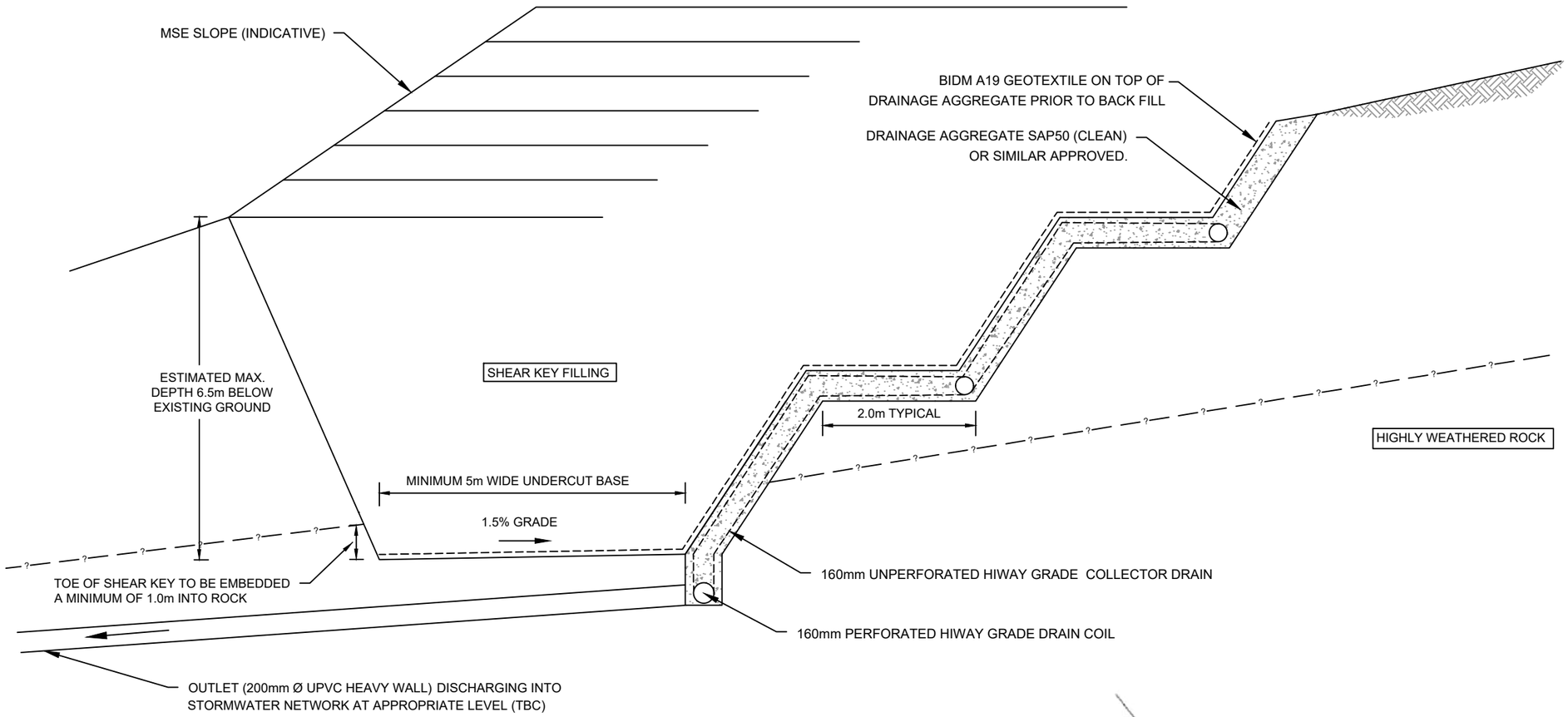
A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

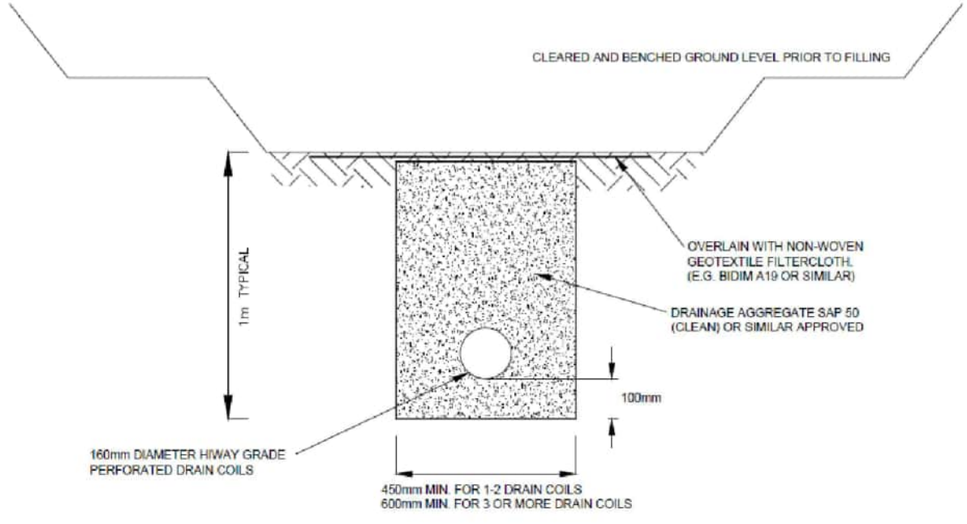
Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Appendix A: Drawings



TYPICAL DETAIL: #1 SHEAR KEY CROSS SECTION
NOT TO SCALE



TYPICAL DETAIL: #2 UNDERFILL DRAIN
NOT TO SCALE

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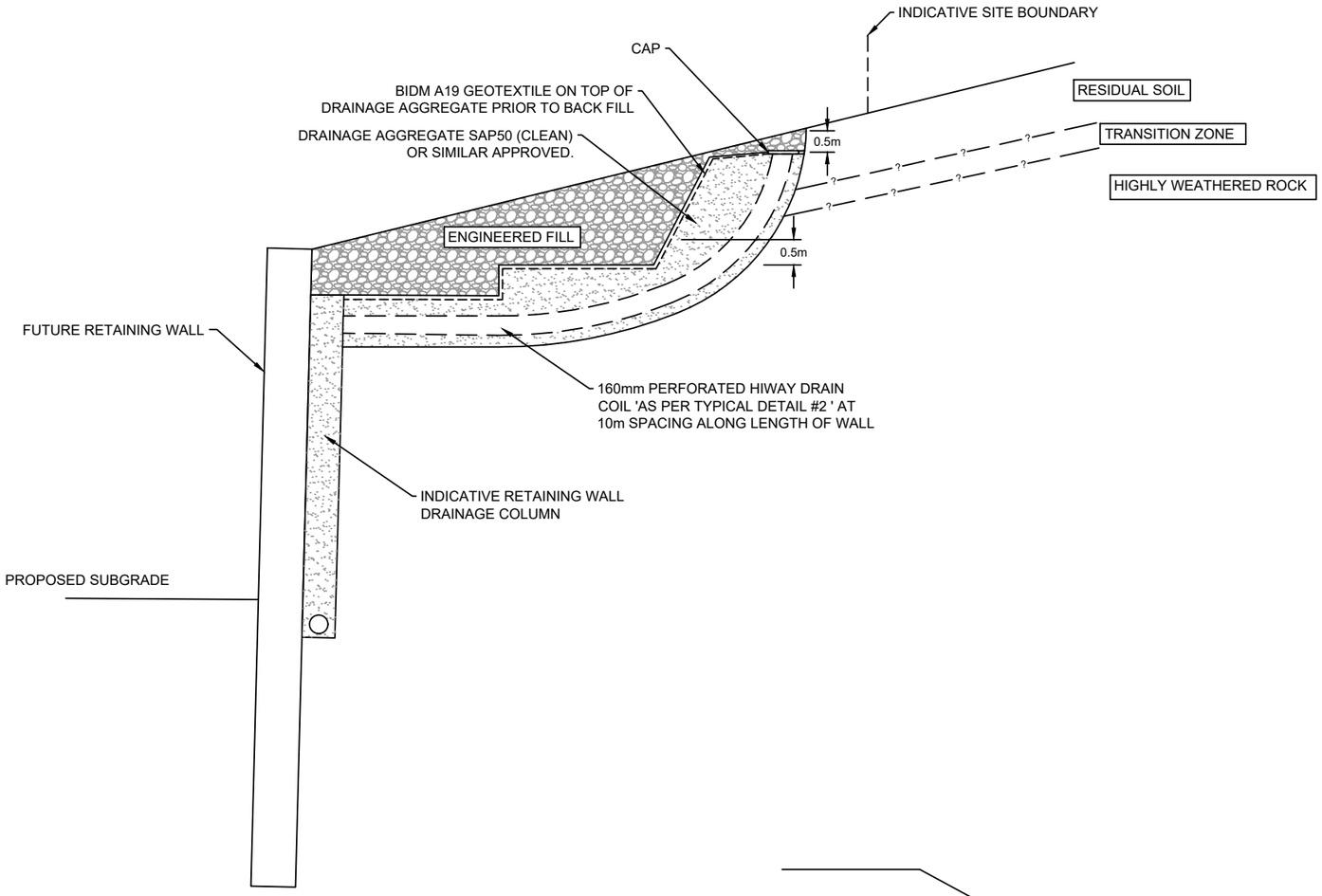
CLIENT: **BUILD RICH LTD**		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: **53 SMALL ROAD, SILVERDALE**		CHECKED: HN	DRAWING: 07
		REVISION: 0	SCALE: NTS
TITLE: **SHEAR KEY / UNDERFILL DRAIN DETAIL**		DATE: 18/09/2023	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL2022-128 SHEARKEY DETAIL.DWG



TYPICAL DETAIL: #3 SLOPE BUTTRESS
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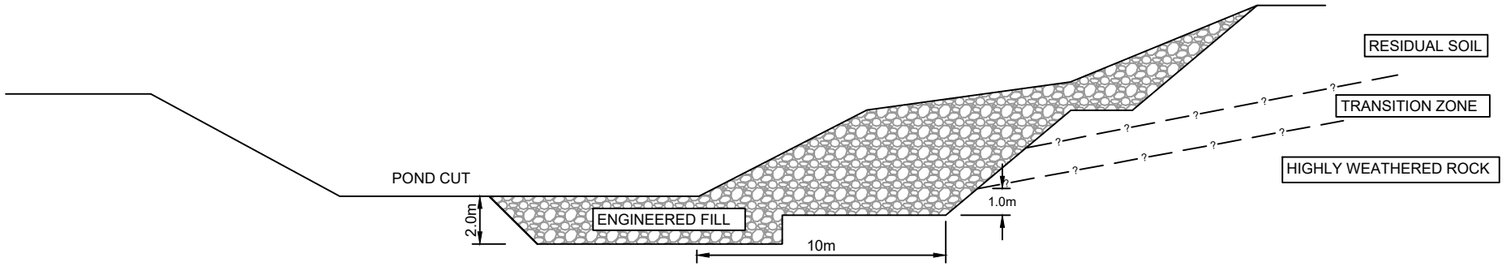
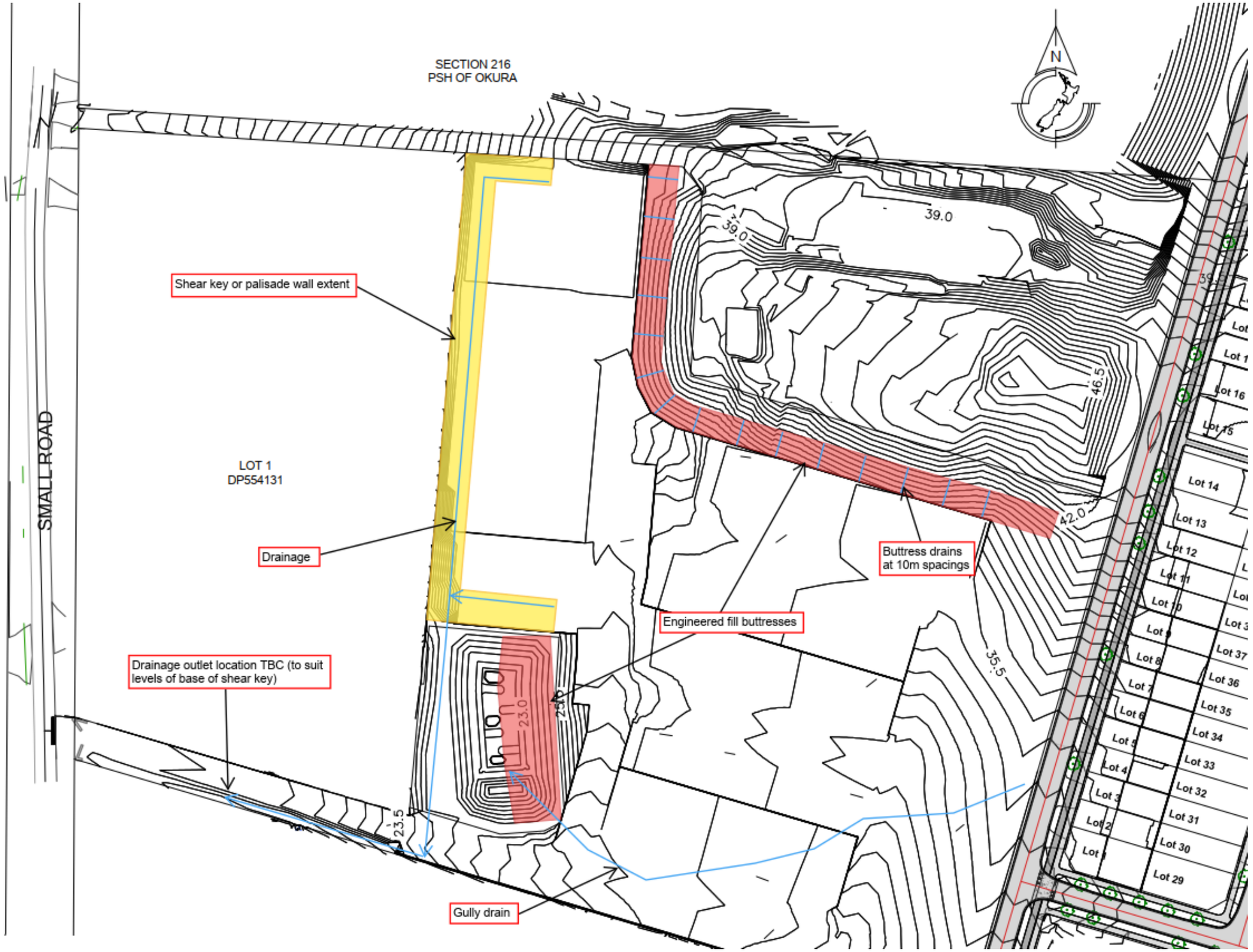


TYPICAL DETAIL: #4 POND BUTTRESS
NOT TO SCALE

CMW Geosciences — Great People | Practical Solutions	CLIENT: **BUILD RICH LTD**	DRAWN: JS	PROJECT: AKL2022-0128
	PROJECT: **53 SMALL ROAD, SILVERDALE**	CHECKED: HN	DRAWING: 08
		REVISION: 0	SCALE: NTS
	TITLE: **TYPICAL DETAILS OF SLOPE AND POND BUTTRESS**	DATE: 18/09/2023	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL2022-128 SHEARKEY DETAIL.DWG



CMW Geosciences

CLIENT: BUILD RICH LIMITED		DRAWN: HN	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: SG	DRAWING: 09
		REVISION: 0	SCALE: NTS
TITLE: REMEDIATION PLAN		DATE: 01/01/2021	SHEET: A3 L

Appendix B: Supplied Earthworks Design Report

EARTHWORKS DESIGN REPORT

53 SMALL ROAD, SILVERDALE

EAST COAST HEIGHTS LIMITED

AUGUST 2023

REPORT 1782 - 1

ASPIRE CONSULTING ENGINEERS
PO BOX 581, OREWA, 0946 | PH. 09 426 6552

Revision History

Revision Nº	Prepared By	Description	Date

Document Acceptance

Action	Name	Signed	Date
Prepared by	P Fairgray		15/08/2023
Reviewed by	P Fairgray		15/08/2023
Approved by	P Fairgray		15/08/2023

ASPIRE CONSULTING ENGINEERS LIMITED
Po Box 581, OREWA 0946
Ph: 09 426 6552

Limitations

This assessment contains the professional opinion of Aspire Consulting Engineers Ltd as to the matters set out herein, in light of the information available to it during the preparation, using its professional judgement and acting in accordance with the standard of care and skill normally exercised by professional engineers providing similar services in similar circumstances. No other express or implied warranty is made as to the professional advice contained in this report.

We have prepared this report in accordance with the brief as provided and our terms of engagement. The information contained in this report has been prepared by Aspire Consulting Engineers Ltd at the request of the client and is exclusively for its client use and reliance. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this assessment by any third party.

The assessment is also based on information that has been provided to Aspire Consulting Engineers Ltd from other sources or by other parties. The assessment has been prepared strictly on the basis that the information that has been provided is accurate, completed, and adequate. To the extent that any information is inaccurate, incomplete or inadequate, Aspire Consulting Engineers Ltd takes no responsibility and disclaims all liability whatsoever for any loss or damage that results from any conclusions based on information that has been provided to Aspire Consulting Engineers Ltd.

1.0 Introduction and Proposal:

The proposal is to undertake earthworks of approx. 3.425 Ha on a greenfield property which previously was farmland and storage.

The site, Lot 2 DP554131, is located on the eastern side of Small Road, Silverdale, with an area of 3.541 ha.

It is proposed to undertake earthworks to create future road subgrades and building platforms.

Fig. 2
Proposed cut to fill depth plan

2.0 Earthworks:

Earthworks will be undertaken to create future road subgrades and building platforms. The earthworks volumes are 33,200 m³ cut and 30,350 m³ fill. The total earthworks area is approximately 3.4 ha. There is a calculated excess which will be lost in the compaction of the material.

Erosion and sediment controls are to be installed prior to the commencement of any earthworks on the site and maintained for the full duration of the works. Erosion and sediment control plans have been prepared refer Appendix A for details. Typical silt control measures will be utilised including sediment retention ponds/decanting earthbunds, silt fences, topsoil bunding, clean water diversion bunds in accordance with Auckland Council GD05. Final design details will be approved by Auckland Council at the engineering design stage. A pre-construction meeting will be held prior to commencement of works.

The entry or exit points of any overland flowpaths will not be changed due to the earthworks. Any steep slopes will be temporarily battered at safe slopes until future development is undertaken.

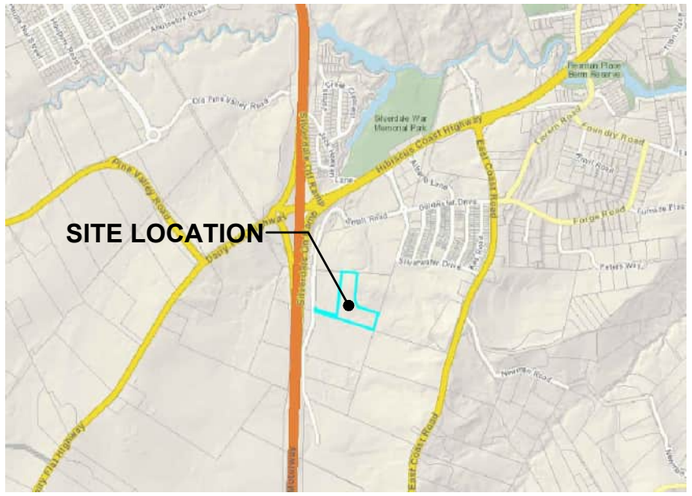
Any dust nuisance will be suppressed by water cart or works temporarily ceasing.

ATTACHMENTS:

APPENDIX A: RESOURCE CONSENT DESIGN DRAWINGS
APPENDIX B: SEDIMENT RETENTION POND CALCS

APPENDIX A: RESOURCE CONSENT DESIGN DRAWINGS

EAST COAST HEIGHTS LIMITED
PROPOSED BULK EARTHWORKS
AT 53 SMALL ROAD
SILVERDALE



SITE LOCALITY PLAN

COVER SHEET PG101

JOB NUMBER: 1782

EARTHWORKS RESOURCE CONSENT DESIGN DRAWINGS:

PRELIMINARY & GENERAL

PG101	COVER SHEET
PG102	CONTENTS PAGE
PG103	EXISTING SITE PLAN

EARTHWORKS

EW201	PROPOSED CONTOUR PLAN
EW202	PROPOSED CUT & FILL DEPTH CONTOUR PLAN
EW203	EROSION & SEDIMENT CONTROL PLAN
EW204-208	EROSION & SEDIMENT CONTROL DETAILS

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE NTS AT A3	NAME	DATE
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					DRAWN	MJ	08.23
					DRAWING CHECK	PF	08.23
					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

CLIENT

EAST COAST HEIGHTS LIMITED

Conditions of Use:
These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.

SITE ADDRESS

PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE

CONTENTS PAGE

DRAWING NUMBER

1782 - RCEW - PG102

DATE

AUG 2023

REVISION

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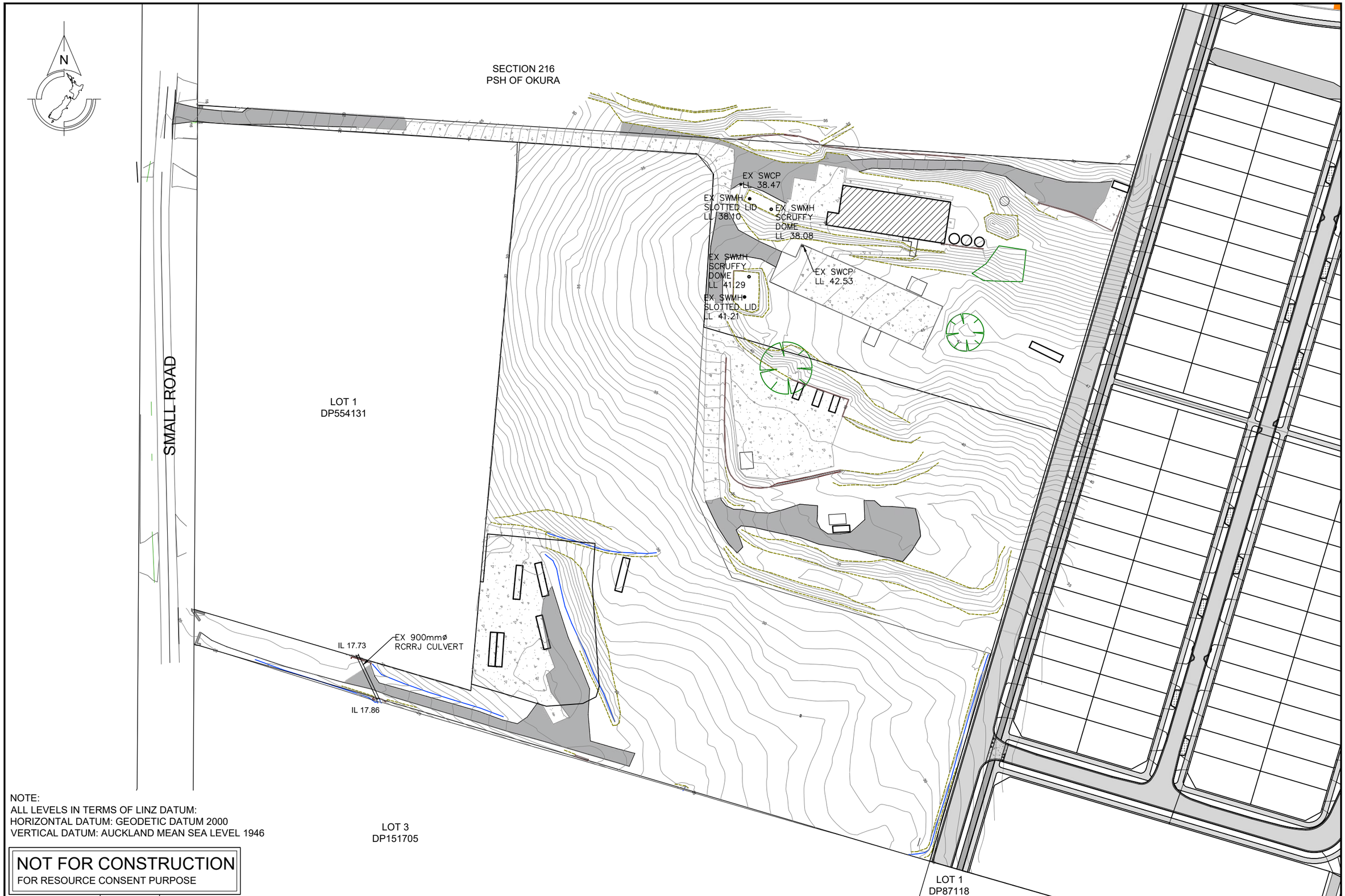
ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspeng.co.nz



NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1250 AT A3	NAME	DATE
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					DRAWN	MJ	08.23
					DRAWING CHECK	PF	08.23
					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EXISTING CONTOUR PLAN

DRAWING NUMBER
1782 - RCEW - PG103

DATE
AUG 2023

REVISION
-

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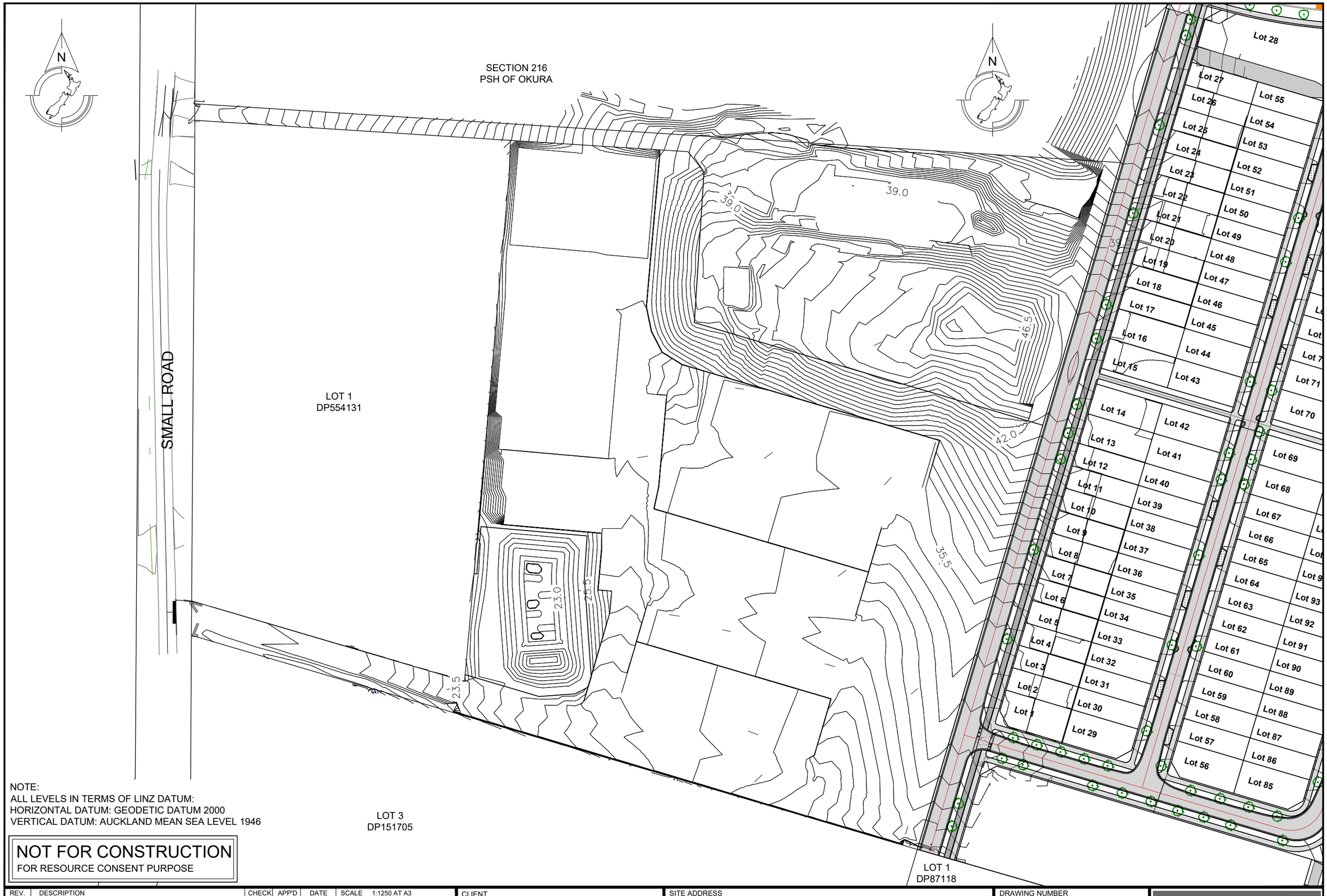

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1250 AT A3	NAME	DATE
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					DRAWN	MJ	08.23
					DRAWING CHECK	PF	08.23
					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED INDUSTRIAL/RESIDENTIAL SUBDIVISION
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
PROPOSED CONTOUR PLAN

DRAWING NUMBER
1782 - RCEW - EW201

DATE
AUG 2023

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-

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SECTION 216
PSH OF OKURA

SMALL ROAD

VOLUMES

FILL VOLUME:
30,350m³

CUT VOLUME:
33,200m³

LOT 1
DP554131

LOT 3
DP151705

LOT 1
DP87118

1.5
-1.5
-3.0
-2.5
-4.0
-0.5
-5.0
-1.0
1.0
2.0
3.0
-2.0

N

Lot 28
Lot 27
Lot 55
Lot 26
Lot 54
Lot 25
Lot 53
Lot 24
Lot 52
Lot 23
Lot 51
Lot 22
Lot 50
Lot 21
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Lot 85
Lot 86
Lot 87
Lot 88
Lot 89
Lot 90
Lot 91
Lot 92
Lot 93

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

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REV.	DESCRIPTION	CHECK	APP'D	DATE

SCALE 1:1250 AT A3

	NAME	DATE
DESIGN	MJ	08.23
DRAWN	MJ	08.23
DRAWING CHECK	PF	08.23
DESIGN CHECK	PF	08.23
APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
PROPOSED CUT TO FILL CONTOUR PLAN

DRAWING NUMBER
1782 - RCEW - EW202

DATE
AUG 2023

REVISION
-

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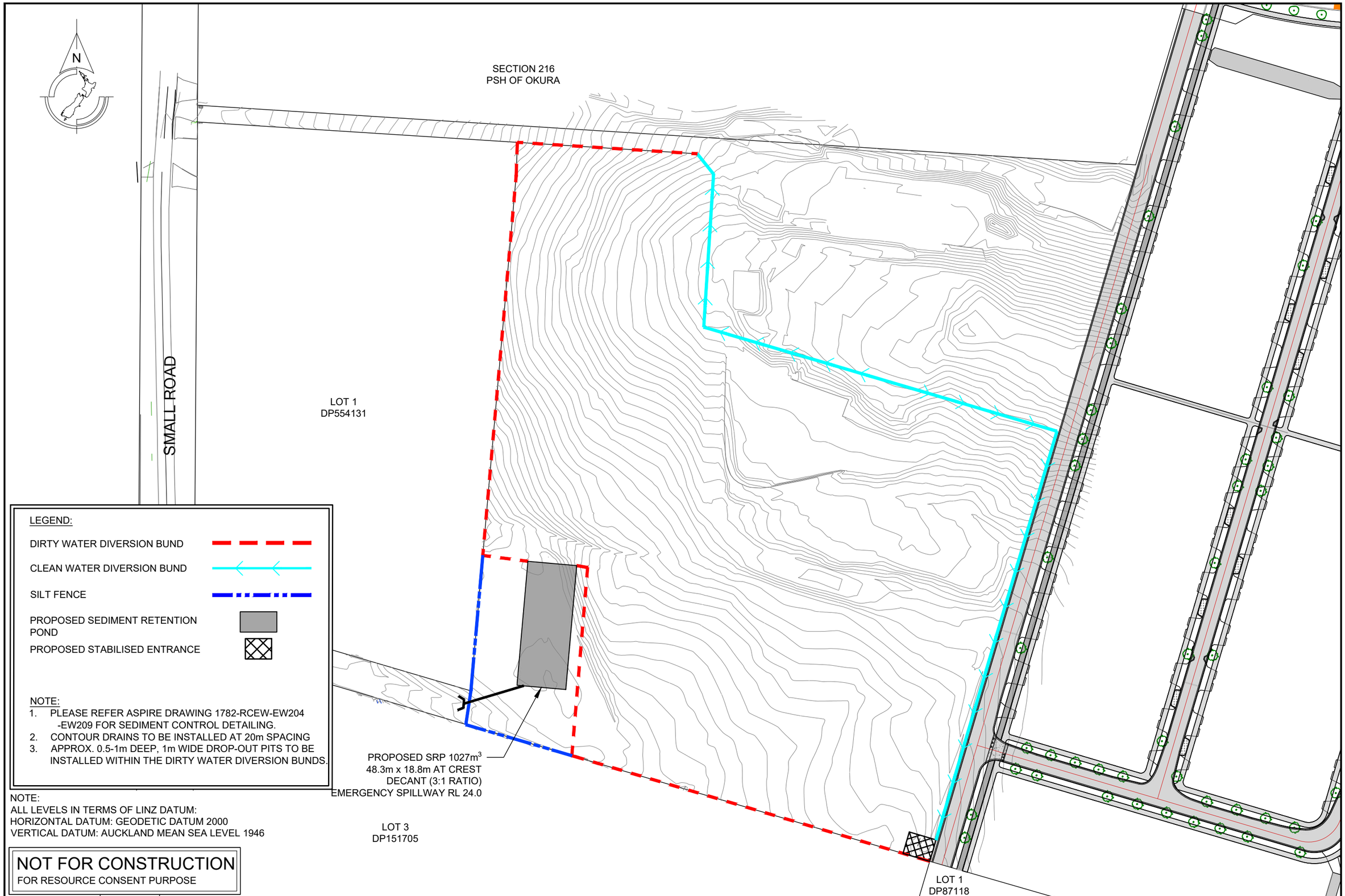

LEGEND:

- DIRTY WATER DIVERSION BUND
- CLEAN WATER DIVERSION BUND
- SILT FENCE
- PROPOSED SEDIMENT RETENTION POND
- PROPOSED STABILISED ENTRANCE

NOTE:

1. PLEASE REFER ASPIRE DRAWING 1782-RCEW-EW204 -EW209 FOR SEDIMENT CONTROL DETAILING.
2. CONTOUR DRAINS TO BE INSTALLED AT 20m SPACING
3. APPROX. 0.5-1m DEEP, 1m WIDE DROP-OUT PITS TO BE INSTALLED WITHIN THE DIRTY WATER DIVERSION BUNDS.

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1250 AT A3	NAME	DATE
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					DRAWING CHECK	MJ	08.23
					DESIGN CHECK	MJ	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
PROPOSED EROSION AND SEDIMENT CONTROL PLAN

DRAWING NUMBER
1782 - RCEW - EW203

DATE
AUG 2023

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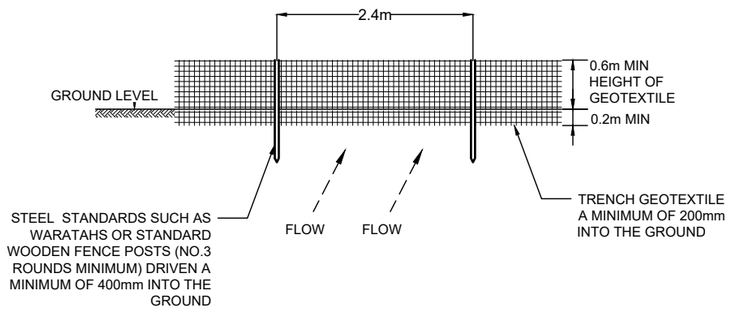
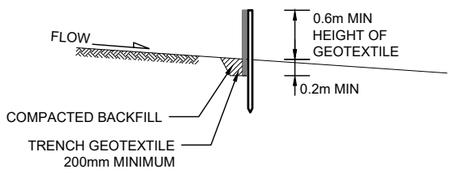
Slope steepness %	Slope length (m) (maximum)	Spacing of returns (m)	Silt fence length (m) (maximum)
Flatter than 2%	Unlimited	N/A	Unlimited
2 – 10%	40	60	300
10 – 20%	30	50	230
20 – 33%	20	40	150
33 – 50%	15	30	75
> 50%	6	20	40

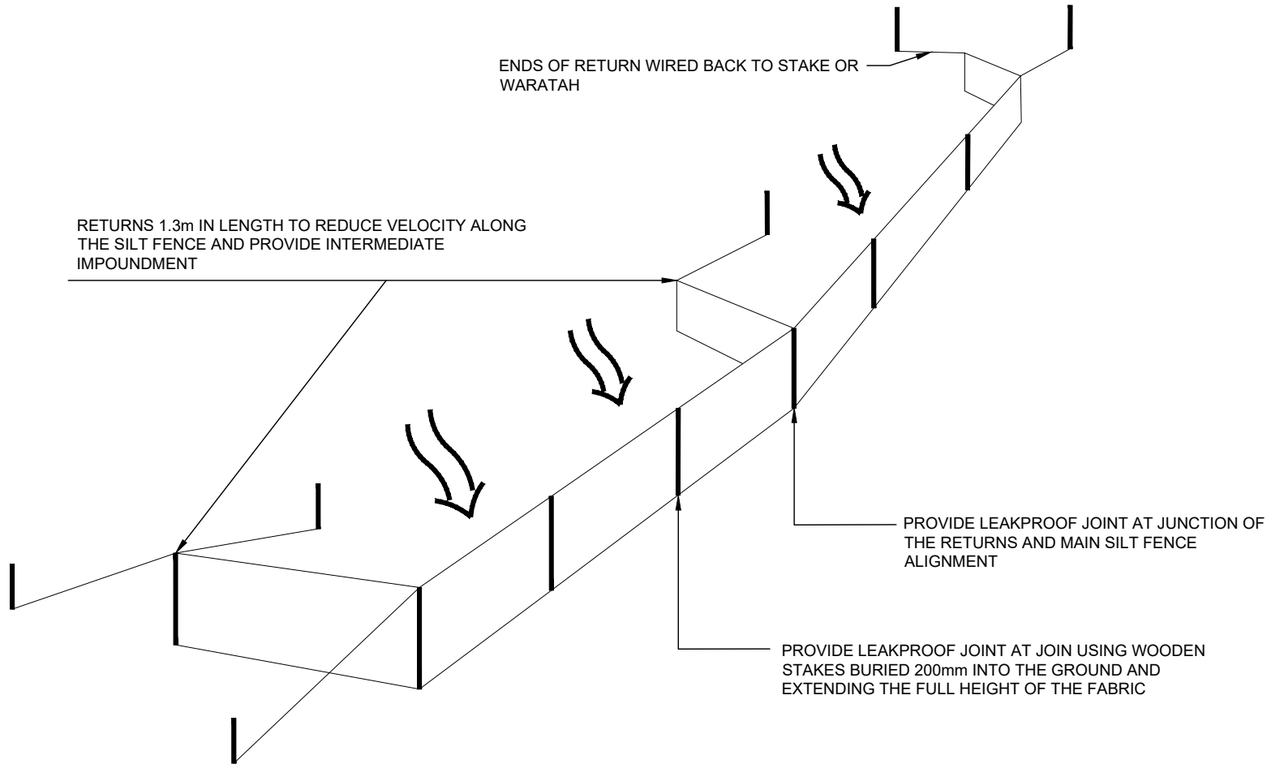
SILT FENCE DESIGN CRITERIA TABLE



SILT FENCE ELEVATION



SILT FENCE CROSS-SECTION



SILT FENCE WITH RETURNS AND SUPPORT WIRE

REFER TO AUCKLAND COUNCIL
GD-05 FOR FURTHER DETAILS

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:75 AT A3	NAME	DATE
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					DRAWN	MB	08.23
					DRAWING CHECK	MJ	08.23
					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS-1

DRAWING NUMBER
1782 - RCEW - EW204

DATE
AUG 2023

REVISION
-

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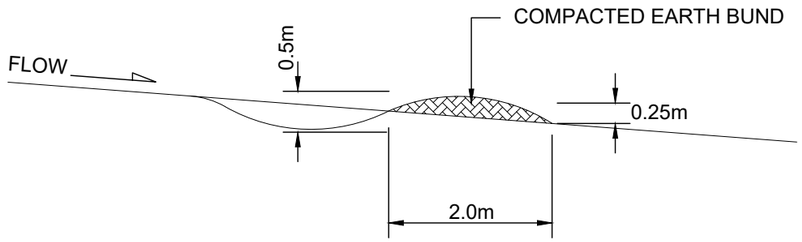
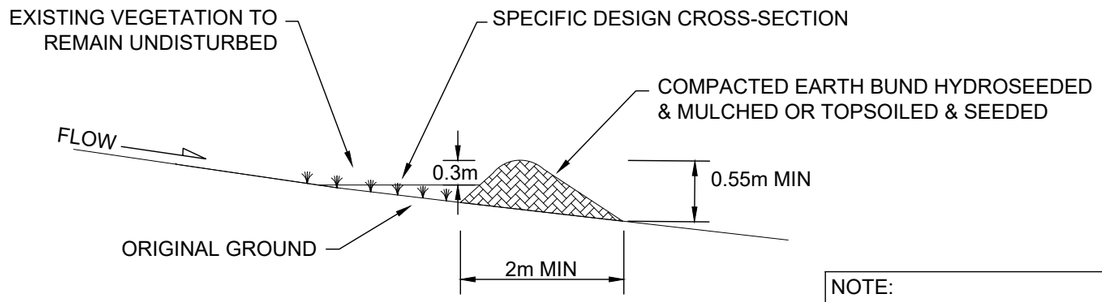
CONTOUR DRAIN SPACING	
SLOPE OF SITE (%)	SPACING (m) OF CONTOUR DRAINS
LESS THAN 5%	50
5 - 10%	40
10 - 15%	30
15 - 30%	20



CONTOUR DRAIN CROSS-SECTION

	CATCHMENT (ha)	5	10	15	20	30
		DESIGN FLOW DEPTH (m)				
CHANNEL SLOPE %	1-2	0.45	0.60	0.70	0.75	0.90
	2-5	0.40	0.55	0.60	0.70	0.80
	5-10	0.35	0.45	0.50	0.60	0.65
	10-20	0.30	0.40	0.45	0.50	0.60
	20-40	0.30	0.35	0.40	0.45	0.50



CLEAN WATER DIVERSION CROSS-SECTION

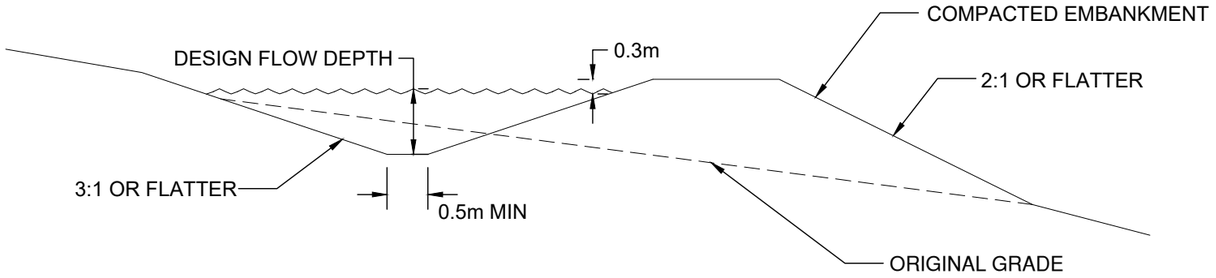
NOTE:

- THE DIVERSION CHANNELS SHOULD BE PARABOLIC OR TRAPEZOIDAL IN SHAPE
- ENSURE INTERNAL SIDES OF THE BUND ARE NO STEEPER THAN 3:1, AND EXTERNAL SIDES NO STEEPER THAN 2:1, AS OUTLINED BELOW

DIRTY WATER DIVERSION
FOR CONSTRUCTION AND OPERATION OF DIRTY WATER DIVERSION CHANNELS AND BUNDS:

- PLAN AND CONSTRUCT ALL DIRTY WATER DIVERSION WORKS AS PART OF THE INITIAL SITE ESTABLISHMENT/ DEVELOPMENT ACTIVITIES
- DEFINE THE ROUTE AND SURVEY IT TO ACHIEVE THE CORRECT GRADIENT
- CONSTRUCT DRAINS WITH A UNIFORM GRADE ALONG THE INVERT, AS SUDDEN DECREASES MAY CAUSE SEDIMENT TO ACCUMULATE CAUSING THE BANK TO OVERTOP
- ENSURE THE BUNDS ASSOCIATED WITH THE DIVERSIONS ARE WELL COMPACTED AND STABILISED. IN SOME INSTANCES, THIS MAY REQUIRE SPECIFIC GEOTECHNICAL DESIGN TO ENSURE THE STABILITY AND INTEGRITY OF THE STRUCTURE
- MONITOR DIVERSIONS FOR EROSION. SUBJECT TO THE SOILS ON SITE IT IS LIKELY THAT EROSION CONTROL WILL BE NEEDED WHERE THE GRADIENTS ARE GREATER THAN 2% OR WHERE THE DESIGN VELOCITIES EXCEED 1m/SEC
- ENSURE THE FINISHED CROSS-SECTION MEETS ALL DESIGN REQUIREMENTS
- PROVIDE AN ADEQUATE OUTLET FOR EACH DIVERSION (i.e DIRTY WATER TO A SEDIMENT CONTROL DEVICE).

REFER TO AUCKLAND COUNCIL
GD-05 FOR FURTHER DETAILS



DIRTY WATER DIVERSION CROSS-SECTION

	CATCHMENT (ha)	1	2	3	4	5
		DESIGN FLOW DEPTH (m)				
CHANNEL SLOPE %	1-2	0.20	0.25	0.30	0.35	0.35
	2-5	0.15	0.20	0.25	0.30	0.30
	5-10	0.15	0.15	0.20	0.25	0.25
	10-20	0.10	0.15	0.15	0.20	0.20
	20-40	0.10	0.15	0.15	0.20	0.20

NOTE: BASED ON 0.5m WIDE BASE WITH 1:3 SIDE SLOPES

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:75 AT A3	NAME	DATE
					DESIGN	MB	08.23
					DRAWN	MB	08.23
					DRAWING CHECK	MJ	08.23
					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS-2

DRAWING NUMBER
1782 - RCEW - EW205

DATE
AUG 2023

REVISION
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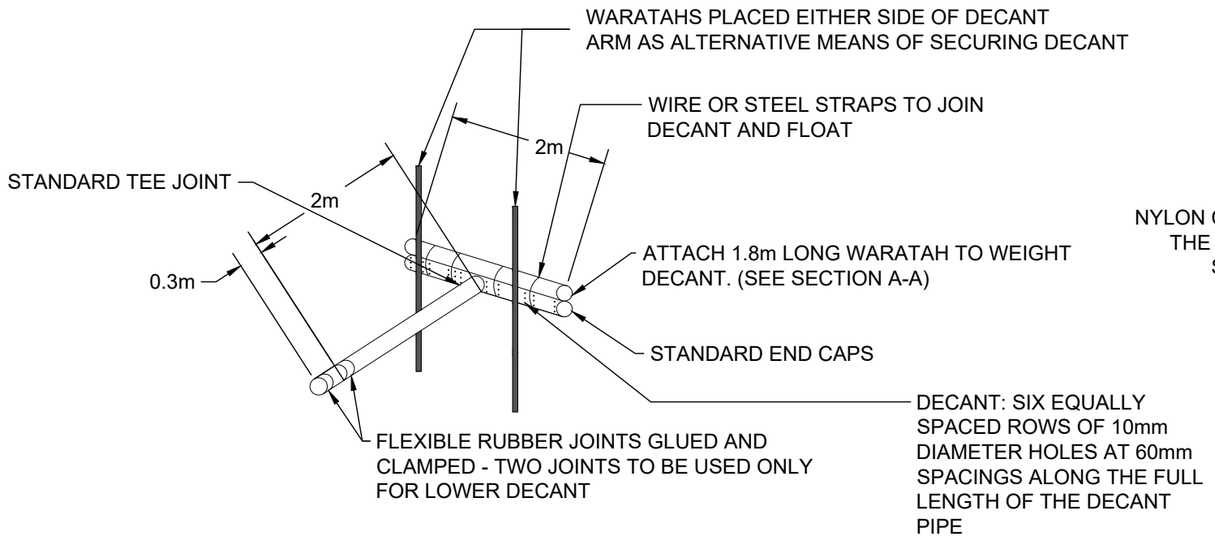
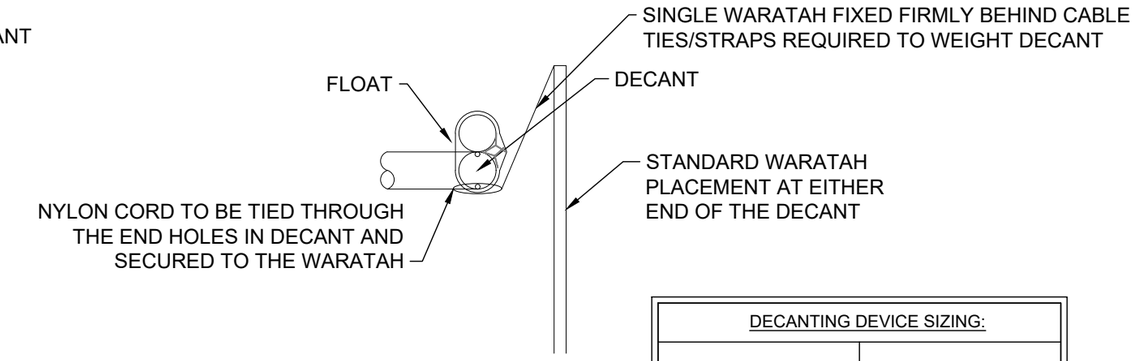
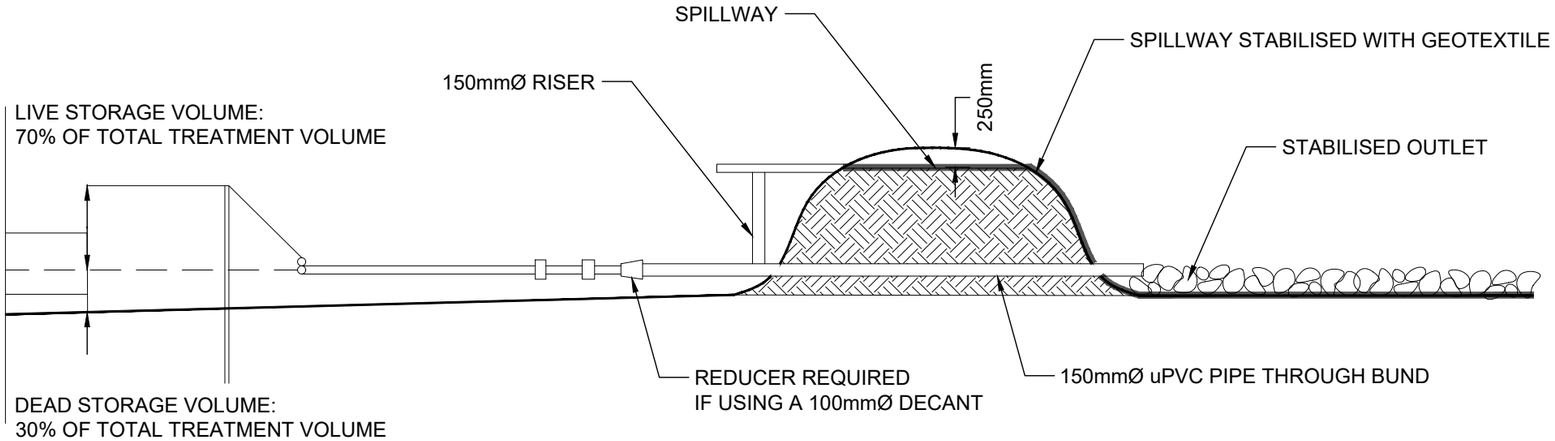


STANDARD T-BAR DESIGN SCHEMATIC



SECTION A-A

DECANTING DEVICE SIZING:	
CONTRIBUTING AREA	STORAGE VOLUME 2%
200m²	4m³
400m²	8m³
600m²	12m³
800m²	16m³
1000m²	20m³
1200m²	24m³
1400m²	28m³
1600m²	32m³
1800m²	36m³
2000m²	40m³
2200m²	44m³
2400m²	48m³
2600m²	52m³
2800m²	56m³
3000m²	60m³



DECANTING EARTH BUND CROSS-SECTION

DEB SIZING:

- DEB SIZING IS BASED ON CONTRIBUTING CATCHMENT AREA
- DECANTING EARTH BUND TO HAVE A MINIMUM VOLUME OF 2% OF THE CONTRIBUTING CATCHMENT AREA (20m³ FOR EACH 1,000m²)
- THE SLOPE ANGLE IS DETERMINED BY THE SLOPE IMMEDIATELY ABOVE THE DEB, OR BY THE AVERAGE SLOPE OVER THE CONTRIBUTING CATCHMENT, WHICHEVER IS GREATER. THE SLOPE ANGLE SHOULD ALSO BE THE GREATER OF THE PRE- OR POST-CONSTRUCTION SLOPE.
- THE ABOVE CALCULATION DEFINES THE TOTAL STORAGE VOLUME WHICH IS MEASURED FROM THE BASE OF THE DEB TO THE TOP OF THE PRIMARY SPILLWAY.
- BASE OF THE DEB TO BE MINIMUM OF 2m WIDE
- LENGTH-TO-WIDTH RATIO TO BE NO LESS THAN 3:1 AND NO GREATER THAN 5:1. LENGTH TO WIDTH RATIO IS MEASURED AT THE HEIGHT OF THE PRIMARY SPILLWAY.
- THE LENGTH OF THE DEB IS MEASURED AS THE DISTANCE BETWEEN THE INLET AND THE OUTLET. THE LENGTH BETWEEN THE INLET AND THE OUTLET SHOULD BE A MINIMUM OF 5m.

REFER TO AUCKLAND COUNCIL
GD-05 FOR FURTHER DETAILS

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:75 AT A3	NAME	DATE
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					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS-3

DRAWING NUMBER
1782 - RCEW - EW206

DATE
AUG 2023

REVISION
-

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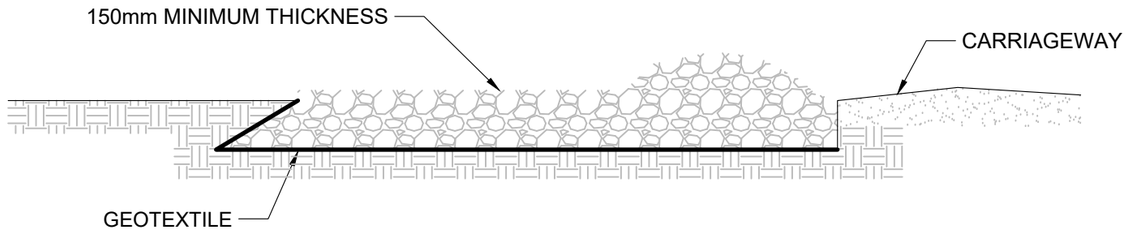
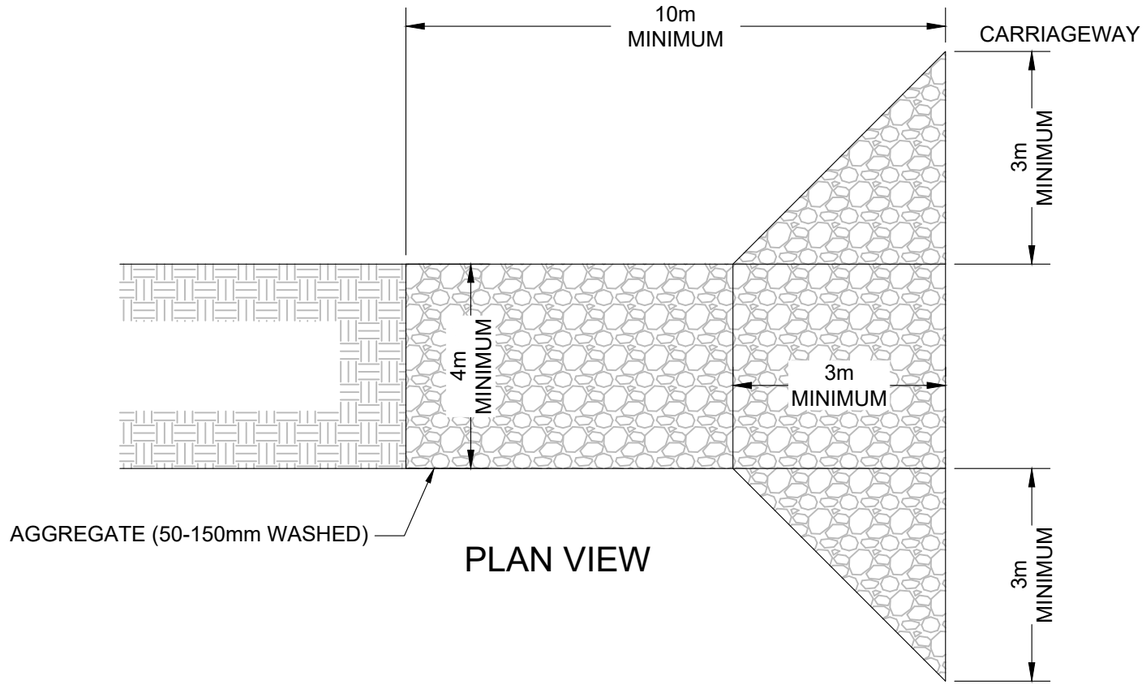


SIDE ELEVATION



PLAN VIEW

REFER TO AUCKLAND COUNCIL
GD-05 FOR FURTHER DETAILS

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE NTS		
						NAME	DATE
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					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS-4

DRAWING NUMBER
1782 - RCEW - EW207

DATE
AUG 2023

REVISION
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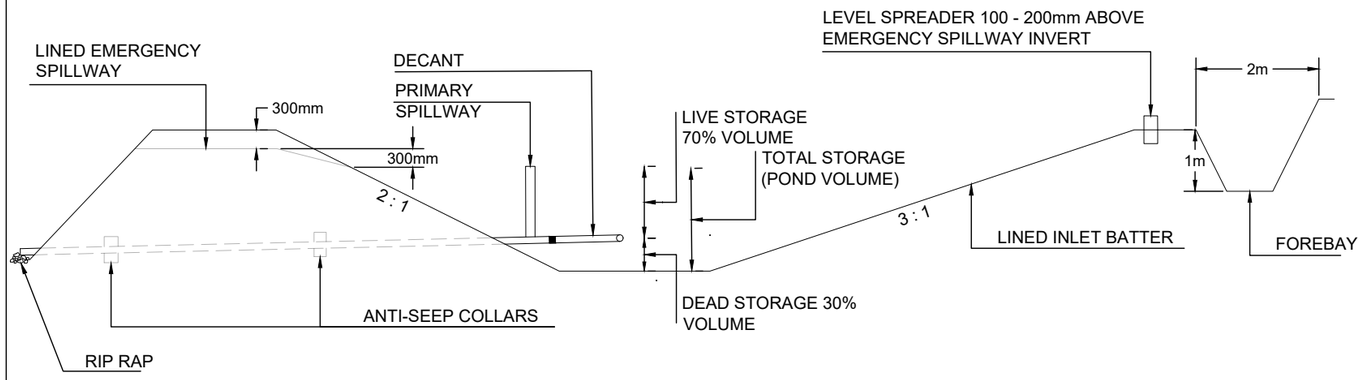
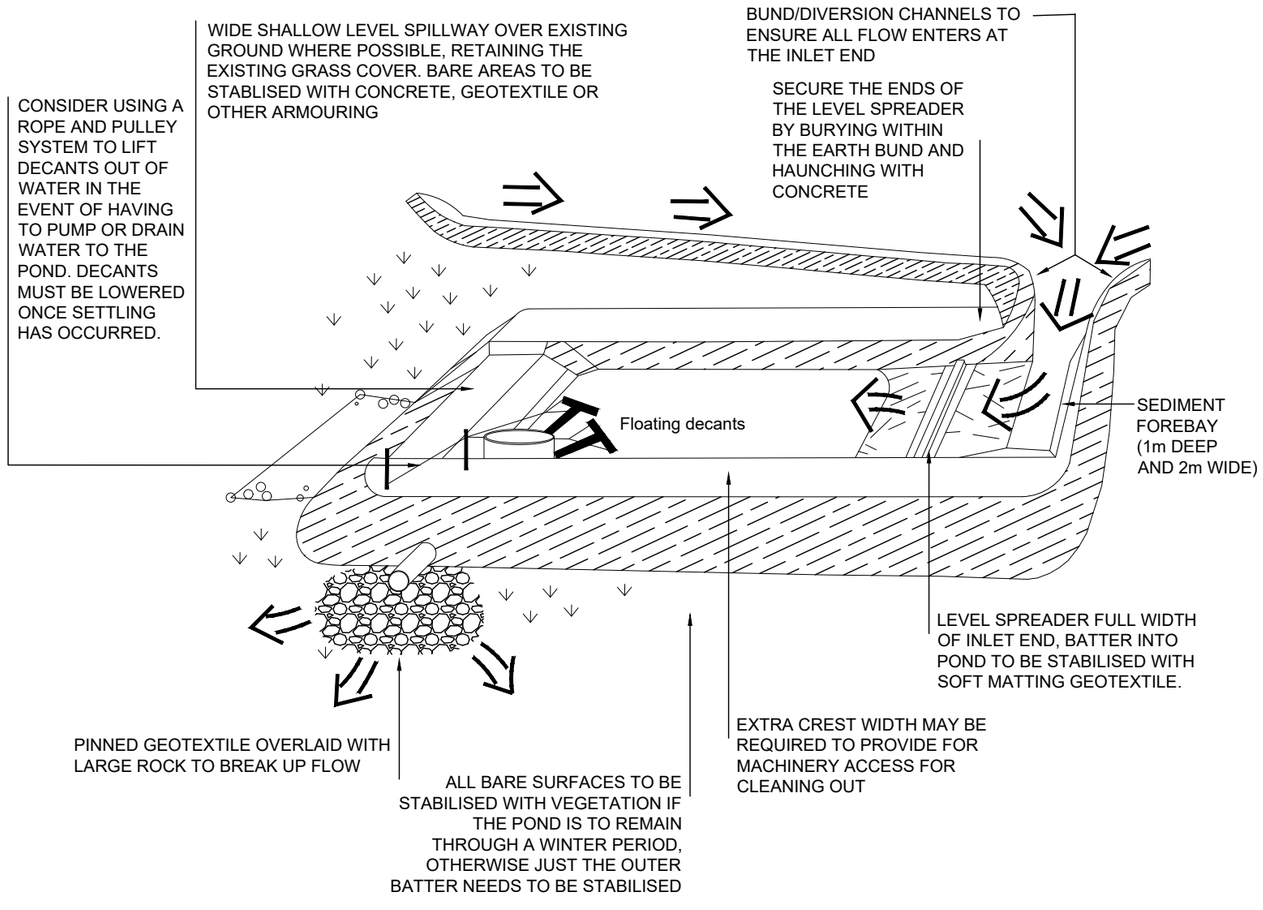


SEDIMENT RETENTION POND CROSS SECTION



SRP SIZING:

- SIZE SRPs BASED ON THE CONTRIBUTING CATCHMENT AREA AND SLOPE LENGTH.
- ON EARTHWORKS SITES WITH SLOPES LESS THAN 18% AND LESS THAN 200m IN LENGTH, DESIGN SRPs WITH A MINIMUM VOLUME OF 2% OF THE CONTRIBUTING CATCHMENT AREA (200m³ FOR EACH Ha OF CONTRIBUTING CATCHMENT).
- ON EARTHWORKS SITES WITH SLOPES GREATER THAN 18% OR GREATER THAN 200m IN LENGTH, DESIGN SRPs WITH A MINUMIM VOLUME OF 3% OF THE CONTRIBUTING CATCHMENT AREA (300m³ FOR EACH Ha OF CONTRIBUTING CATCHMENT).
- THE ABOVE CALCULATION DEFINES THE TOTAL STORAGE VOLUME, WHICH IS MEASURED FROM THE BASE OF THE POND TO THE TOP OF THE PRIMARY SPILLWAY.
- THE SLOPE ANGLE IS DETERMINED BY THE SLOPE IMMEDIATELY (WITHIN 20m) ABOVE THE SRP, OR BY THE AVERAGE SLOPE OVER THE CONTRIBUTING CATCHMENT, WHICHEVER IS GREATER. THE SLOPE ANGLE SHOULD ALSO BE THE GREATER OF THE PRE- OR POST- CONSTRUCTION SLOPE.

REFER TO AUCKLAND COUNCIL GD-05 FOR FURTHER DETAILS

SEDIMENT RETENTION POND SCHEMATIC

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE NTS	NAME	DATE
					DESIGN	MB	08.23
					DRAWN	MB	08.23
					DRAWING CHECK	MJ	08.23
					DESIGN CHECK	PF	08.23
					APPROVED	PF	08.23

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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS-5

DRAWING NUMBER
1782 - RCEW - EW208

DATE
AUG 2023

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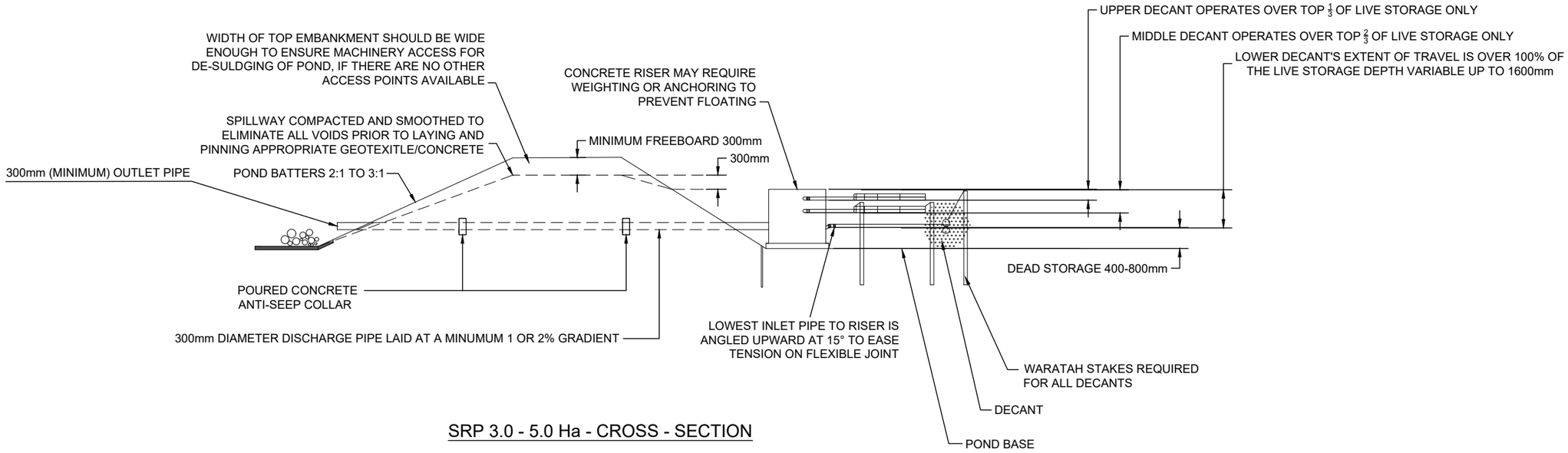
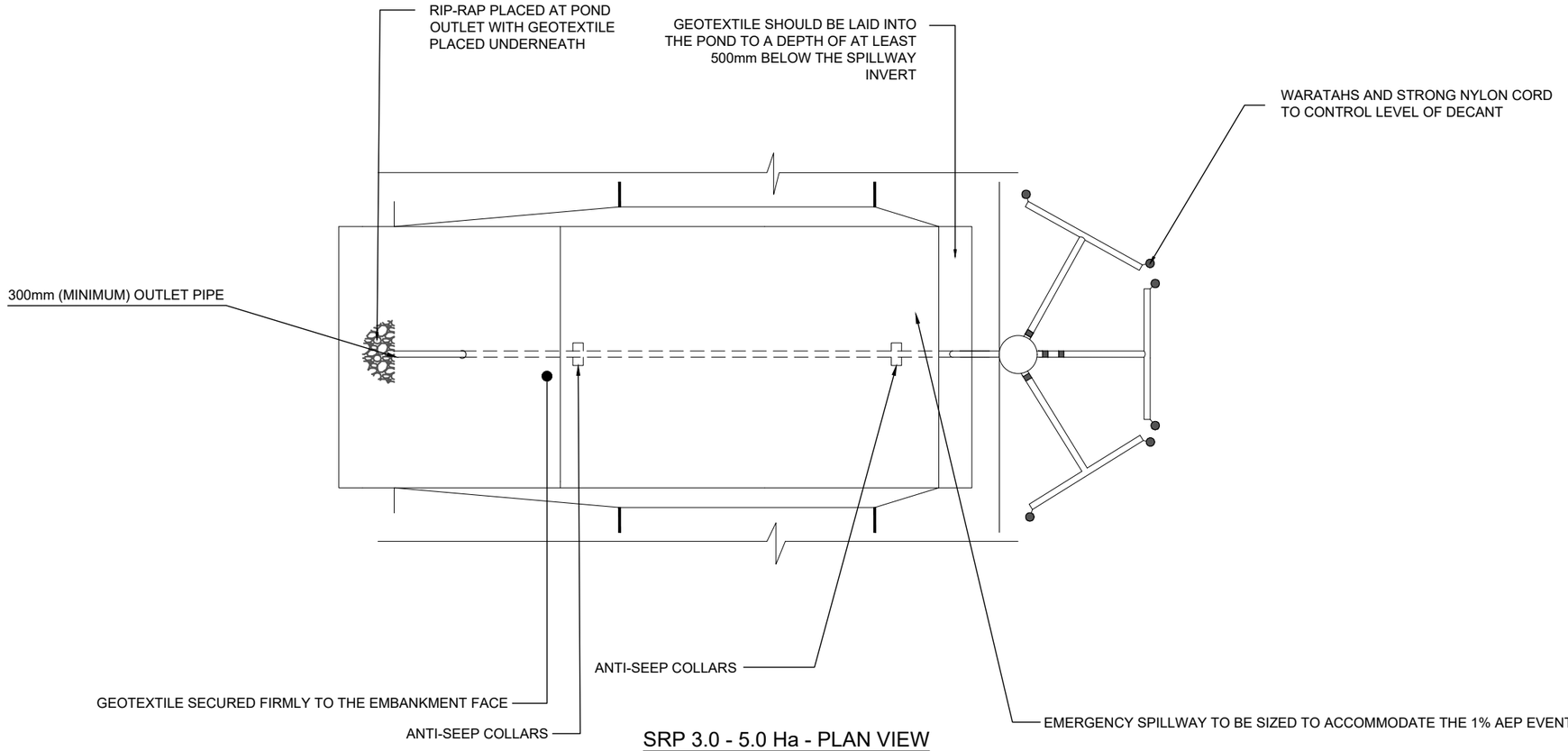


SRP 3.0 - 5.0 Ha - CROSS - SECTION



SRP 3.0 - 5.0 Ha - PLAN VIEW

REFER TO AUCKLAND COUNCIL GD-05 FOR FURTHER DETAILS

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:75 AT A3	NAME	DATE
					DESIGN	MB	08.23
					DRAWN	MB	08.23
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SITE ADDRESS
PROPOSED EARTHWORKS
AT 53 SMALL ROAD, SILVERDALE

DRAWING TITLE
EROSION & SEDIMENT CONTROL DETAILS-6

DRAWING NUMBER
1782 - RCEW - EW209

DATE
AUG 2023

REVISION
-

ASPIRE CONSULTING ENGINEERS
Ph: 09 426 6552
Web: www.aspeng.co.nz

APPENDIX B: SEDIMENT RETENTION POND CALCS

Project Name	53 Small Road Silverdale	
Catchment Information		
Location	Orewa	
Total Area (ha)	3.43	
Length of Catchment (m)	170	
Average Slope (%)	12	
Ground Cover	ha	% total
Bare Soil (SRP Catchment)	3.425	100.00
Vegetated	0	0.00
Impervious	0	0.00

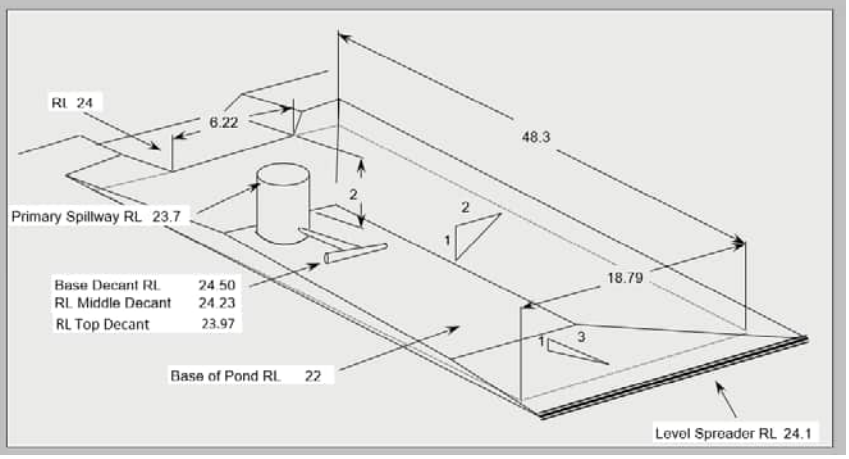
Note Sum of areas must equal total Area

Sediment Retention Pond 53 Small Road

Size criteria	Length Ratio	Side slopes	Depth from Emergency Spillway	R.L. of Emergency Spillway
Auto	3:1	2:1	2	24

3.425

Storage Volume Criteria		3%
Contributing Catchment (ha)	3.425	3.43
Minimum Storage Volume (m3)		1027.5
Length at Spillway Level	170	48.33
Width at Spillway Level		18.79
Spillway base width (300mm deep)		6.22
Primary Spillway diameter (min)		Manhole Required
Number of decants		3
Number of holes per decant	3.425	152
Minimum outlet diameter		300mm
RL Base of Pond		22
RL Primary Spillway		23.7
RL Level Spreader (min)		24.15
RL Base Decant		24.50
RL Middle Decant		24.23
RL Top Decant		23.97



ASPIRE CONSULTING ENGINEERS LIMITED
Po Box 581, OREWA 0946
Ph: 09 426 6552

Appendix C: CMW Preliminary Geotechnical Investigation Report

7 October 2022

SMALL ROAD DEVELOPMENT

53 SMALL ROAD, SILVERDALE

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

Build Rich Limited

AKL2022-0128AB Rev. 0

AKL2022-0128AB		
Date	**Revision**	**Comments**
7 October 2022	A	Initial draft for internal review
11 October 2022	0	Final issue

	Name	**Signature**	**Position**
Prepared by	Henry Nagel		Project Engineering Geologist
Reviewed by	Sam Gibb		Principal Geotechnical Engineer CMEngNZ, CPEng
Authorised by	Richard Knowles		Principal Geotechnical Engineer CMEngNZ, CPEng

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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Build Rich Limited to carry out a geotechnical investigation of a site located at 53 Small Road, Silverdale, which is being considered for the construction of a residential subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2022-0128AA Rev. 0, dated 12 July 2022.

This report is to support preliminary design of the subdivision.

1.2 Scope of Work

As detailed in our proposal letter, the agreed scope of work to be conducted by CMW was defined as follows:

- Desktop study of available information relevant to the proposed development.
- Geotechnical site investigation, comprising the drilling of hand auger boreholes and excavation of test pits.
- Evaluate and develop an appropriate geological and geotechnical model.
- Identify any geohazards to the proposed development, including instability, groundwater issues, and provide strategies to mitigate.
- Compile all of the above detail into a concise geotechnical investigation report, incorporating relevant plans, field investigation data, laboratory test data and calculations.

2 SITE DESCRIPTION

2.1 Site Location

The site, legally described as Lot 2 DP 554131 comprises an area of approximately 25,419m^2 and is located at 53 Small Road, Silverdale, as shown on Figure 1 below. The proposed development area also includes a 1,000m^2 portion of 39 Small Road, legally described as Lot 3 DP 554131.

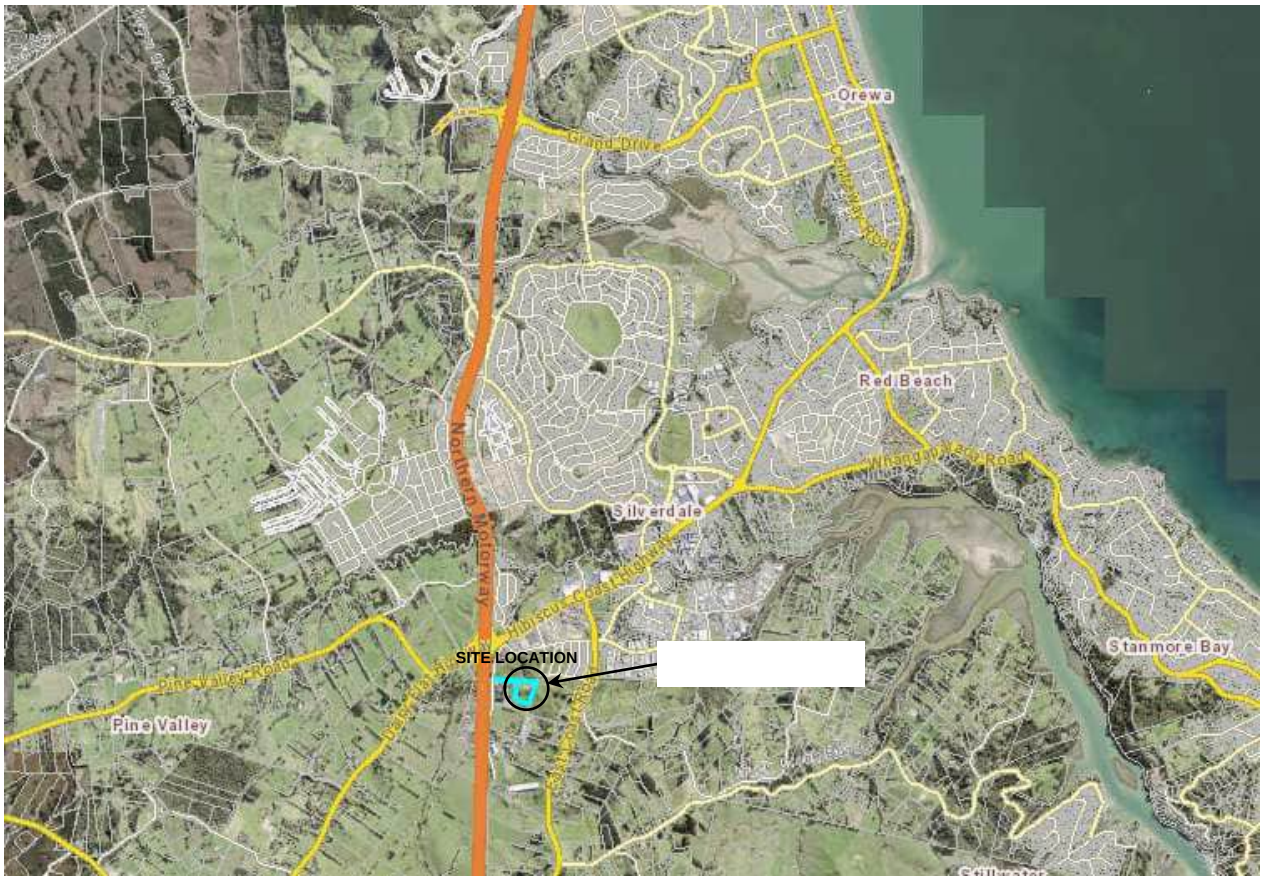


Figure 1: Site Location Plan (Reference Auckland Council GeoMaps[1])

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on the attached Site Plan as ***Drawing 01.***

Overall, the slope across the site slopes moderately towards the south-west. The southern portion of the site is generally the lowest lying area of the site and the gradient becomes gentler towards this area (1V:12H). The northern boundary the site follows the southern face of a ridgeline that trends east to west, where gradients are steepest (1V:5H). Elevations drop from approximately 40m RL to 20m RL from north to south.

A small gully feature/overland flow path is located at the south-east end of the site, which is fed from a larger gully feature beyond the eastern boundary of the site. Wetland marsh is present in this area.

Contours across the southern half of the site and within the portion of 39 Small Road, as well as historic aerial photographs, suggest that historic fills have been placed within this portion of the site, including a hardstand along the eastern boundary and farm pond backfills.

[1] Auckland Council GeoMaps <https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html>

The site is bound to the north by the Botanic Retirement Village, and to the south and east by rural properties. 43 Small Road is located west of the site, which has a series of man-made cut batter slopes down to a building and hardstand area. A recently developed church is located on the northern half of 39 Small Road.

The site is currently covered with grass.

3 PROPOSED DEVELOPMENT

At the time of undertaking this investigation and of writing this report the project was in the early stages of planning and it was anticipated that the geotechnical investigation would provide details of preliminary feasibility options for the site.

No architectural or engineering design drawings have been supplied to date and we have prepared this report on the basis that a future development will broadly comprise minor cuts and fills and associated retaining walls to form a terraced site supporting residential NZS3604 type buildings with shallow strip and pad foundations.

4 INVESTIGATION SCOPE

4.1 Desktop Study

A desktop study was carried out before commencing fieldwork. This included online research through Auckland Council Geo Maps, Dial Before You Dig, aerial photographs and review of previous investigation and reporting.

A review of historic and recent aerial photographs between 1940 and 2017 indicated the following activity:

- Largely pasture farmland until 1960;
- Track running west to east and hardstand east formed in 1963;
- Formation of a man-made pond on 39 Small Road area between 1963 and 1996. Appeared to have been created by formation of a bund. Hardstand area mostly grassed.
- Second pond formed in the eastern corner of 53 Small Road between 1996 and 1999.
- Formation and abandonment of a dirt bike track on 39 Small Road area east of the man-made pond between 2001 and 2006.
- Formation of a hardstand area within the western half of 53 Small Road between 2011 and 2017.
- Filling of both man-made ponds between 2017 and 2022.

4.2 Field Investigation

Following a dial before you dig search, and onsite service location, the field investigation was carried out between 8 August 2022 and 11 August 2022. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[2] and logged in accordance with NZGS guidance[3]. The scope of fieldwork completed was as follows:

- Undertook a walkover survey of the site to assess the general landform, site conditions and adjacent structures/infrastructure;
- Six test pits, denoted TP01-22 to TP06-22, were excavated using a 20-tonne hydraulic excavator fitted with a 2m wide blade bucket and 0.8m wide toothed rock bucket to depths of between 3.4m and 6m below existing ground levels. TP02-22 was terminated due to refusal while the remaining test pits were terminated at the maximum reach of the excavator. Engineering logs and photographs of the test pits are presented in ***Appendix B***;
- Eight hand auger boreholes, denoted HA01-22 to HA08-22, were drilled using a 50mm diameter auger to target depths of up to 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ vane shear strength testing. All hand augers refused at depths of 1.2m to 4.1m and Dynamic Cone Penetrometer (DCP) testing was carried out within the bases from refusal depth. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths are presented in ***Appendix B***;
- Groundwater monitoring was undertaken on one occasion during a further visit following the initial fieldwork to monitor the groundwater levels in HA03-22 and HA07-22.

The approximate locations of the respective investigation sites referred to above are shown on the Site Plan as ***Drawing 01***. Test locations were measured using handheld GPS. Elevations were inferred from Auckland Council GIS contours.

[2] NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification
[3] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

5 GROUND MODEL

5.1 Published Geology

Published geological maps[4] depict the regional geology for the area as comprising Hukerenui Mudstone (Mangakahia Complex) of the Northland Allochthon as illustrated in ***Figure 2*** below.

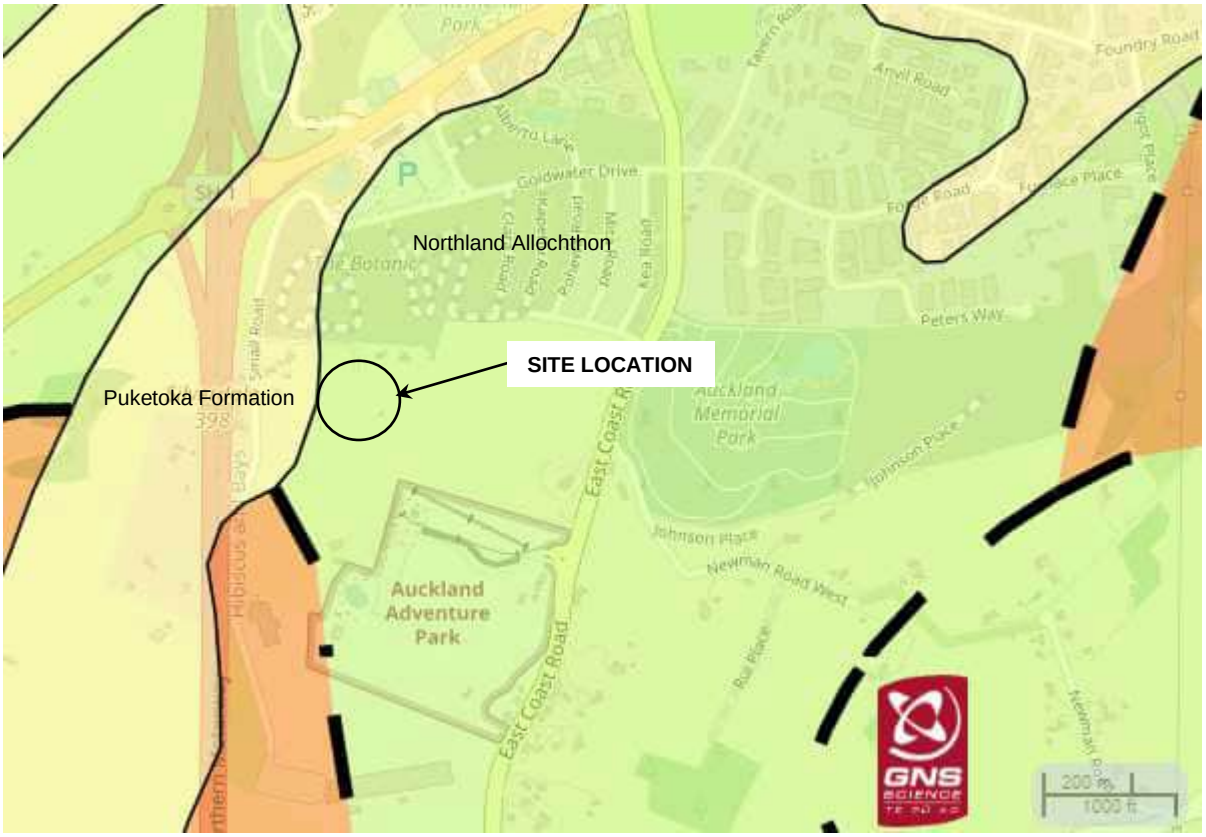


Figure 2: Regional Geology (GNS Sciences Geology Web Map)

This strata is part of an allochthonous (meaning removed from its formation location) mass of continental crust that had been peeled from the subduction zone north of New Zealand and emplaced through low angle thrust faulting onto areas of Northland and the Silverdale area.

Due to the nature of the faulting and emplacement, the materials which form the Northland Allochthon are highly fractured, variably weathered and often form a melange of strata including mudstones, siltstones, limestones, ultra-mafic rocks and shales. This geological formation is often unstable even on gentle slopes.

Two lithologies are present within the Northland Allochthon. Whangai Formation is described as cream to grey siliceous and locally calcareous mudstone while Hukerenui Mudstone is described as commonly sheared and deformed mudstone with small serpentine bodies.

Tauranga Group alluvial and colluvial materials generally fill the low-lying areas and gullies. These materials are described as clays and silts. The Tauranga Group contact is mapped near the western boundary of the site.

[4] Edbrooke, S. W. (complier) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3.1 sheet +74p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences

Based on the known history of the site and surrounding land levels, some depths of fill could be anticipated as a result of earthwork works operations and the filling of historic ponds.

5.2 Geomorphology

Geomorphology has been based on historical aerial photographs, a site walkover and our investigations on neighbouring sites.

The geomorphology reflects the underlying geology and associated slope processes. The dominant regional structure is evident in the subject and neighbouring sites in the form of features such as gullies and ridgelines.

This geology is typically known for its deformed, crushed and sheared nature and is notorious for instability even at gentle slopes. The combination of the existing elevation of the northern ridgeline and the shallow Northland Allochthon rock controls the geomorphology of the site.

A large west-trending gully feature was observed in the neighbouring site to the east, which continues towards the southern end of 53 Small Road. Where the gradient becomes shallower, an overland flow path is evident, which trends towards the west.

Minor head scarp features were observed on the southern face of the northern ridgeline, but the man-made hardstand and fills conceal the original geomorphology in the middle portion of the site. Gentler gradients are present towards the south-west and west, typical of Puketoka Formation alluvial processes.

Several mounds in the topography are present predominantly in the southern half of the site, indicating historical filling.

5.3 Stratigraphic Units

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area, apart from TP06-22, which encountered Tauranga Group Alluvium in an area that was mapped as Northland Allochthon. The ground conditions can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented in the appended Geological Plan/Geological Sections on ***Drawing 01***.

5.3.1 Topsoil

Topsoil was encountered in all boreholes and test pits apart from HA01-22, HA08-22, TP01-22, TP02-22, TP03-22 and TP06-22. The thickness ranged from 0.1m to 0.5m.

5.3.2 Uncontrolled Fill

Uncontrolled fill was encountered in HA08-22, and all test pits. The fill generally comprised clayey silts and silty clays with a maximum thickness of up to 4m depth. The majority of the fills are associated with the formation of the hardstands on site and also backfilling of the ponds. Vane shear strengths within the fill ranged from 46kPa to 160kPa and were inconsistent indicating non-engineered fill.

5.3.3 Colluvium

Colluvium was encountered in HA05-22. The colluvium generally had the appearance of residual Northland Allochthon soils, with evidence of rootlets mixed towards the base of the deposit. Vane shear strengths ranged from 50kPa to 147kPa and depth extended to 2.3m.

5.3.4 Puketoka Formation

Puketoka Formation (Tauranga Group) clayey silts and silty clays were encountered within HA07-22 and TP06-22, generally within the low-lying areas of the site. Vane shear strengths ranged from 99kPa to 174kPa and depth extended up to 5.8m.

5.3.5 Residual Northland Allochthon

Residual soils of the Northland Allochthon Formation were encountered in all hand auger boreholes and within all test pits apart from TP06-22. These soils generally consisted of stiff to hard, light grey mottled orange, bluish grey, light orange brown, clays silty clays and clayey silts with minor fine to medium sands. Vane shear strengths ranged from 87kPa to greater than 200kPa.

5.3.6 Transitional Northland Allochthon

The transitional unit is where the residual soils transition into completely weathered to highly weathered rock. This unit is typically highly sheared, with blocky fabric and has evidence of groundwater such as limonite staining.

5.3.7 Northland Allochthon Rock

Completely weathered to highly weathered Northland Allochthon Rock was encountered in TP04-22, TP05-22 and TP06-22. It was also inferred in all hand augers based on refusal depth. The rock consisted of extremely weak to weak siltstones and mudstones of the Whangai Formation encountered at depths between 1.2m and 5.8m.

5.3.8 Summary

The distribution of these units is illustrated on the appended Geological Sections A-A and B-B (***Drawing 03***) and presented below in Table 1.

Table 1: Summary of Strata Encountered

Unit	Depth to base (m)		Thickness (m)	
	Min	**Max**	**Min**	**Max**
Topsoil	0.2	0.4	0.2	0.4
Uncontrolled Fill	1	4	0.9	4
Colluvium	2.3	2.3	1.9	1.9
Puketoka Formation	1.8	5.8	1.6	4.3
Residual Northland Allochthon	1.2	5.5	1	4
*Northland Allochthon Rock	-	-	-	-

Notes: *Thickness only recorded where base of strata has been confirmed.

5.4 Groundwater

During the investigation, which was completed in mid-winter conditions (August 2022), groundwater was encountered within boreholes at the depths provided in Table 2, which also presents the results of groundwater monitoring undertaken following the investigation:

Table 2: Groundwater Monitoring Data			
Borehole	**Screen Depth (mbgl)**	**11 August 2022**	**27 September 2022**
		Depth (mbgl)	**Depth (mbgl)**
HA01-22	-	0.8	-
HA03-22	3.1	2.2	1.97
HA04-22	-	1.1	-
HA06-22	-	1.6	-
HA07-22	3.3	3.0	0.73
TP01-22	-	3.6	-
TP02-22	-	2.0	-
TP03-22	-	1.2	-
TP05-22	-	1.4	-
TP06-22	-	2.0	-

However, given the presence of a variable and clayey soil profile, it is possible that perched groundwater may occur during and following periods of rainfall. It should also be noted that while groundwater was not encountered across all investigation boreholes or test pits, it is typical in this geology for the groundwater to flow through the more permeable transition zone, which in this site is relatively shallow in depth.

6 GEOHAZARDS ASSESSMENT

6.1 Context

The following sections of this report provide an assessment of the geohazards relevant to this site.

6.2 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[5] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.1 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (for importance level 2)

f = site response factor subject to subsoil class (refer Section 7.1 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[6] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 3: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	$Magnitude_{eff}$
ULS	1/500	1.0	0.19	6.5
SLS	1/25	0.25	0.05	5.9
ACCOPS	1/150	0.58	0.10	5.75

Note: ULS = ultimate limit state; ACCOPS = Auckland Council seismic stability case[7], AEP = annual exceedance probability

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

In accordance with NZGS guidance[8] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency/density.

[5] NZ Geotechnical Society publication “Earthquake geotechnical engineering practice, Module 1: Overview of the standards”, (March 2016)
[6] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)
[7] Auckland Council Code of Practice for Land Development and Subdivision, version 1.6, 24 September 2013, Table 2.C.1
[8] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards”, (May 2016)

6.3.2 Geological Age

The vast majority, and nearly all, case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[9] [10]. Pleistocene aged alluvium (>12,000 years) is also considered to have a very low to low risk of liquefaction[10].

The Puketoka Formation alluvium (river and hill slope), found within the low-lying areas of the site are of middle to late Pleistocene geological age and therefore, in terms of geological age, are considered to be low risk of liquefaction.

Across the elevated terraces, soils below the water table comprise Northland Allochthon deposits. These soils are defined as having a dated age of 37.0 million to 98.9 million years old. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance[5] sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

PI < 7: Susceptible to Liquefaction

7 ≤ PI ≥ 12: Potentially Susceptible to Liquefaction

PI ≥ 12: Not Susceptible to Liquefaction

The natural soils beneath the site comprise silts and clays of low plasticity. The presence of silts within the soil profile also has a significant impact on the liquefaction susceptibility.

6.3.4 Discussion

Across the site, the subsoils generally comprised deposits the Northland Allochthon, with Puketoka Formation present in the low-lying areas. Auckland Council GeoMaps depict these deposits to be of very low liquefaction vulnerability.

Although the soils contain varying silt contents, the mapped risk level, geological age, as well as our investigation findings (stiff to very stiff soils), we do not consider liquefaction to be a risk to the proposed development. Liquefaction has therefore not been considered further.

6.4 Slope Stability

6.4.1 Design Criteria

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment as set out in the Auckland Council Code of Practice for Land Development and Subdivision (residential subdivision/development):

[9] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[10] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

Table 4: Slope Stability Factor of Safety Criteria	
Condition	**Required Factor of Safety**
Normal Groundwater Condition	1.5
Extreme (worst credible) groundwater condition	1.3
Seismic condition with 150 yr event	1.2

6.4.2 Shear Strength Parameters

6.4.2.1 Effective Stress Parameters

Drained shear strength parameters for the various geological units that underlie the site were inferred from the field investigation, laboratory test data and experience in similar ground conditions within the neighbouring sites and across the Northland and Auckland regions. CMW have undertaken extensive work in the area and on adjacent sites and have gained considerable knowledge in the behaviour of these materials and their properties.

Table 5: Summary of Effective Stress Shear Strength Parameters			
Geological Unit	**Unit Weight (kN/m^3)**	**Effective Stress Shear Strength Parameters**	
		c' (kPa)	**Ø' (deg)**
Colluvium	18	4	26
Puketoka Formation	18	3	26
Residual Northland Allochthon	18	5	26
Transitional Northland Allochthon	18	0	20
Completely Weathered to Highly Weathered Northland Allochthon	23	10	40
Note: Where c' = effective cohesion, Ø' = effective friction angle			

6.4.2.2 Total Stress Parameters

The soils that underlie the site comprise predominantly cohesive silts and clays that will behave in an undrained state during short term seismic loading. Undrained soil shear strengths (Su), used for assessing the stability of slopes during seismic loading, were taken from the hand-held shear vane results and are summarised as follows:

Table 6: Summary of Undrained Shear Strength Parameters	
Geological Unit	**Design Su (kPa)**
Colluvium	50
Alluvium	90
Residual Northland Allochthon	100
Transitional Northland Allochthon	20

6.4.3 Slope Stability Analyses

As proposed development plans have not been provided, we have only assessed the prevailing stability conditions of the existing contours (derived from Auckland Council GIS). Stability conditions for the proposed levels should be assessed when plans are available.

Slope stability analyses were undertaken using the proprietary software SLIDE Version 6. Analysis was undertaken using the Morgenstern-Price method of slices under the translational failure mechanism which is the anticipated failure mechanism in this geology.

Selected stability printouts are attached in ***Appendix C*** and summarised as follows:

Table 7: Slope Stability Analyses Results

Location	Slope Stability Factor of Safety (Existing Contour)		
	Prevailing	Transient	Seismic
Geological Section A-A	2.4	1.6	1.8
Geological Section B-B	2.3	1.8	2.0

Results show that the slope stability factor of safety criteria are achieved for the existing landform and assessed ground model conditions described above.

6.5 Erosion

Earthworks involving cuts, particularly on ridges, may expose erodible rock layers which were once capped and create the potential for consequential piping/tunnelling erosion and slope failure.

Erosion of cut and fill batters during earthworks is considered to be a high-risk natural hazard and easily addressed during construction. Erosion around batters may subsequently contribute to slope instability and falling debris. This hazard is typically controlled during the design phase by limiting batters to a maximum of 1(V):3(H) gradients and during earthworks via benches, erosion control blankets, geotextiles and stormwater control.

6.6 Load Induced Settlement

Deep fills may be subject to ongoing settlement for a period following completion of works. Our experience indicates that with appropriate gully preparation and drainage, settlements are typically complete soon after the earthworks are finished.

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for the proposed development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is be agreed with the Geotechnical Engineer during construction.

6.7 Uncontrolled Fills

Due to the unknown history of the uncontrolled fills encountered on site there is risk of potential settlement within these fills or lower available bearing capacities.

6.8 Expansive Soils

Seasonal shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have

returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011[11] excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870[12]. for foundation design advice. However the November 2019 update of Acceptable Solution B1/AS1[13] provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

Nevertheless, there is evidence[14] indicating that the use of the B1/AS1 method of assessment of expansiveness may be inaccurate. Accordingly, our assessments herein have been made in line with our experience, BRANZ Report SR120A[15] and AS2870.

6.9 Groundwater Impact Assessment

As we have not been provided with proposed earthworks plans, we have not undertaken a groundwater impact assessment. However, due to the recorded groundwater measurements, it is anticipated that an impact assessment will be required if cuts are proposed. This should be addressed at detailed reporting stage.

[11] Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard
[12] Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW
[13] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/AS1, Amendment 19
[14] Rogers, N., McDougall, N., Twose, G., Teal, J. & Smith, T. (2020) The Shrink Swell Test: A Critical Analysis, *NZ Geomechanics News,* Issue 99, pages 66-80.
[15] Fraser Thomas Limited (2008) - Addendum Study Report (BRANZ SR120A), Soil Expansivity in the Auckland Region – Final Report

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

Based on the findings of our investigation, including the presence of hard deposits at relatively shallow depths, the seismic site subsoil category defined in Section 3.1.3 of NZS 1170.5 is assessed to be C (shallow soil site).

7.2 Slope Stability Management

Specific slope stability analysis of the proposed contours should be undertaken once plans are available.

Typical remediation methods to provide adequate factors of safety in this geology include construction of shear keys and/or palisade walls, retaining walls, installation of subsoil drainage within gullies and counterfort drains.

7.3 Earthworks

7.3.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431[16] and the requirements of the Auckland Council Infrastructure Development Code under the guidance of a Chartered Professional Geotechnical Engineer. Geotechnical Works Specification should be addressed in the detailed report.

The following sections provide general earthworks recommendations for the site based on our experience in this geology.

7.3.2 Site Stripping

Prior to earthworks commencing topsoil should be stripped and uncontrolled fills undercut. Additionally, soft deposits within gullies should be cleaned out.

Locations of any stockpiles should be carefully considered as to not compromise stability conditions.

7.3.3 Excavatability

Rock is likely to be encountered at shallow depths close to ridgelines if cuts are to be made in these areas. Given the highly fractured/completely weathered nature of the rock, it is expected that excavation of these materials will be readily achieved with normal earthworks plant, such as scrapers and bulldozers with scoops.

7.3.4 Underfill Drainage

Underfill drains will need to be installed beneath any new fills within low lying tributaries and gully inverts. Effective drainage is a key factor required for maintaining slope stability and reducing the geotechnical hazards across the site.

Drain positions should be determined once earthworks plans are available.

7.3.5 Capping Layer

Exposure of the rockmass within cuts is susceptible to rapid weathering and infiltration of surface water that could comprise stability conditions. Rock could be encountered as shallow as 1.2m, particularly on ridgelines.

[16] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

Typical mitigation of this risk is to over-excavate these deposits to a depth of 1m and cap with engineered filling.

7.4 Civil Works

7.4.1 Service Trenches

Services trenches excavated along contour in areas of steep ground may need to be backfilled with engineered filling and if in natural ground, may require a drain coil in the base of the trench connected to the stormwater system. Identification of critical service lines must be made once drawings are available.

8 FOUNDATIONS

8.1 Shallow Foundations

Based on the assumption that the development will comprise the construction of standard NZS3604-type structures we anticipate that a preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 2.5m in plan.

There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms.

8.2 Expansive Soils

On this basis of our visual tactile assessment, results of laboratory testing and reference to BRANZ Report SR120A, we have assessed the AS2870 Site Class to be M (moderate) with an anticipated characteristic surface movement of up to 40mm. Foundation design may be selected in accordance with appropriate solutions for this Class from AS2870 or may be undertaken by specific engineering design.

9 FURTHER WORK

This report has been undertaken to assess the preliminary feasibility of the site for residential development. Further reporting, analyses and/or investigation will be required once proposed development plans are available.

10 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Build Rich Limited in relation to the Small Road Development at 53 Small Road, Silverdale in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Build Rich Limited seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report 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 and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Appendix A: Drawings

Drawing 01:	Site Investigation Plan
Drawing 02:	Geology Plan
Drawing 03:	Geological Section A-A and B-B

LEGEND:

- HA01-22 — HAND AUGER (HA) LOCATION
- TP01-22 — TEST PIT (TP) LOCATION
- 53 SMALL ROAD BOUNDARY
- 39 SMALL ROAD BOUNDARY

NOTES:

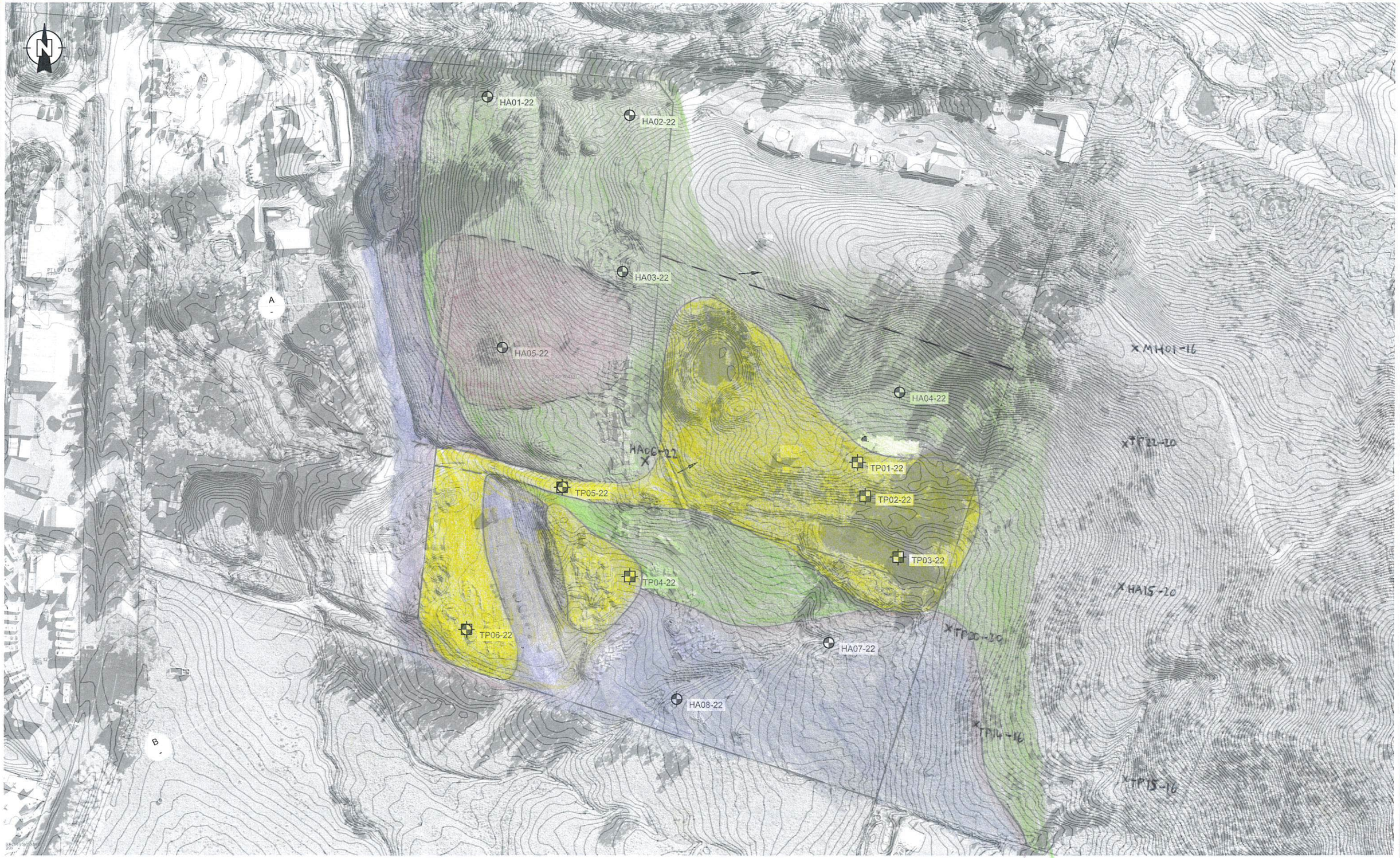
1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS MAP.
2. CONTOURS ARE IN 0.25m INTERVALS.

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH LTD		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: HN	DRAWING: 01
		REVISION: 0	SCALE: 1:1250
TITLE: SITE INVESTIGATION PLAN		DATE: 03/10/2022	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL2022-0128 SITE INVESTIGATION PLAN.DWG



LEGEND:

- HA01-22 HAND AUGER (HA) LOCATION
- TP01-22 TEST PIT (TP) LOCATION
- SITE BOUNDARY

- Uncontrolled Fill
- Colluvium
- Puketoka Formation
- Northland Allochthon

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS MAP.
2. CONTOURS ARE IN 0.25m INTERVALS.

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH LTD		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: HN	DRAWING: 01
		REVISION: 0	SCALE: 1:1250
TITLE: GEOLOGY PLAN		DATE: 07/09/2022	SHEET: A3 L

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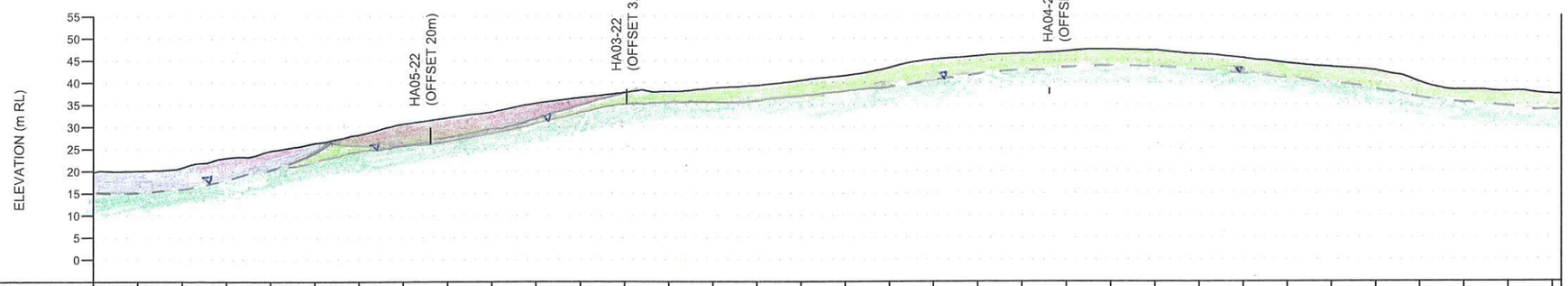
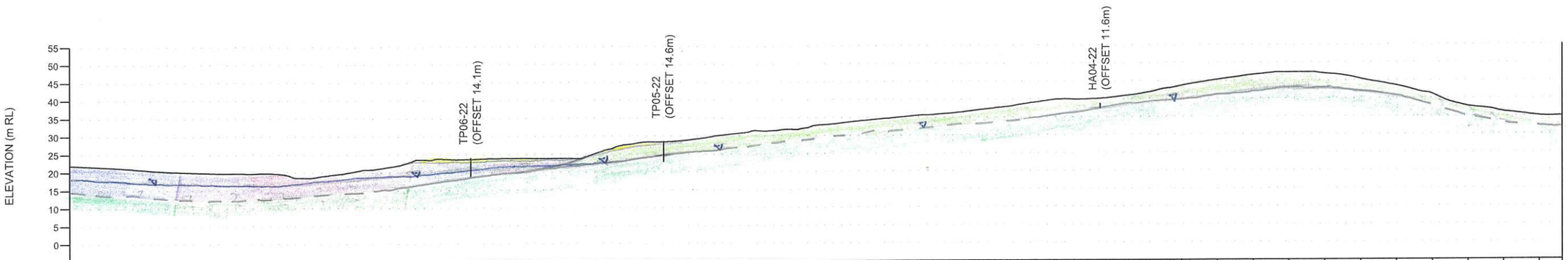

ELEVATION (m RL)
55
50
45
40
35
30
25
20
15
10
5
0
HA05-22 (OFFSET 20m)
HA03-22 (OFFSET 3.6m)
HA04-22 (OFFSET 46m)

| | | |



DISTANCE (m)	EXISTING GROUND (m RL)
10	21.50
20	20.79
30	20.16
40	19.83
50	19.68
60	19.39
70	18.96
80	20.42
90	21.67
100	23.43
110	23.62
120	23.81
130	23.82
140	23.75
150	26.28
160	28.29
170	28.65
180	30.03
190	31.43
200	31.75
210	33.05
220	34.04
230	34.93
240	35.69
250	36.59
260	37.76
270	39.25
280	39.92
290	40.34
300	41.67
310	43.64
320	45.28
330	46.64
340	47.26
350	46.94
360	45.42
370	43.55
380	41.16
390	37.75
400	36.26
410	35.09
416	35.00

SECTION-B

- Uncontrolled Fill
- Puhetoha Formation
- Residual Northland Allochthon
- Northland Allochthon Rock

LEGEND:

EXISTING SURFACE

1:1250 0 12.5 25 37.5 50 62.5 m

CMW Geosciences

CLIENT: BUILD RICH LTD		DRAWN: JS	PROJECT: AKL2022-0128
PROJECT: 53 SMALL ROAD, SILVERDALE		CHECKED: HN	DRAWING: 03
		REVISION: A	SCALE: 1:1250
TITLE: SECTION-B		DATE: 07/09/2022	SHEET: A3 L

\\CMWGEOSCIENCES.SHAREPOINT.COM@SSL\DAVWWWROOT\SITES\AUCKLANDTEAM\SHARED DOCUMENTS\AUCKLAND PROJECT DOCUMENTS\2022\AKL2022-0128 53 SMALL ROAD, SILVERDALE\DRAWINGS\CAD\AKL 2022-0128 SITE INVESTIGATION PLAN.DWG

Appendix B: Hand Auger Borehole and Test Pit Logs

HAND AUGER BOREHOLE LOG - HA01-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1748879.4mE; 5945117.6mN Projection: NZTM
Elevation: 29.20m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			29.2			MH: Clayey SILT: Orange brown mottled grey. High Plasticity. (Northland Allochthon)			
			29.0			ML: Clayey SILT: Brownish grey. Low Plasticity. (Northland Allochthon)			
	0.4	Peak = 61kPa Residual = 32kPa					W	St	
▼	0.8	Peak = UTP		1		... at 1.00m, becoming SILT with some sand. Grey.			
	1.2	Peak = >203kPa							
	1.6	Peak = 131kPa Residual = 15kPa					S	VSt to H	
	2.0	Peak = 131kPa Residual = 58kPa		2		... at 2.00m, becoming Clayey SILT with minor fine sand. Grey mottled orange.			
	2.4	Peak = >203kPa							
	2.8	Peak = UTP				Borehole terminated at 2.8 m			20
				3					
				4					
				5					

Dynamic Cone Penetrometer (Blows/100mm): 5, 10, 15

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 0.8m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA02-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: HN Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 1748930.0mE; 5945111.0mN Projection: NZTM
Elevation: 37.45m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			37.4			ML: SILT with trace clay : Dark brown with minor rootlets. Low plasticity (Topsoil)	M to W		
			37.2			CH: Silty CLAY: Light grey streaked light yellowish brown. High plasticity. (RS Northland Allochthon)			
	0.4	Peak = 154kPa Residual = 46kPa							
	0.8	Peak = 157kPa Residual = 64kPa						VSt	
			36.6	1		ML: SILT with minor clay : Greyish white streaked yellowish brown Low plasticity. (RS Northland Allochthon)			
	1.2	Peak = 141kPa Residual = 64kPa	36.2			CH: Silty CLAY : Light grey with minor yellowish brown streaks. High plasticity. (RS Northland Allochthon)			
	1.6	Peak = 77kPa Residual = 40kPa						St	
			35.6			ML: Clayey SILT : Light grey with minor yellowish brown streaks. Low plasticity. (RS Northland Allochthon)	M		
	2.0	Peak = 172kPa Residual = 61kPa	35.4	2		ML: SILT with trace clay : Light grey with minor yellowish brown streaks. Low plasticity. (RS Northland Allochthon)			
						... at 2.00m, becoming SILT with trace clay			
	2.4	Peak = >200kPa				*... at 2.40m, becoming light grey streaked yellowish brown with minor dark grey streaks.*			
	2.8	Peak = >200kPa						VSt to H	
				3		*... at 3.00m, becoming Clayey SILT. Light grey, dark grey, and orange brown.*			
	3.2	Peak = >200kPa				*... at 3.20m, becoming SILT. Grey with orange brown stains. Friable.*			
						... at 3.50m, becoming SILT with minor clay. Grey streaked dark grey.	D to M		
						Borehole terminated at 3.6 m			
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1702 DCP No: 01
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 11/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1748927.6mE; 5945055.5mN Projection: NZTM
Elevation: 38.32m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			38.3			OL: Organic SILT: Dark brown. Low Plasticity. (Topsoil)			
			38.1			ML: Clayey SILT with some fine sand: Orange grey. Low Plasticity. (Northland Allochthon)	M		
	0.4	Peak = >203kPa				... at 0.40m, becoming brownish grey mottled orange.			
	0.8	Peak = >203kPa		1					
	1.2	Peak = UTP					W		
						... at 1.40m, becoming SILT with some fine sand. Grey mottled orange.			
	1.6	Peak = UTP						H	
						... at 1.80m, becoming Sandy SILT with minor clay. Whitish grey mottled orange with limonite staining.			
	2.0	Peak = UTP		2					
	2.4	Peak = UTP					S		
	2.8	Peak = >203kPa				... at 2.80m, becoming SILT with some sand. Bluish grey with brown streaks.			
				3					
						Borehole terminated at 3.1 m			17
									20
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 2.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA04-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 11/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749026.5mE; 5945012.6mN Projection: NZTM
Elevation: 38.62m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			38.6			OL: Organic SILT: Dark brown. Low Plasticity. (Topsoil)	M		
			38.4			ML: Clayey SILT with some fine sand: Whitish grey mottled orange. Low Plasticity. (Northland Allochthon)			
	0.4	Peak = 133kPa Residual = 15kPa					W	VSt	
	0.8	Peak = UTP		1				H	
▼	1.2	Peak = UTP					S		
						Borehole terminated at 1.2 m			20
				2					
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 1.1m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA05-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: HN Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 1748885.0mE; 5945028.5mN Projection: NZTM
Elevation: 29.76m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			29.8			OL: Clayey SILT : Dark brown with minor rootlets. Low plasticity. (Topsoil)	M to W		
	0.4	Peak = 147kPa Residual = 55kPa	29.4			CH: Silty CLAY: Light yellowish brown with minor light orange brown streaks. High plasticity. (Colluvium)		St to VSt	
	0.8	Peak = 77kPa Residual = 40kPa		1					
						... at 1.00m, becoming CLAY with trace silt.		F	
	1.2	Peak = 50kPa Residual = 20kPa				... at 1.20m, becoming light grey streaked light yellowish brown. Trace rootlets.			
	1.6	Peak = 63kPa Residual = 20kPa					M		
	2.0	Peak = 89kPa Residual = 20kPa		2		... at 2.00m, becoming silty CLAY, light brown to light grey with with minor grey blocky silt clasts. Trace rootlets.		St	
			27.5			ML: Clayey SILT: Dark grey streaked light grey. Low plasticity. (Northland Allochthon)			
	2.4	Peak = >200kPa							
	2.8	Peak = >200kPa				... at 2.90m, with trace blackish grey shear planes.			
				3		... at 3.00m, becoming friable.		H	
	3.2	Peak = >200kPa					D to M		
						Borehole terminated at 3.6 m			20
				4					
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1702 DCP No: 01
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749014.9mE; 5944995.1mN Projection: NZTM
Elevation: 31.50m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			31.5			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)			
	0.4	Peak = 136kPa Residual = 29kPa	31.1			ML: Clayey SILT with minor fine sand: Grey mottled orange. Low Plasticity. (Northland Allochthon)			
						... at 0.50m, becoming Clayey SILT with some gravel. Gravel is fine to coarse, subangular, derived from siltstone clasts.			
	0.8	Peak = UTP					W		
			30.5	1		CH: Silty CLAY: Grey mottled orange. High Plasticity. (Northland Allochthon)			
	1.2	Peak = 162kPa Residual = 17kPa						VSt to H	
▼	1.6	Peak = >203kPa	29.9			ML: Clayey SILT with minor fine sand: Grey mottled orange. Low Plasticity. (Northland Allochthon)			
							S		
	2.0	Peak = UTP		2		*... at 2.00m, becoming Sandy SILT with trace gravel. Gravel is coarse, subangular, derived from siltstone clasts.*			
						Borehole terminated at 2.2 m			16
									20
				3					
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 1.6m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA07-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 11/08/2022
Borehole Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749001.7mE; 5944923.4mN Projection: NZTM
Elevation: 29.23m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			29.2			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)			
			29.0			CH: Silty CLAY: Grey mottled orange streaked dark grey. High Plasticity. (Tauranga Group)			
	0.4	Peak = 96kPa Residual = 55kPa	28.8			ML: Clayey SILT with some fine sand: Grey mottled orange. Low Plasticity. (Tauranga Group)		St	
	0.8	Peak = 133kPa Residual = 49kPa		1					
	1.2	Peak = 177kPa Residual = 67kPa				... at 1.20m, becoming orange grey	M		
	1.6	Peak = >203kPa							
			27.4			ML: Sandy SILT with trace gravel: Blue with minor grey mottles. Low Plasticity. Gravel is coarse, subangular siltsone clasts. (RS Northland Allochthon)			
	2.0	Peak = 148kPa Residual = 87kPa		2				VSt	
	2.4	Peak = 145kPa Residual = 102kPa					W		
	2.8	Peak = 148kPa Residual = 104kPa							
				3					
	3.2	Peak = UTP					S		
						Borehole terminated at 3.3 m			20
				4					
				5					

Termination Reason: Target Depth Reached
Shear Vane No: 1195 DCP No: 05
Remarks: Groundwater encountered at 3.0m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA08-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 08/08/2022
Borehole Location: Refer to Site Plan Logged by: HN Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 1748947.4mE; 5944903.6mN Projection: NZTM
Elevation: 26.10m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			26.1			ML: SILT with minor clay : Dark brownish grey with trace brown mottles. Low plasticity. (Alluvium)			
	0.4	Peak = 50kPa Residual = 15kPa					M to W	F	
			25.5			ML: SILT with minor clay: Blackish brown with trace light grey mottles. Low plasticity. Minor sub-angular light grey silt clasts. (Fill)			
	0.8	Peak = 46kPa Residual = 12kPa		1					
			25.0			CH: Silty CLAY : Light grey with minor light orange brown streaks. High plasticity. (Tauranga Group)			
	1.2	Peak = 104kPa Residual = 9kPa							
	1.6	Peak = 141kPa Residual = 6kPa						VSt	
	2.0	Peak = >200kPa		2		... at 2.00m, becoming CLAY. Greyish white streaked light orange brown.			
	2.4	Peak = 98kPa Residual = 58kPa					M		
			23.4			ML: SILT with some clay: Light grey. Low plasticity. Homogeneous. (RS Northland Allochthon)			
	2.8	Peak = >200kPa		3				VSt to H	
	3.2	Peak = 172kPa Residual = 80kPa				... at 3.20m, relict blocky structure.			
	3.6	Peak = >200kPa							
	4.0	Peak = >200kPa		4		... at 4.00m, becoming with trace blackish grey shear planes.			
						Borehole terminated at 4.1 m			
				5					

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1702 DCP No: 01
Remarks: Groundwater not encountered. Overland flow at 1.0m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP01-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP01-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1
Position: 1749011.6mE; 5944987.6mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 35.62m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			35.6			ML: Clayey SILT with minor gravel and trace cobbles: Grey streaked white. Low Plasticity. (Fill)				
	0.4	Peak = 87kPa Residual = 35kPa						St		
	0.8	Peak = 160kPa Residual = 58kPa	34.8			ML: Sandy SILT: Orange brown. Low Plasticity. (Fill)				
			34.6	1		ML: Clayey SILT with minor gravel and trace cobbles: Grey streaked white. Low Plasticity. (Fill)				
	1.2	Peak = >203kPa				*... from 1.20m to 1.30m, becoming brown*				
	1.4	Peak = 148kPa Residual = 58kPa					W			
				2				VSt		
	2.3	Peak = 160kPa Residual = 58kPa				*... at 2.30m, becoming brownish grey*				
						... at 2.40m, becoming purplish brown mottled orange				
	2.6	Peak = 119kPa Residual = 35kPa								
						... at 2.80m, becoming whitish grey mottled orange				
				3						
	3.2	Peak = 160kPa Residual = 49kPa						St		
▼	3.6	Peak = 84kPa Residual = 44kPa								
	4.0	Peak = 151kPa Residual = 73kPa	31.6	4		ML: Sandy SILT: Whitish grey mottled orange. Low Plasticity. (Northland Allochthon)				
						... at 4.00m, Transition to rock bucket	S			
	4.4	Peak = 133kPa Residual = 44kPa	31.2			CH: Silty CLAY with minor fine sand: Whitish grey mottled orange. High Plasticity. (Northland Allochthon)		VSt		
	4.8	Peak = 139kPa Residual = 41kPa								
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 3.6m. Changed to rock bucket at 4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP02-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP02-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1

Position: 1749014.4mE; 5944975.6mN Projection: NZTM
Elevation: 33.75m Datum: AUCKHT1946

Pit Dimensions: 4.0m by 2.0m
Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			33.8			ML: Clayey SILT with trace gravel: Brown mottled orange. Low Plasticity. Gravel is coarse, subangular. (Fill)				
	0.4	Peak = 58kPa Residual = 29kPa				... at 0.40m, becoming Clayey SILT with minor fine sand and trace gravel. Orange grey. Gravel is coarse, subangular.		St		
	0.8	Peak = 99kPa Residual = 67kPa		1			W			
	1.2	Peak = 102kPa Residual = 29kPa								
	1.6	Peak = 116kPa Residual = 20kPa								
▼	2.0	Peak = 99kPa Residual = 20kPa	31.8	2		OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)		VSt		
	2.4	Peak = 107kPa Residual = 29kPa	31.4			MH: Clayey SILT: Whitish grey mottled orange. High Plasticity. (Northland Allochthon)	S			
	3.0	Peak = 162kPa Residual = 52kPa		3						
						Test pit terminated at 3.40 m				
				4						
				5						

Termination Reason: Hole collapsed despite benching
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 2.0m. Pit collapse.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 2

Position: 1749026.1mE; 5944953.9mN Projection: Pit Dimensions: 4.0m by 2.0m
Elevation: 31.75m Datum: Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			31.8			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				0.0-5.5m:
			31.6			CL: Silty CLAY with minor fine sand and trace gravel: Brown mottled orange and dark grey. Low Plasticity. Gravel is fine to medium, subangular. (Fill)				
	0.4	Peak = 87kPa Residual = 15kPa					W			
	0.8	Peak = 70kPa Residual = 26kPa						St		
			30.8	1		OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				
▼	1.2	Peak = 61kPa Residual = 15kPa				*... at 1.20m, groundwater pooling on surface.*				
			30.2			MH: Clayey SILT: Brownish grey mottled orange. High Plasticity. (Northland Allochthon)				
	1.6	Peak = 107kPa Residual = 29kPa								
	2.0	Peak = 131kPa Residual = 26kPa		2						
						... at 2.20m, groundwater seepage through walls and minor wall collapses.				
	2.4	Peak = 107kPa Residual = 49kPa						VSt		
	2.8	Peak = 104kPa Residual = 29kPa								
			28.8	3		ML: Sandy SILT: Whitish grey mottled orange. Low Plasticity. Sand is fine to medium grained. (Northland Allochthon)	S			
	3.2	Peak = 90kPa Residual = 29kPa								
	3.6	Peak = 61kPa Residual = 44kPa				*... at 3.60m, becoming bluish grey mottled orange.*		St		
	4.0	Peak = 61kPa Residual = 49kPa		4						
				5						

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 1.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP03-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 2 of 2

Position: 1749026.1mE; 5944953.9mN Projection: Pit Dimensions: 4.0m by 2.0m
Elevation: 31.75m Datum: Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			26.2			CH: Silty CLAY: Brownish grey streaked black. High Plasticity. (Northland Allochthon)			5 10 15 20	
				6		Test pit terminated at 6.00 m				
				7						
				8						
				9						
				10						

Material Description: Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Structure & Other Observations: Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 1.2m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP04-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP04-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1
Position: 1748930.5mE; 5944947.0mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 26.75m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			26.8			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				
	0.4	Peak = 174kPa Residual = 29kPa	26.4			CH: Silty CLAY: Grey mottled orange. High Plasticity. (Fill)				
	0.8	Peak = 133kPa Residual = 44kPa		1				VSt to St		
	1.2	Peak = 87kPa Residual = 46kPa								
	1.6	Peak = 104kPa Residual = 46kPa								
	2.0	Peak = 133kPa Residual = 46kPa		2				VSt		
	2.4	Peak = 189kPa Residual = 58kPa	24.4			ML: Sandy SILT with minor gravel: Brownish grey mottled orange. Low Plasticity. Sand is fine to coarse grained. Gravel is coarse, subangular, siltstone clasts. (Northland Allochthon)	W			
	3.0	Peak = 160kPa Residual = 55kPa		3						
	3.4	Peak = >203kPa								
	4.0	Peak = UTP		4		... at 4.00m, transition to rock bucket		H		
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater not encountered. Changed to rock bucket at 4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP05-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP05-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 1
Position: 1748906.4mE; 5944978.7mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 28.47m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
			28.5			OL: Organic SILT: Dark brown. Low Plasticity. Minor rootlets. (Topsoil)				
	0.5	Peak = 102kPa Residual = 17kPa	28.0			CH: Silty CLAY: Whitish grey mottled orange. High Plasticity. (Fill)	W	VSt		
	0.8	Peak = 116kPa Residual = 44kPa								
			27.5	1		ML: Clayey SILT: Bluish grey mottled orange. Low Plasticity. (Northland Allochthon)		St		
▼	1.4	Peak = 87kPa Residual = 58kPa								
	1.6	Peak = 90kPa Residual = 58kPa								
			26.5	2		CH: Silty CLAY with trace fine sand: Whitish grey mottled orange. High Plasticity. (Northland Allochthon)		St to VSt		
	2.4	Peak = 148kPa Residual = 58kPa								
	2.8	Peak = 174kPa Residual = 44kPa						VSt		
	3.0	Peak = 160kPa Residual = 38kPa	25.5	3		ML: Sandy SILT: Blue. Low Plasticity. Sand is fine to medium grained. Blue highly weathered SILTSTONE present. Extremely weak. Blocky fabric with randomly oriented microfractures. (Northland Allochthon)	S			
	3.5	Peak = >203kPa								
	4.0	Peak = UTP		4				H		
				5		Test pit terminated at 5.00 m				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 1.4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

PHOTOGRAPH SHEET - TP06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Location: Silverdale
Project ID: AKL2022-0128
Date: 09/08/2022
Investigation Location: Refer to Site Plan

Long Wall

Narrow Wall

TEST PIT LOG - TP06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 1 of 2

Position: 1748872.6mE; 5944928.3mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 22.90m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			22.9			CH: Silty CLAY with minor fine sand and gravel: Orange grey. High Plasticity. Gravel is coarse, subangular, siltstone clasts. (Fill)				
	0.4	Peak = 99kPa					M	St		
	0.8	Peak = 75kPa				*... at 0.80m, becoming bluish grey streaked dark grey with minor wood/bark fragments.*				
				1						
	1.2	Peak = 148kPa	21.7			ML: Clayey SILT with minor gravel: Bluish grey mottled dark grey and white. Low plasticity. Gravel is coarse, subangular, siltstone clasts. (Fill)				
			21.4			CH: Silty CLAY: Brownish grey mottled orange. High Plasticity. (Puketoka Formation)				
	1.6	Peak = 128kPa Residual = 12kPa								
▼	2.0	Peak = 174kPa Residual = 41kPa	20.9	2		ML: Clayey SILT with minor fine sand: Whitish grey mottled orange. Low Plasticity. Blocky fabric is siltstone clasts. (Puketoka Formation)	W	VSt		
	2.7	Peak = >203kPa				*... at 2.60m, becoming whitish grey with trace light orange brown stains.*				
			19.9	3		CL: Silty CLAY: Brownish grey with trace organic staining. Low Plasticity. Organic odour. (Puketoka Formation)				
	3.2	Peak = 102kPa Residual = 29kPa				*... at 3.00m, minor pit collapse.*				
	3.5	Peak = 99kPa Residual = 29kPa	19.4			ML: SILT with minor fine sand: Whitish grey. Low Plasticity. Blocky fabric. (Puketoka Formation)				
			19.1			CH: Silty CLAY with minor fine sand: Whitish grey mottled orange. High Plasticity. (Puketoka Formation)				
				4			S	VSt to H		
			17.9	5		ML: Clayey SILT: Dark grey mottled orange. Low Plasticity. Trace organics present. (Puketoka Formation)				

Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 2.0m. Changed to rock bucket at 3.5m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT LOG - TP06-22

Client: Build Rich
Project: 53 Small Road, Silverdale
Site Location: Silverdale
Project No.: AKL2022-0128
Date: 09/08/2022
Test Pit Location: Refer to Site Plan Logged by: NK Checked by: HN Scale: 1:25 Sheet 2 of 2

Position: 1748872.6mE; 5944928.3mN Projection: NZTM Pit Dimensions: 4.0m by 2.0m
Elevation: 22.90m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
			17.4			ML: Sandy SILT: Bluish grey. Low Plasticity. Sand is fine to medium grained. Derived from completely weathered to highly weathered SANDSTONE. Extremely weak. Includes SILT. Blue mottled orange. Low Plasticity. Trace organics. (Puketoka Formation)			5 10 15 20	
			17.1			ML: SILT: Blue streaked purplish brown. Low Plasticity. Derived from completely weathered to highly weathered SILTSTONE. Blocky fabric with randomly oriented microfractures. (Northland Allochthon)				
				6		Test pit terminated at 6.00 m				
				7						
				8						
				9						
				10						

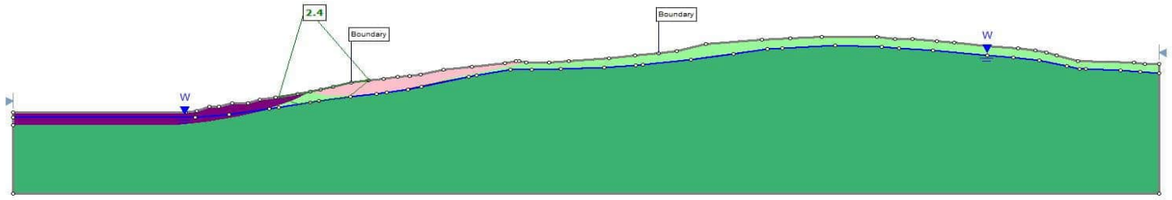
Termination Reason: Target depth reached
Shear Vane No: 1195 DCP No:

Remarks: Groundwater encountered at 2.0m. Changed to rock bucket at 3.5m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

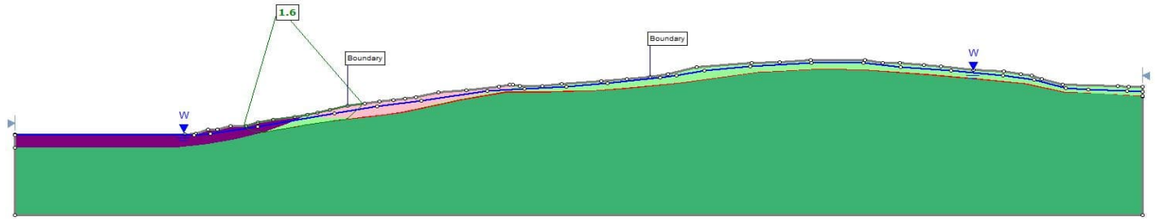
Appendix C: Slope Stability Printouts

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

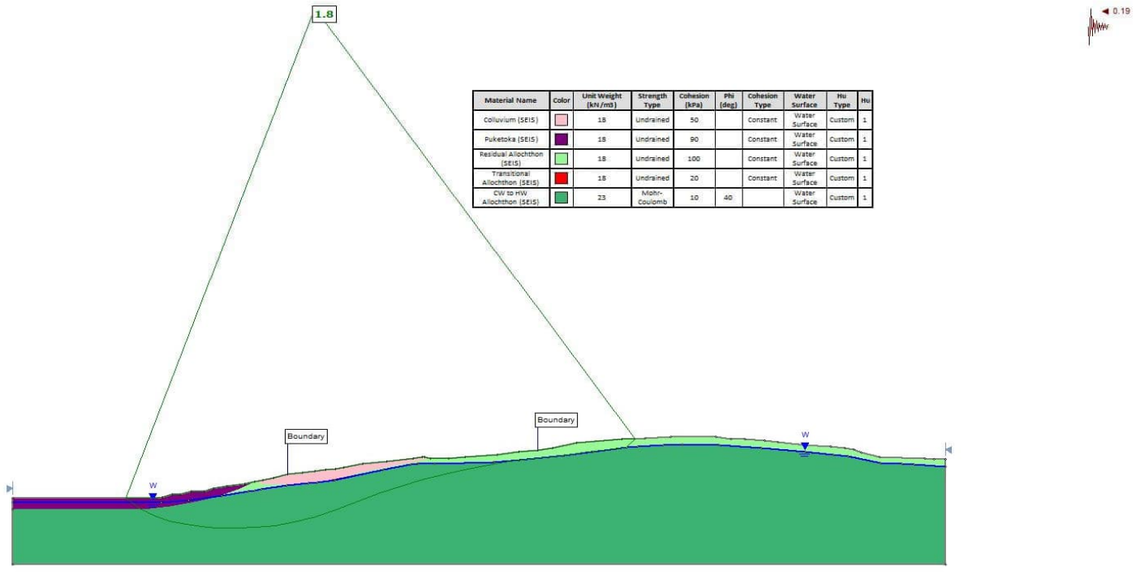


Normal Groundwater Conditions

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1



Transient Groundwater Conditions



Seismic Event

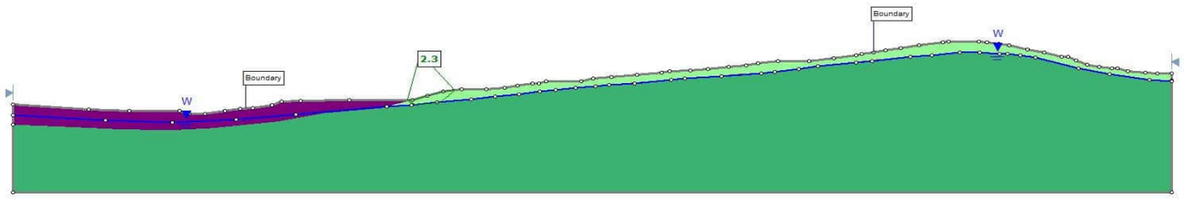
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Colluvium (SEIS)		18	Undrained	50		Constant	Water Surface	Custom	1
Puketoka (SEIS)		18	Undrained	90		Constant	Water Surface	Custom	1
Residual Allochthon (SEIS)		18	Undrained	100		Constant	Water Surface	Custom	1
Transitional Allochthon (SEIS)		18	Undrained	20		Constant	Water Surface	Custom	1
CW to HW Allochthon (SEIS)		23	Mohr-Coulomb	10	40		Water Surface	Custom	1

Parameters

CMW Geosciences

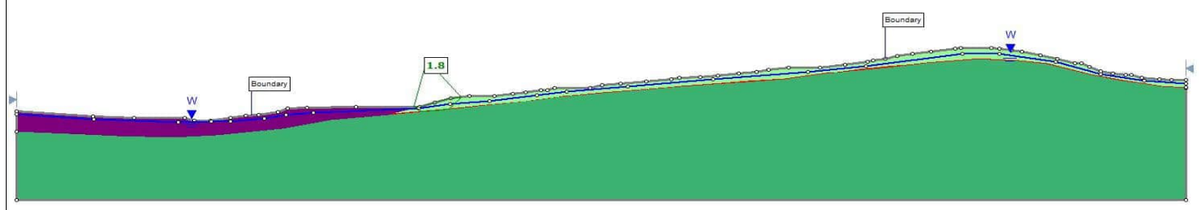
Project 53 Small Road, Silverdale	*Analysis* Cuckoo	*Project No.* AKL2022-0128
Title Section A - Existing	*Date* 3/10/2022	*Drawing* STAB 01

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

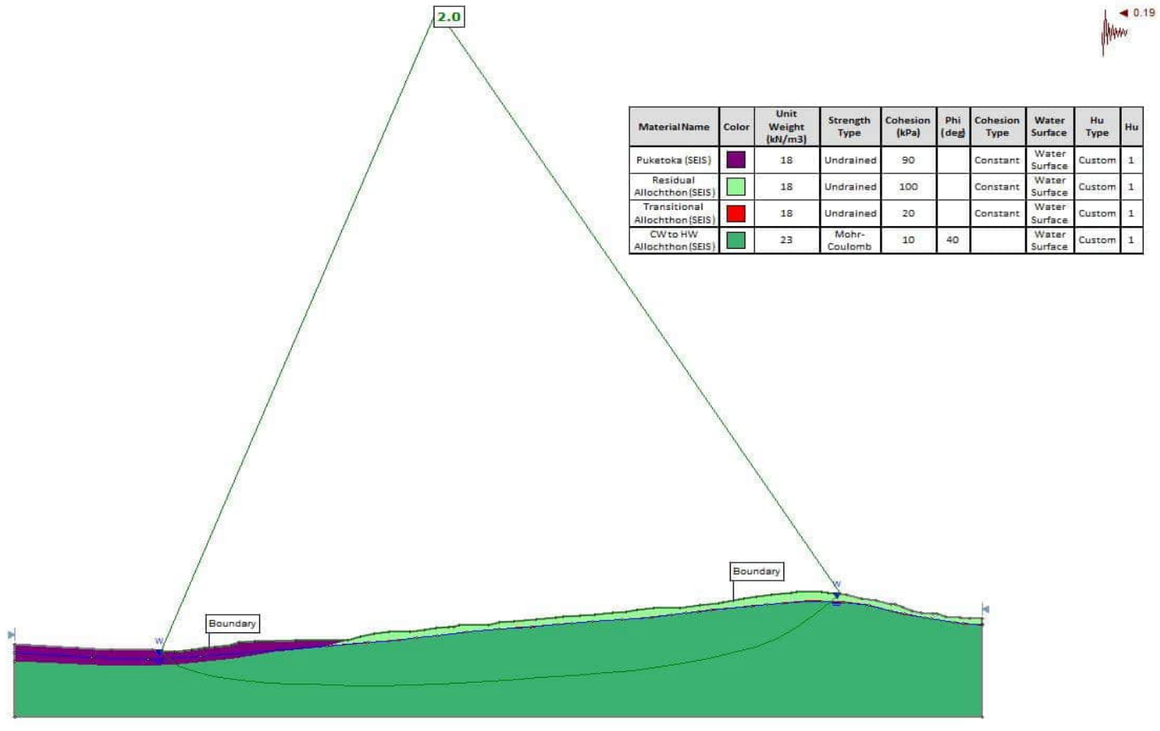


Normal Groundwater Conditions

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1



Transient Groundwater Conditions



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Puketoka (SEIS)		18	Undrained	90		Constant	Water Surface	Custom	1
Residual Allochthon (SEIS)		18	Undrained	100		Constant	Water Surface	Custom	1
Transitional Allochthon (SEIS)		18	Undrained	20		Constant	Water Surface	Custom	1
CW to HW Allochthon (SEIS)		23	Mohr-Coulomb	10	40		Water Surface	Custom	1

Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Colluvium		18	Mohr-Coulomb	4	26	Water Surface	Custom	1
Puketoka Formation		18	Mohr-Coulomb	3	26	Water Surface	Custom	1
Residual Northland Allochthon		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Transitional Northland Allochthon		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
Completely Weathered to Highly Weathered Northland Allochthon		23	Mohr-Coulomb	10	40	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Colluvium (SEIS)		18	Undrained	50		Constant	Water Surface	Custom	1
Puketoka (SEIS)		18	Undrained	90		Constant	Water Surface	Custom	1
Residual Allochthon (SEIS)		18	Undrained	100		Constant	Water Surface	Custom	1
Transitional Allochthon (SEIS)		18	Undrained	20		Constant	Water Surface	Custom	1
CW to HW Allochthon (SEIS)		23	Mohr-Coulomb	10	40		Water Surface	Custom	1

Parameters

CMW Geosciences

Project 53 Small Road, Silverdale	*Analysis* Cuckoo	*Project No.* AKL2022-0128
Title Section B - Existing	*Date* 3/10/2022	*Drawing* STAB 02

Appendix D: Laboratory Test Results

ROADTEST LTD

Revision: 1

DETERMINATION OF THE WATER CONTENT, CONE PENETRATION LIMIT & LINEAR SHRINKAGE
TEST METHOD NZS 4402 : 1986 TEST 2.1, 2.5 & 2.6

Project Name :	**53 Small Road**		
		Project No :	22 0001 75
Client :	CMW Geosciences	Page :	1 of 1
Address :	PO Box 300206 Albany, Auckland 0754	Date of Order :	30.09.22
		Sample Method :	Hand auger
Attention :	Henry Nagel	Sample Date :	30.09.22
		Sampled By :	CMW Geosciences

Test Details :

Test performed on :	Whole Sample
History :	Natural

Sample No.	Location	Depth (m)	Cone Penetration (CPL)	Linear Shrinkage (LS)	Natural Water Content (%)
636N	Expansive 2	0.4 - 0.8	83	17	37.5
637N	Expansive 1	0.4 - 0.8	71	16	37.0

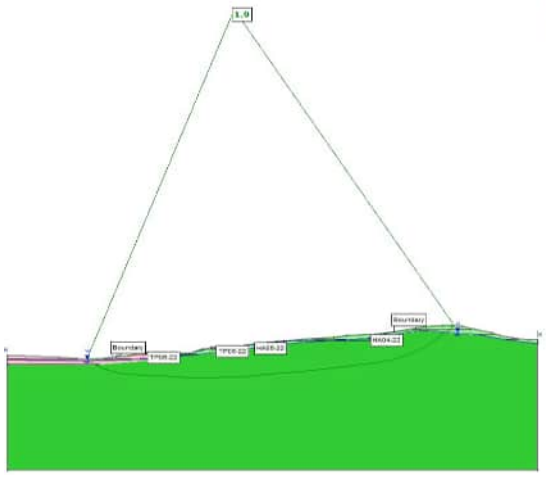
Comments :

Tested By:	RS	Date :	03 to 05.10.22
Calculated By :	AS	Date :	06.10.22
Checked By :	EC	Date :	06.10.22

Appendix D: Slope Stability Printouts

Existing Profile - Normal Groundwater Conditions

Existing Profile - Worst Credible Groundwater Conditions



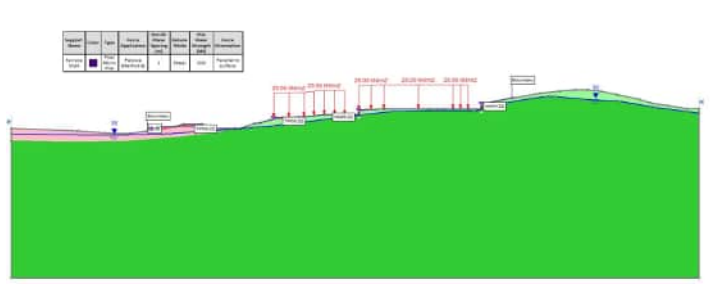
Existing Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

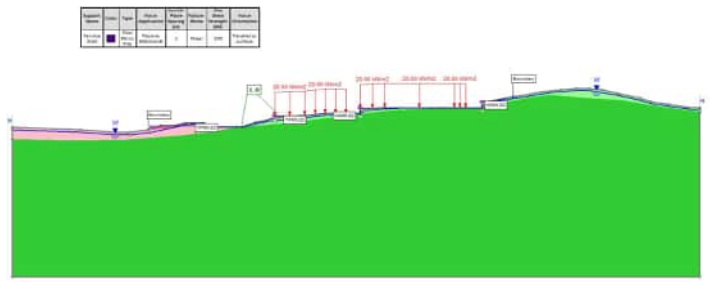
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

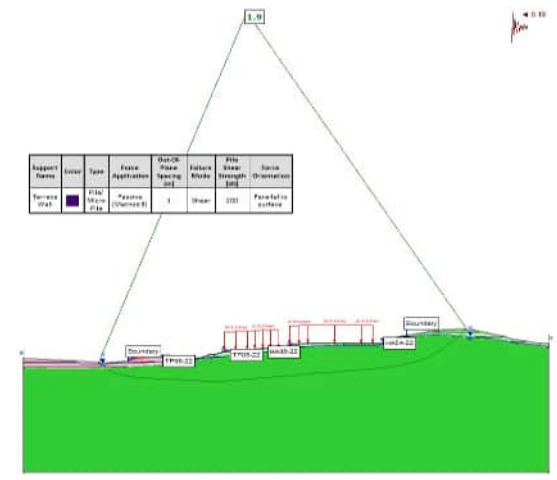
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section B - Existing	Date: 18/09/2023	Drawing: STAB 03



Proposed Profile - Normal Groundwater Conditions



Proposed Profile - Worst Credible Groundwater Conditions



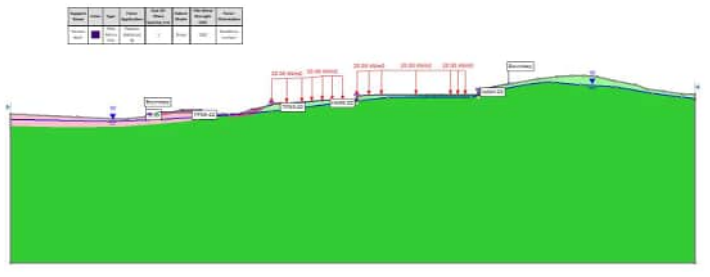
Proposed Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

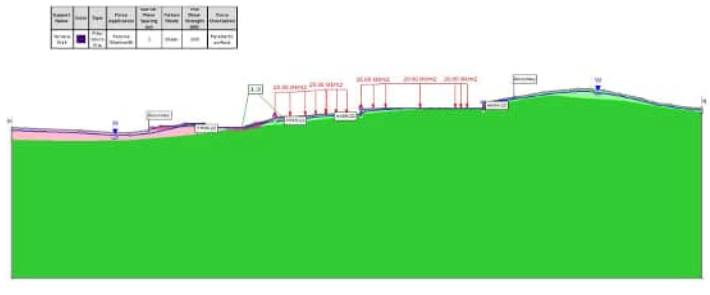
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

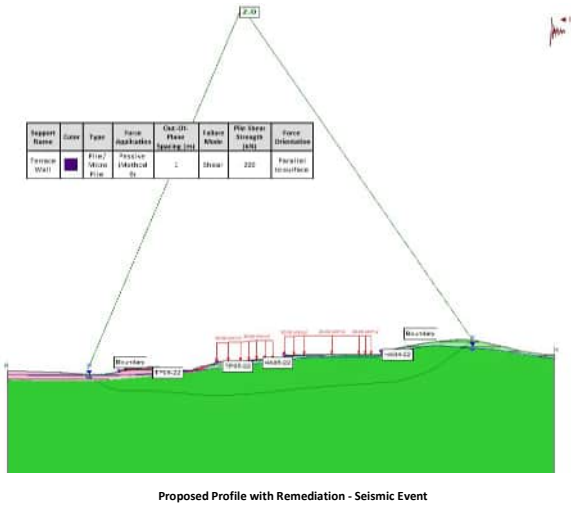
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section B - Proposed	Date: 18/09/2023	Drawing: STAB 03



Proposed Profile with Remediation - Normal Groundwater Conditions



Proposed Profile with Remediation - Worst Credible Groundwater Conditions



Proposed Profile with Remediation - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

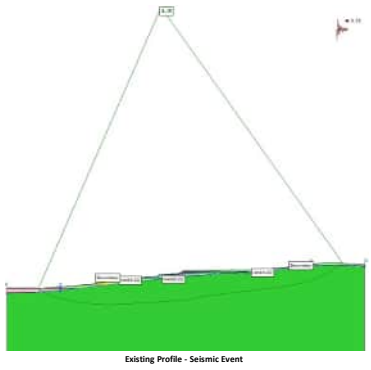
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section B - Remediated	Date: 18/09/2023	Drawing: STAB 03

Existing Profile - Normal Groundwater Conditions

Existing Profile - Worst Credible Groundwater Conditions



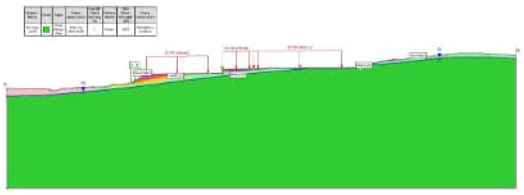
Existing Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

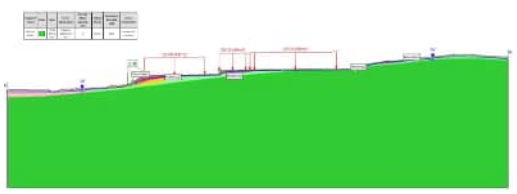
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

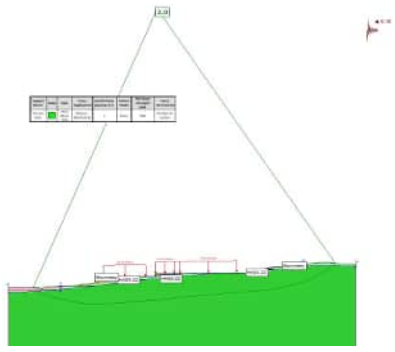
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section C - Existing	Date: 18/09/2023	Drawing: STAB 04



Proposed Profile - Normal Groundwater Conditions



Proposed Profile - Worst Credible Groundwater Conditions



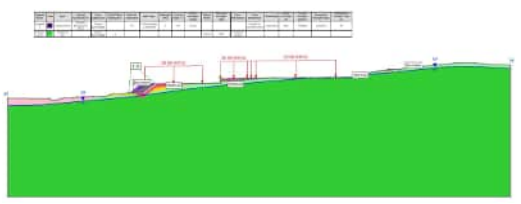
Proposed Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

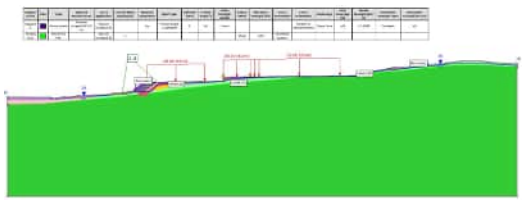
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

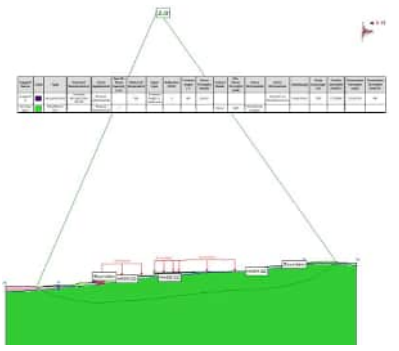
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section C - Proposed	Date: 18/09/2023	Drawing: STAB 04



Proposed Profile with Remediation (Shear Key) - Normal Groundwater Conditions



Proposed Profile with Remediation (Shear Key) - Worst Credible Groundwater Conditions



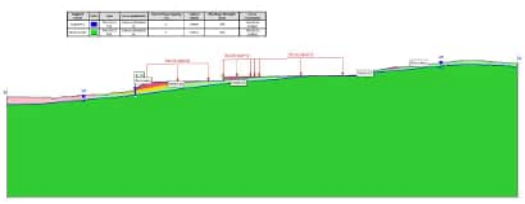
Proposed Profile with Remediation (Shear Key) - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

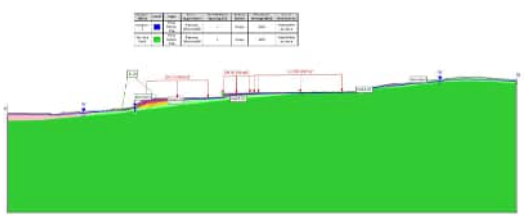
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

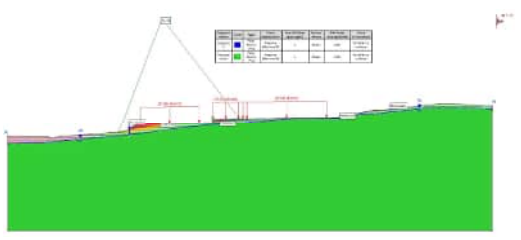
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section C - Remediated (Shear Key)	Date: 18/09/2023	Drawing: STAB 04



Proposed Profile with Remediation (Piles) - Normal Groundwater Conditions



Proposed Profile with Remediation (Piles) - Worst Credible Groundwater Conditions



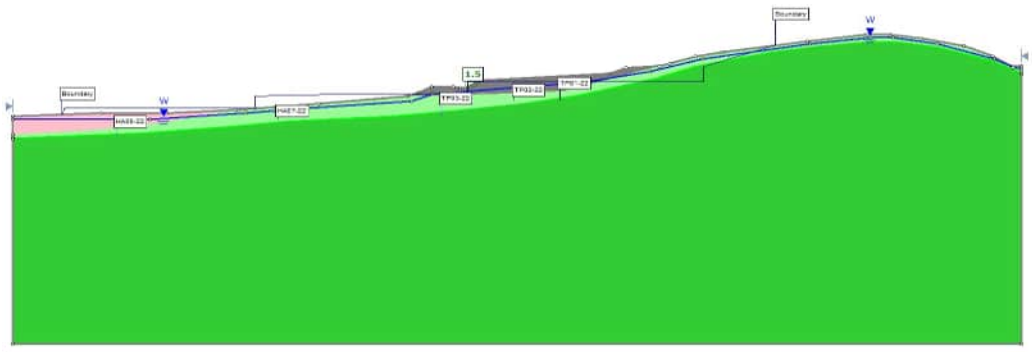
Proposed Profile with Remediation (Piles) - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

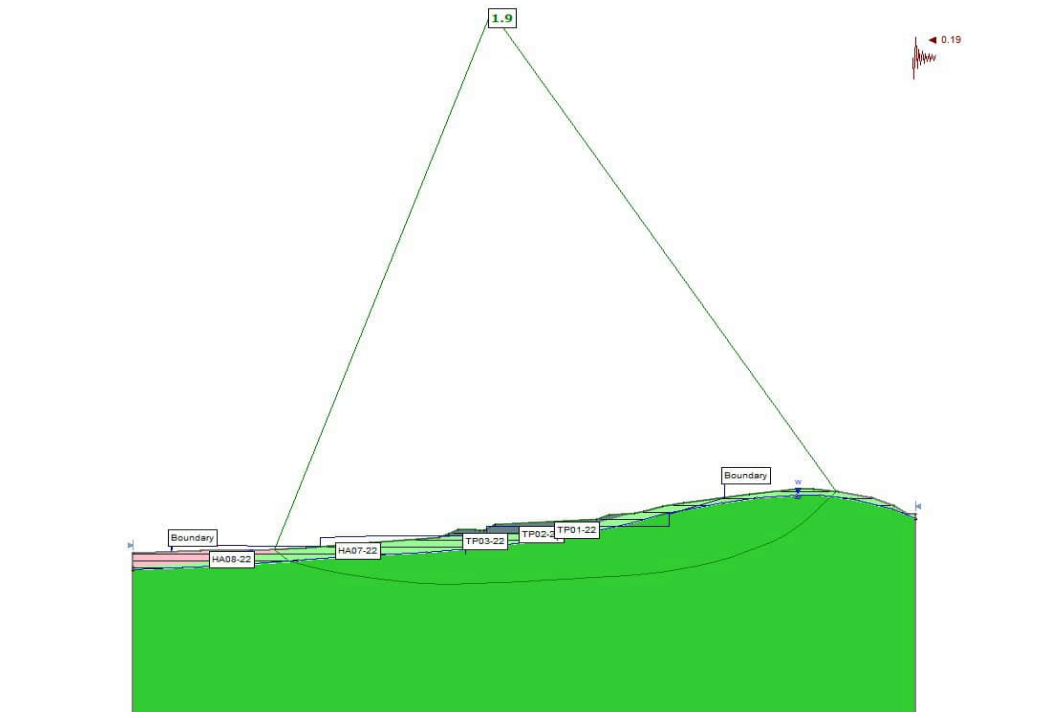
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section C - Remediated	Date: 18/09/2023	Drawing: STAB 04

Existing Profile - Normal Groundwater Conditions



Existing Profile - Worst Credible Groundwater Conditions



Existing Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
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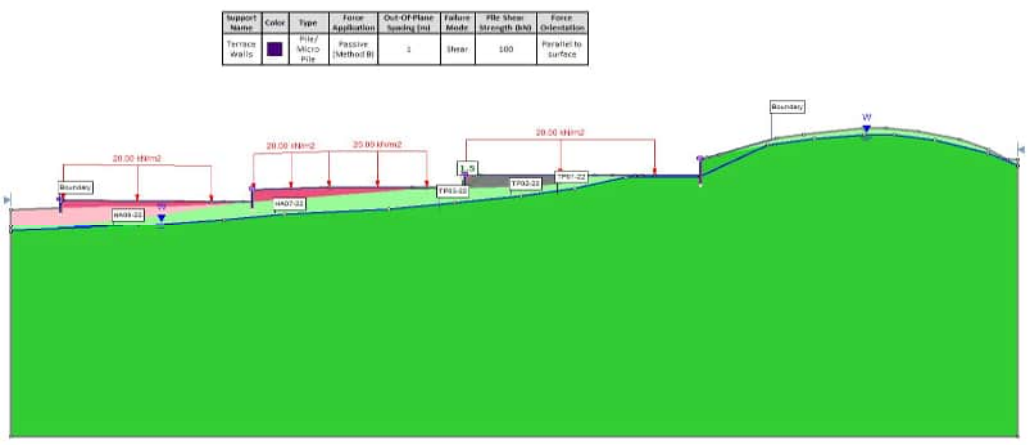
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

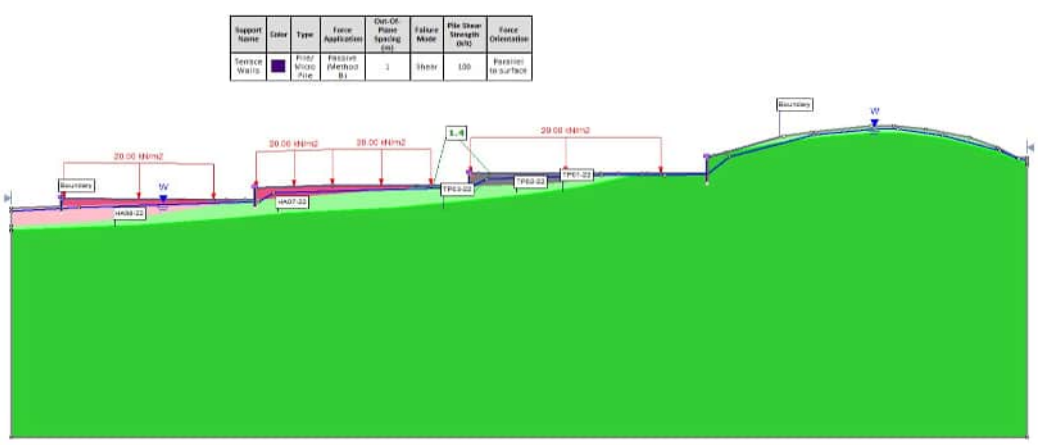
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

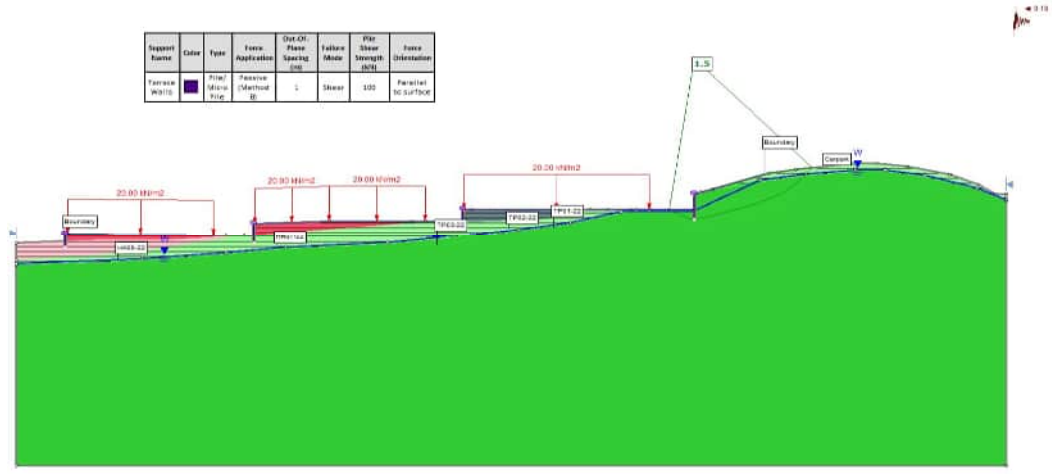
CMW Geosciences Great People | Practical Solutions	*Project* 53 Small Road, Silverdale	*Analysis* Cuckoo	*Project No.* AKL2022-0128
	Title Section D - Existing	*Date* 18/09/2023	*Drawing* STAB 05



Proposed Profile - Normal Groundwater Conditions



Proposed Profile - Worst Credible Groundwater Conditions



Proposed Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
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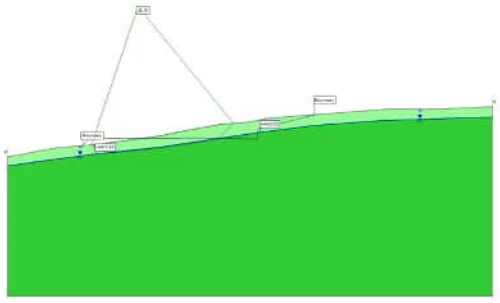
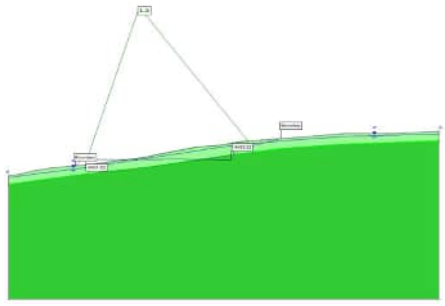
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

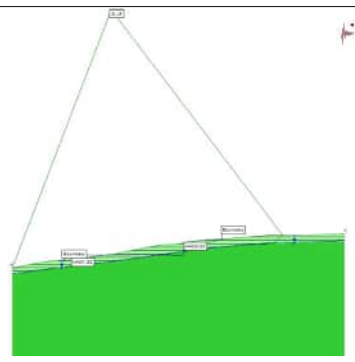
CMW Geosciences Great People | Practical Solutions	*Project* 53 Small Road, Silverdale	*Analysis* Cuckoo	*Project No.* AKL2022-0128
	Title Section D - Proposed	*Date* 18/09/2023	*Drawing* STAB 05



Existing Profile - Normal Groundwater Conditions



Existing Profile - Worst Credible Groundwater Conditions



Existing Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
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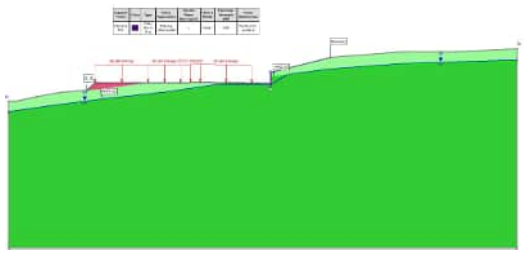
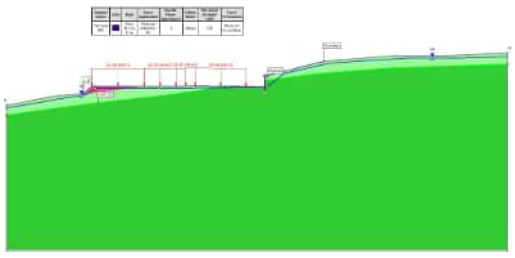
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section E - Existing	Date: 18/09/2023	Drawing: STAB 06



Proposed Profile - Normal Groundwater Conditions



Proposed Profile - Worst Credible Groundwater Conditions

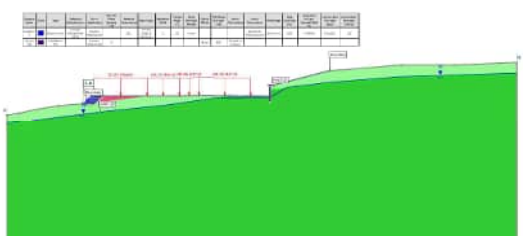
Proposed Profile - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

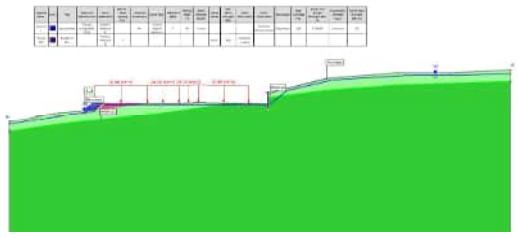
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

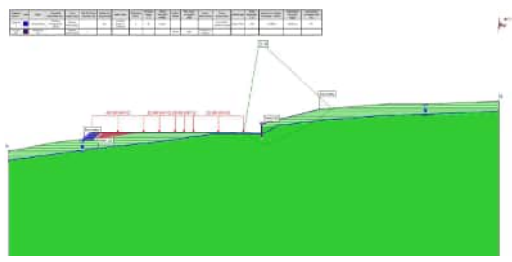
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section E - Proposed	Date: 18/09/2023	Drawing: STAB 06



Proposed Profile with Remediation (MSE) - Normal Groundwater Conditions



Proposed Profile with Remediation (MSE) - Worst Credible Groundwater Conditions



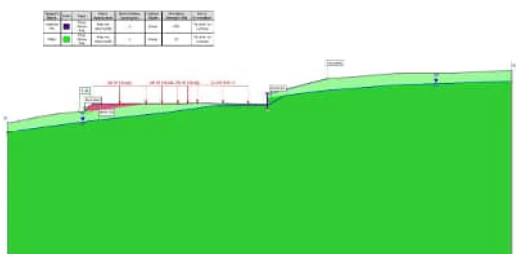
Proposed Profile with Remediation (MSE) - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

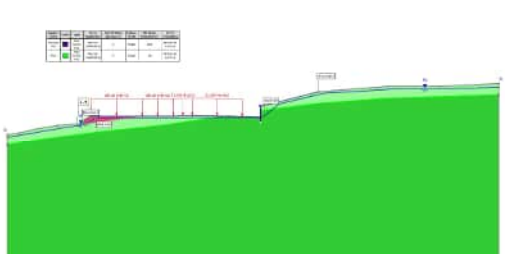
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

Parameters

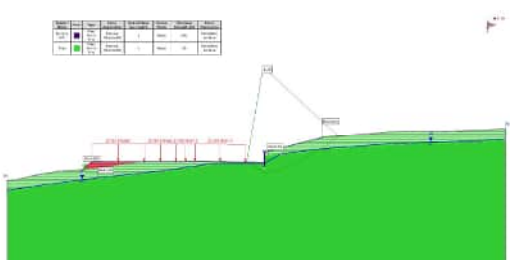
	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section E - Remediated (MSE)	Date: 18/09/2023	Drawing: STAB 06



Proposed Profile with Remediation (Piles) - Normal Groundwater Conditions



Proposed Profile with Remediation (Piles) - Worst Credible Groundwater Conditions



Proposed Profile with Remediation (Piles) - Seismic Event

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		18	Mohr-Coulomb	2	26	Water Surface	Custom	1
RS NA		18	Mohr-Coulomb	5	26	Water Surface	Custom	1
Trans		18	Mohr-Coulomb	0	20	Water Surface	Custom	1
HW NA		23	Mohr-Coulomb	10	40	Water Surface	Custom	1
Engineered Fill		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Puketoka		18	Mohr-Coulomb	3	26	Water Surface	Custom	1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
HW NA		23	Mohr-Coulomb	10	40		Water Surface	Custom	1
Existing Fill (S)		18	Undrained	50		Constant	Water Surface	Custom	0
RS NA (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Trans (S)		18	Undrained	20		Constant	Water Surface	Custom	0
Engineered Fill (S)		18	Undrained	100		Constant	Water Surface	Custom	0
Puketoka (S)		18	Undrained	90		Constant	Water Surface	Custom	0

	Project	Analysis	Project No.
CMW Geosciences	53 Small Road, Silverdale	Cuckoo	AKL2022-0128
	Title: Section E - Remediated	Date: 18/09/2023	Drawing: STAB 06

Appendix E: Groundwater Drawdown Calculations

CMW Geosciences Great People | Practical Solutions	CLIENT: **Build Rich Limited**	DESIGNER:	HN
	PROJECT: **53 Small Road, Silverdale**	CHECKED:	SG
		REVISION:	0
	TITLE: **Groundwater Drawdown Calculation Section D**	DATE:	11/09/2023
		PROJECT:	AKL2022-0128

Hydraulic conductivity of saturated zone

Horizontal k_h = 1.00E-07 m/s Anisotropy parameter m_2 = 1.732050808

Vertical k_v = 3.33E-08 m/s

Recharge W = 279.75 mm/yr = 8.9E-09 m/s 25-40% annual rainfall (1119mm) (NIWA NZ)

Area of excavation Radius of open excavation

A= 12500 m^2 r_p = 63.078

Water thickness above bottom of excavation

h_0 = 4 m

Saturated thickness of excavation wall

h_p = 0 m assumed wall will be fully drained

Radius of influence:

Initial radius of influence

r_0 = 76.0891893 m h_0 = 4.00 0

Note (r0 > rp)

Inflow from the sides

Q_1 = 4.36 m^3/day

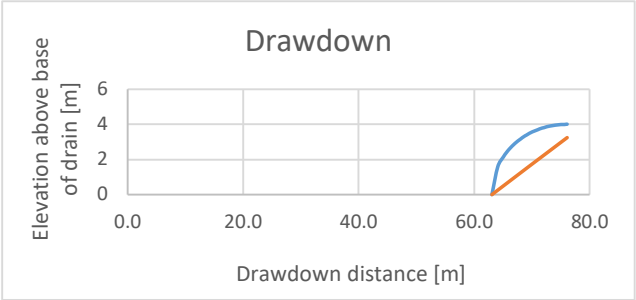
0.5046 l/s

Inflow from the bottom

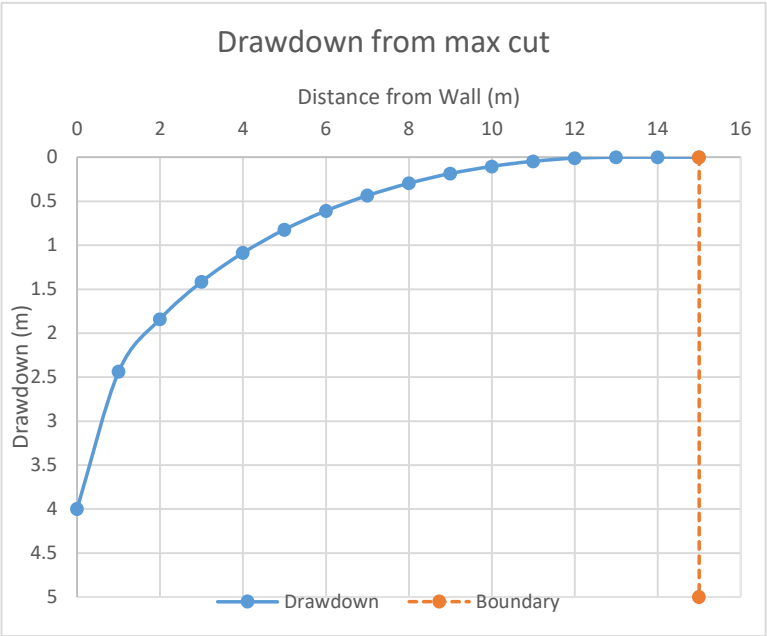
Q_2 = 5.03 m^3/day

0.58 l/s

Drawdown curve



Drawdown curve relative to max cut



REFERENCES: Fred Marinelli and Walter L. Niccoli, March-April, 2000, Groundwater, Vol. 38, No. 2, Simple Analytical Equations for Estimating Ground Water Inflow to a Mine Pit

CMW Geosciences Great People | Practical Solutions	CLIENT: **Build Rich Limited**	DESIGNER:	HN
	PROJECT: **53 Small Road, Silverdale**	CHECKED:	SG
		REVISION:	0
	TITLE: **Groundwater Drawdown Calculation (Northern Driveway)**	DATE:	11/09/2023
		PROJECT:	AKL2022-0128

Hydraulic conductivity of saturated zone

Horizontal k_h = 1.00E-07 m/s Anisotropy parameter m_2 = 1.732050808

Vertical k_v = 3.33E-08 m/s

Recharge W = 279.75 mm/yr = 8.9E-09 m/s 25-40% annual rainfall (1119mm) (NIWA NZ)

Area of excavation Radius of open excavation

A= 12500 m^2 r_p = 63.078

Water thickness above bottom of excavation

h_0 = 1.5 m

Saturated thickness of excavation wall

h_p = 0 m assumed wall will be fully drained

Radius of influence:

Initial radius of influence

r_0 = 68.0509115 m h_0 = 1.50 0

Note (r0 > rp)

Inflow from the sides

Q_1 = 1.57 m^3/day

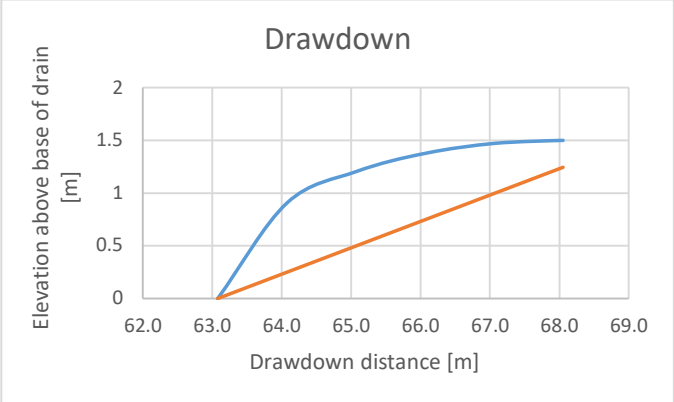
0.1817 l/s

Inflow from the bottom

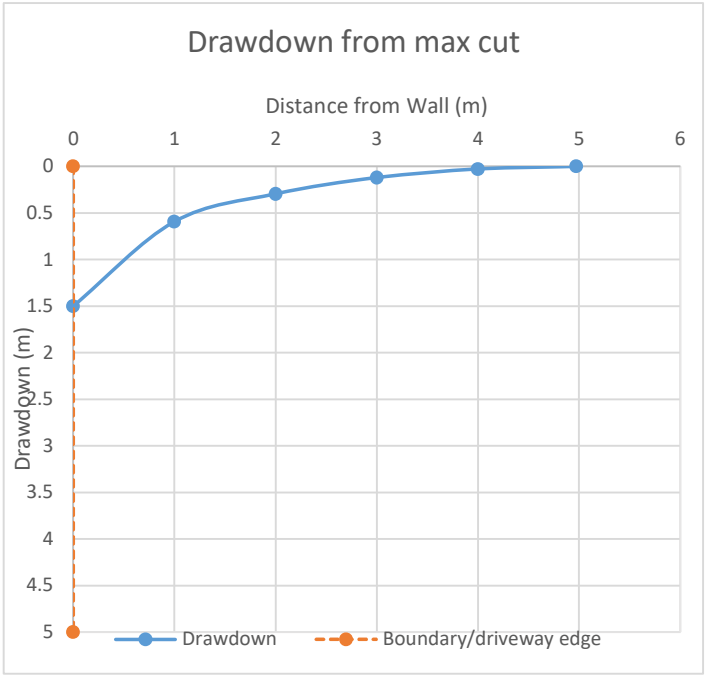
Q_2 = 1.89 m^3/day

0.22 l/s

Drawdown curve



Drawdown curve relative to max cut



REFERENCES: Fred Marinelli and Walter L. Niccoli, March-April, 2000, Groundwater, Vol. 38, No. 2, Simple Analytical Equations for Estimating Ground Water Inflow to a Mine Pit

Appendix F: Groundwater Impacts Assessment

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.6. Dewatering or groundwater level control associated with a groundwater diversion permitted under Standard E7.6.1.10

Condition		Geotechnical Interpretation of Compliance
1. The water take must not be geothermal water *2. The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock* *3. The water take must only occur during construction*	**Non-Compliant**	1. Water take is not geothermal 2. Water take will be >30 days 3. As above

Chapter E: Auckland-wide rules, Natural resources»E7 Taking, using, damming and diversion of water and drilling»E7.6. Standards Permitted activities»E7.6.1. Permited activities »E7.6.1.10. Diversion of groundwater caused by any excavation, (including trench) or tunnel

Condition		Geotechnical Interpretation of Compliance
1.All of the following activities are exempt from the Standards E7.6.1.10(2) – (6) *a. pipes cables or tunnels including associated structures which are drilled or thrust and are less than 1.2m in external diameter* *b. pipes including associated structures up to 1.5m in external diameter where a closed faced or earth pressure balanced machine is used* *c. piles up to 1.5m in external diameter are exempt from these standards* *d. diversions for no longer than 10 days; or* *e. diversions for network utilities and road network linear trenching activities that are progressively opened, closed and stabilised where the part of the trench that is open at any given time is no longer than 10 days*	**Non-Compliant**	a. No pipes >1.2m diameter proposed b. As above c. No piles >1.5m proposed d. Diversion will be >10 days e. N/A
2.Any excavation that extends below natural groundwater level, must not exceed: *a. 1ha in total area; and* *b. 6m depth below the natural ground level*	**Non-Compliant**	a. Area >1ha b. Excavations extend to 6m below ground level
3.The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.	**Non-Compliant**	3. Groundwater drawdown >2m anticipated
4.any structure, excluding sheet piling that remains in place for no more than 30 days, that physically impedes the flow of groundwater through the site must not: *a. impede the flow of groundwater over a length of more than 20m; and* *b.extend more than 2m below the natural groundwater level.*	**Non-Compliant**	a. Retaining wall lengths >20m b. As above
5.The distance to any existing building or structu re (excluding timber fences and small structures on the boundary) on an adjoining site from the edge of *a.trench or open excavation that extends below natural groundwater level must be at least equal to the depth of the excavation* *b.tunnel or pipe with an external diameter of 0.2 - 1.5m that extends below natural groundwater level must be 2m or greater; or* *c.a tunnel or pipe with an external diameter of up to 0.2m that extends below natural groundwater level has no separation requirement.*	**Compliant**	a. Nearest structure (church carpark) is as close as 30m b. As above c. N/A
6.The distance from the edge of any excavation that extends below natural groundwater level, must not be less than: *a.50m from the Wetland Management Areas Overlay* *b.10m from a scheduled Historic Heritage Overlay; or* *c.10m from a lawful groundwater take.*	**Compliant**	

Appendix G: Geotechnical Works Specification

19 September 2023 Document Ref: AKL2022-0128AE Rev. 0

Land Development Geotechnical Works Specification

For: 53 Small Road, Silverdale

1 INTRODUCTION AND SCOPE

This specification covers the geotechnical remediation works and associated earthworks outlined in the CMW Geotechnical Earthworks Design Report, referenced AKL2022-0128AD Rev. 0. It supplements the information provided on the design drawings and within the report. It provides detail on the required specification for:

- Site clearance and preparation including topsoil stripping and stockpiling;
- Geotechnical stabilisation works such as shear keys and stability undercuts;
- Subsoil drainage installation;
- Cut to fill earthworks operations;
- Fill materials and testing requirements;
- Earthworks finishing and respread of topsoil; and,
- As-built records.

Excluded from the scope are geotextile reinforced slopes with a face and steeper than 30-degrees or retaining structures covered by a building consent. Such works will be carried out in accordance with an independent structure specific specification.

Unless varied onsite by the Geotechnical Engineer, the following specification requirements must be met in order for CMW Geosciences (CMW) to provide a Geotechnical Completion Report for the works.

2 RELEVANT DOCUMENTS

2.1 Standards, Guidelines and Consents

The works shall comply with the relevant sections of the following standards, guidelines and consents:

1. Health and Safety at Work Act 2015 and Regulations 2016;
2. All Project Resource Consent Conditions and Engineering Works Approvals;
3. The applicable Council Infrastructure Design Standard;
4. The Auckland Council, Erosion and Sediment Control Guidelines – Guidance document 2016/005;

5. NZS 4431:2022 Engineered Fill Construction for Lightweight Structures;
6. NZS 4402: 1986 Methods of Testing Soils for Civil Engineering Purposes; and,
7. NZS 4404: 2010 Code of Practice for Urban Land Subdivision.
8. WorkSafe NZ – Excavation Safety Good Practice Guidelines, July 2016.

2.2 Geotechnical Investigation Report

Details of the geotechnical investigation, soil and rock conditions encountered, and the design of the geotechnical remedial works are contained in the CMW report AKL2022-0128AD Rev. 0. The contractor should be aware of the contents and recommendations contained in that report.

The works shall comply with the recommendations contained in that report.

2.3 Construction Drawings

The works shall comply with the following geotechnical design drawings and standard details:

- Aspire Consulting Engineers, 53 Small Road, Silverdale – Report 1782-1, dated August 2023.
- CMW Typical Details #1, 3, 4: shear key, slope buttress and pond buttress.

2.4 Conflicting Information

Where there is any conflict or discrepancy in the requirements of this specification and the documents listed above the matter shall be referred to the Geotechnical Engineer (CMW) for clarification.

3 GEOTECHNICAL OBSERVATION REQUIREMENTS

The following items form hold points in the construction works that require observation, testing and approval by the Geotechnical Engineer (CMW):

1. Foundations for filling once topsoil and unsuitable materials have been stripped prior to fill placement;
2. Shear key excavations and undercuts to confirm depth and extents prior to backfilling;
3. Subsoil drain excavations prior to placement of aggregate;
4. Any imported soil fill materials prior to placement on site;
5. Drainage aggregate quality prior to placement;
6. Geotextile layers once in place and prior to backfilling;
7. Filling placed at regular intervals to comply with the fill test frequency requirements below;
8. Compaction of backfilling in critical service trenches;
9. Flushing of the subsoil drainage system at the completion of earthworks;
10. Any unforeseen ground conditions that may impact on the construction works or future land use; and,

It is the contractor's responsibility to ensure that the Geotechnical Engineer is given reasonable notice and opportunity to observe the above works and that the works do not proceed until approval has been gained from the Geotechnical Engineer.

24 hours is considered reasonable notice.

4 SAFETY IN DESIGN

The design landform requires site excavations that may include geotechnical works such as undercuts, temporary excavations, steep fill batters, shear key excavations, deep and shallow subsoil drains as

specified in the Geotechnical report and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent part in that respect). The CMW designs/specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/or methods and avoid risk to personnel.

5 TEMPORARY BATTERS AND EXCAVATION STABILITY

The temporary stability of the works is the responsibility of the main contractor. All works are to be completed in accordance with the requirements of current safety legislation and WorkSafe NZ.

Slope instability during construction is a significant risk where earthworks may cause changes to slope geometry or groundwater conditions.

The causes of instability during earthworks may include:

- Removal of toe support due to excavation;
- Over steepening of slope angles in temporary batters;
- Geological defects in the soil or rock mass, particularly where these are exposed in excavation faces;
- Elevated groundwater levels following rainfall, perched groundwater or rapid recharge due to the reduced distance to an impermeable layer (i.e. undisturbed rock) due to cut operations; and,
- Additional loading upslope of excavations. i.e. construction equipment or stockpiles.

To help mitigate these risks the contractor should consider:

- Staging excavations which reduce support to slopes or create temporarily over steepened slopes, to ensure large areas are not left unsupported. The allowable length of excavation to have open at any one time will vary and is dependent on a number of factors such as, local ground conditions, groundwater, length of time the excavation will be open, weather, depth of excavation, geological defects present and the earthworks equipment and methodology used;
- Ceasing works in excavations during rainfall and assessing stability of excavations following rainfall events prior to resuming work;
- Benching or battering back of excavation faces;
- Ensuring good control of surface water runoff above excavations and batters;
- Covering steep batters with impermeable covers where they may be left without support for any significant period of time;
- Avoiding loading the crests of slopes and excavations (including loading with working plant);
- Putting in place comprehensive risk identification and management procedures and work methodologies for temporary excavation stability;
- Carrying out regular inspections upslope of excavations and of the excavation slope to look for signs of instability such as ground displacement and the development or propagation of cracks; and,

- Seeking advice from the Geotechnical Engineer where there is doubt as to the stability of a slope or excavation.

6 CONSTRUCTION SPECIFICATION

6.1 Site Preparation

The Contractor shall remove all vegetation from the site of the earthworks except for trees indicated for preservation either by marking on the site or noted on the drawings, and clear the remainder of the site.

Clearing shall mean the felling of all trees, except those indicated, removal of all growth other than grass and weeds, extraction of tree stumps, demolition of fences and other minor items remaining in the way of site stripping, and the complete disposal of all items. Stumping shall mean the removal of all roots greater than 25mm in diameter.

Cleared areas shall be stripped to remove all turf and organic topsoil to depths designated by the Engineer ahead of or during the stripping operations. Stripping shall also cover picking up any old topsoil stockpiles and any buried topsoil detected during the course of the works. The depth shall be sufficient to remove all materials considered unsuitable as fill or unsuitable to remain beneath fill but will not necessarily extend to the full limit of organic penetration.

6.2 Erosion and Sediment Control

The works shall be carried out in accordance with the project Erosion and Sediment Control Management Plan and associated drawings.

The contractor shall ensure good control of surface water runoff at all times by shaping of the surface in cut and fill areas to prevent ponding during rainfall events.

The location of temporary Sediment Retention Ponds (SRP) on sloping ground shall be decided upon with input from the Geotechnical Engineer. Where comment of SRP stability is sought by Council then all fill materials used to form batters, must be placed as engineered fill and tested accordingly unless advised otherwise by the Geotechnical Engineer.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

6.3 Stockpiles

Topsoil stockpiles can add significant driving force for slope instability when placed at or near the crest of a slope. The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

6.4 Fill Foundations and Benching of Slopes

The foundation on which filling is to be placed must be observed by the Geotechnical Engineer following clearing and prior to the placement of any filling to confirm the strength of the underlying soils is sufficient.

Where it is found, after clearing and stripping operations as specified, that the foundation on which filling is to be placed is unstable, or in cuttings if it is found after the excavation has been cut down to the levels shown in the drawings that unstable ground is encountered, then the Engineer may direct that the soft, yielding or unstable materials causing such instability shall be removed to such depth as directed.

Benching of slopes prior to the placement and compaction of filling should be carried out in accordance with the normal requirements of NZS 4431 and related documents as mentioned above, especially on the steeper areas of the site, to ensure that the filling placed is keyed into the underlying natural ground.

This would involve the cutting of benches approximately the width of a bulldozer, with a slight reverse gradient back into the slope. The optimum depth of each bench is best confirmed by careful Engineering inspections during construction.

6.5 Shear Key, Fill Drainage Key and Buttress Fill Excavations

All shear keys, fill drainage keys and buttress fills required to improve long term stability conditions are to be constructed in accordance with the design drawings and standard details. The key/buttress base width, lateral extent and benching requirements need to be confirmed on site by the Geotechnical Engineer during construction. In most cases this requires detailed logging of the excavation faces by a geo-professional and may require trial pits to be dug in the base of the excavation. The contractor should make allowance for the time and plant required for these inspections in their work programme.

6.6 Fill Materials and Conditioning

6.6.1 Soil Fill, Rock Fill or Soil and Rock Mixed Fill

Site won materials used as engineered filling shall be free of topsoil, organic matter, rubbish and other unsuitable materials. The maximum particle size for soil and rock blended fill shall be 200mm and mixing and/or crushing shall be carried in a manner that ensures that significant voids are not present in the filling between rock fragments.

For rock fill without soil blending, crushing is to occur to comply with the requirements for blended fills and needs to ensure that uniform compaction can occur without significant voids between particles in the absence of the soil fill.

6.6.2 Blending of Unsuitables

The blending of ‘unsuitables’ into structural fills may be undertaken only at the discretion of the Geotechnical Engineer following a request by the contractor and with sufficient time for appropriate consideration. Approval for any such blending must be sought from and provided by the Geotechnical Engineer in writing prior to the commencement of any blending.

In consideration of any such requests, the Geotechnical Engineer will need to be able to assess, et. al., the composition of the materials requested to be blended, the location on the site for the proposed fills, the fill depths and the elevation of the blended materials within the fills and any environmental constraints.

As a minimum, it is expected that any blended fills will be directed to comply with the following conditions:

- All significant, solid organics (such as roots and stumps) to be removed prior to blending; and,
- All inclusions of suitable man-made materials (e.g. concrete) and any excavated rock must comply with the normal compaction requirements specified herein in terms of size and ability for appropriate compaction to be achieved in close vicinity to the inclusions.
- All blended materials must be appropriately mixed/ blended normal fill materials to the specified ratio. Un-mixed interlayering of normal engineered filling with unsuitables will not be accepted.
- As a preliminary indication, it is expected that the ratio of unsuitables to suitable fill will not exceed 1 in 10 by volume.

It is expected that the Geotechnical Engineer will also need to apply limits to the location/depth of blended fills within any specified fill area.

6.6.3 Hardfill

Hardfill used as structural filling shall be a graded, unweathered, durable, crushed rock product approved by the Geotechnical Engineer, with a grading suitable for compaction.

6.6.4 Material Conditioning

The cut materials on site may require some drying prior to compaction to achieve the required specification. This may be done by harrowing (such as with discs) and air drying when conditions permit or by the addition of hydrated lime.

The addition of lime and/or cement to engineered filling in concentrations greater than 3% requires the approval of the Geotechnical Engineer.

All additives such as lime or cement proposed for use in backfill materials for Reinforced Earth Slopes or other materials in contact with geosynthetics must be approved and monitored by the Geotechnical Engineer.

6.7 Fill Placement, Compaction and Testing Requirements

6.7.1 Soil Fill

Soil placed in fills shall be conditioned and compacted until the following conditions are satisfied. Alternative methods based on specified compaction techniques may be selected by the Geotechnical Engineer if the method below is considered inappropriate due to the granular nature of the materials.

There are three classes of filling defined:

1) General Fill: Structural engineered fill which does not fall into either of the other two classes below;
2) High Strength Fill: Where specified on the drawings or GDR. Typically used for critical batter faces, shear keys and road subgrades;
3) Landscape Filling: Lower strength filling (than General Filling) may be specified on a case by case basis by the Geotechnical Engineer where the strength and properties of General fill is not required and such filling is approved by the client and regulatory authorities.

It should be noted that the surface of the fill area prior to placement of subsequent fill lifts should be in a state so as not to create a break in the consistency of the fill material between lifts. For example, if surfaces are left to dry out, or rolled to seal them from rainfall infiltration then the surface must be broken up and scarified with rippers or by other means to ensure a good bond between fill lifts.

The maximum lift of filling placed before compaction is dependent on the size and nature of the compaction equipment. Typically, 300mm loose depth is considered the maximum for a Cat 815/820 type compactor. In any event the contractor must ensure that the fill is placed and compacted to achieve even and adequate compaction throughout each layer/lift.

The test criteria and frequency for cohesive materials (Clays & Silts) are set out in Table 1 and 2 below. If non cohesive soils (i.e., Sands) are to be placed as engineered fill the matter should be referred to the Geotechnical Engineer to define the testing requirements.

Table 1 – Cohesive Materials (soil fill and soil/rock blended fill) Compaction Test Criteria for Engineered Filling:

	Air Voids (1)		Vane Shear Strength (2)		Moisture Content(3)	Dry Density(3)
	Average	**Maximum Single Value**	**Average**	**Minimum Single Value**	**Maximum**	**Minimum**
General Fill	10%	12%	140 kPa	110 kPa	40%	1.25 t/m^3
High Strength Fill	8%	10%	150 kPa	120 kPa	40%	1.3 t/m^3
Landscape Fill	TBC by Geotechnical Engineer of case by case basis					

(1) Air Voids Percentage (as defined in NZS 4402:1986)

(2) Undrained Shear Strength (Measured by hand shear vane – calibrated using NZGS 2001 method)

(3) Moisture content and minimum dry density non-compliance may be accepted on site by the Geotechnical Engineer on a case by case basis depending on the nature of the material and the other criteria results.

Table 2 – Cohesive Materials (soil fill and soil/rock blended fill) Compaction Testing Frequencies for Engineered Filling:

	Field Density & Air Voids %	**Vane Shear Strength**	**Solid Density**	**Compaction Curve**
General Fill	1 test per 1500m^3 of fill placed with not less than 1 test per 500mm lift of filling for each area.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling for each fill area.	1 test per material type per 50,000m3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m3 or at least 1 test every 5 weeks.
High Strength Fill	1 test per 1000m^3 of fill placed with not less than 1 test per 500mm lift of filling and for each 50m length of shear key excavation.	1 set of tests (4 readings within 1 metre of each other) per 500m^3 of filling placed with not less than 1 test per 500mm lift of filling per 25m of shear key excavation.	1 test per material type per 50,000m3 or at least 1 test every 8 weeks.	1 test per material type per 30,000m3 or at least 1 test every 5 weeks.
Landscape Filling	TBC by Geotechnical Engineer of case by case basis			

The test criteria and/or frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.7.2 Site Won Rock Fill

A compaction specification is to be determined by the Geotechnical Engineer based on site trials.

6.7.3 Compaction Testing Reporting Requirements

1 All test location coordinates to be recorded by hand held GPS with reference to the NZTM projection. Test location coordinates, with date and test number reference are to be provided to the Geotechnical Engineer in electronic (excel) format on a weekly basis). Alternatively, the Geotechnical Engineer may approve the use of site plans to mark the location of tests in lieu of GPS location.

2. The volume of filling placed for each progress claim month (typically ending 20th of the month) including all filling placed (undercut and cut to fill) to be provided to the Geotechnical Engineer monthly by the contractor or Engineer to the Contract to allow assessment of test frequency adequacy.

3. Interim fill test summaries are to be provided to the Geotechnical Engineer for review on a regular basis.

6.7.4 Hardfill

A plateau compaction test shall be carried out on site under the supervision of the Geotechnical Engineer, for each type of hardfill placed to determine the achievable maximum dry density (MDD) with no more than 20% total voids unless a laboratory derived MDD can be provided. The Geotechnical Engineer shall be given the opportunity to approve the size and type of compaction equipment to be used prior to any plateau testing.

Hardfill shall be placed and compacted to 95% of the MDD determined from the plateau test or laboratory MDD. If these conditions are not able to be met then appropriate adjustment of the moisture content or compaction equipment will be required.

In all cases, the dry density of the compacted fill at any one test site shall be not more than 5% below the minimum and the average of the dry densities of any ten consecutive test sites shall not be less than the specified minimum.

The Geotechnical Engineer may at their discretion, alter the compaction specification to a method compaction specification based on the plateau test result for materials with a maximum particle size greater than 65mm.

The test frequency shall be 1 test per 500m^3 of hardfill placed with not less than 1 test per 500mm lift of filling for each fill area.

The test frequency may be relaxed at the discretion of the Geotechnical Engineer (CMW) for the project or in a discrete fill area subject to the consistency of the results achieved being acceptable over a specified period of time.

6.8 Subsurface Drainage

6.8.1 General

Drainage for shear keys, fill drainage keys, buttress fills, underfill gully drains and counterfort drains shall be constructed in accordance with the design drawings and standard details.

6.8.2 Materials

6.8.2.1 Pipes

Drainage pipes used in subsoil drainage shall be 160mm diameter highway grade drain coil. Drain coil walls shall be perforated or solid as detailed in the design drawings or directed by the Geotechnical Engineer on site. Drain coils shall not have a geofabric filter sock unless requested by the Geotechnical Engineer on site.

6.8.2.2 Aggregate

Auckland Council now generally require that subsoil drainage has a 100-year design life and is essentially maintenance free, unless there is an entity such as body corporate or residents association that maintenance responsibility can be transferred to. Maintenance by individual owners is not practical as the subsoil drainage systems usually cross over, and generally benefit, multiple lots.

This requires a high quality drainage aggregate with the following properties:

- Self-filters against the soils present on site preventing loss of permeability over time; or, able to be practically wrapped in a suitable geofabric filter;
- High permeability, which translates to a low fines content; and
- Stable and not subject to crushing, weathering, internal erosion or piping, or significant loss of volume (settlement) over time.

Ideally the drainage aggregate should be a well graded self-filtering material such as a clean (free of significant cohesive fines) scoria SAP50 product or Transit F/2 specification filter media.

Alternatively, for shear key drainage, blanket drains, underfill drainage and all applications where full encapsulation with a geofabric filter cloth can be relatively simply and safely achieved, an open graded product, preferably 27/7 Scoria may be used. Care will need to be taken to ensure that the cloth fully encapsulates the aggregate. Observation of the cloth wrap should form an inspection hold point prior to backfilling over the drain. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is not critical to maintaining slope stability then a SAP20 or SAP50 may be used without a filter cloth wrap. Drains which fall into this category must be defined and confirmed as such by the Geotechnical Engineer. Additionally, where such materials are used, regular visual inspections and approval of the aggregate quality and laboratory grading curves is required. This is to comprise visual inspection of each site stockpile prior to material being placed in the trench. One wet sieve grading curve from each site stockpile per week is required while material is being imported to site to monitor the fines content. Drain coils in this instance do not require a filter sock.

For counterfort trench drains and applications where a full filter cloth wrap is not practical to construct, and the performance of the drain is critical to maintaining slope stability then a TNZ/F2 or (approved) modified F2 aggregate must be used. In conjunction with this an approved high specification drainage pipe with filter cloth surround such as the Megaflo products may be specified.

Light compaction (i.e. tamping with back of excavator bucket) only is to be applied to drainage aggregates.

6.8.2.3 Filter Cloth

Any filter cloth surround specified on the drawings shall meet the requirements of Transit Specification TNZ/F7, Filtration Class 2 and Strength Class B unless otherwise specified on the drawings.

6.8.2.4 Trench Backfill in Service Trenches

It is important on all sloping land that service trenches running parallel to contours are avoided where possible as they can permit the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage, help develop tension cracks and possibly lead to slope and building instability.

Backfilling of all trenches should be to the general fill standard above unless specifically varied in writing by the Geotechnical Engineer and where possible the pipe bedding in all trenches on steep ground should contain a 50mm diameter perforated drain coil that is connected into each manhole on the line. This is to help prevent instability arising from the ingress of surface water and/or lateral movement of trench sides that could lead to progressive land slippage and is especially important where the lines are in close proximity to buildings.

The subdivision drain laying contractor must be made aware of these requirements and of the need to contact us when trench backfilling is to take place.

6.8.3 Depth and Extent

The location, extent and depth of the drainage shown on the design drawings may be varied on site by the Geotechnical Engineer in response to the ground conditions encountered.

6.8.4 Drainage Outlets and Inspection Points

Outlets for subsurface drainage shall be provided at regular intervals shown on the drawings or as determined on site by the Geotechnical Engineer. Pipe outlets shall be specifically formed structures with adequate protection such as a headwall and/or rock rip rap. The position of all outlets shall be recorded on the asbuilt drawings.

Where possible it is good practice to include additional inspection and/or flushing points in the subsoil drainage system in the event that their performance needs to be confirmed in the future.

In any event, at least one temporary flush point is required for each subsoil drainage system to enable flushing of the system once the earthworks are substantially complete.

The flushing of the subsoil drainage system must be witnessed by the Geotechnical Engineer.

6.9 Finishing Works and Topsoil Respread

6.9.1 Overcut

All areas cut to below finished level should be reinstated with engineered filling to the satisfaction of the Geotechnical Engineer.

6.9.2 Topsoil Depth

Topsoil respread depth should be between 100mm and 300mm, or as directed by the Engineer to the contract. On ground steeper than 1V:3H the surface should be roughened under the supervision of the Geotechnical Engineer prior to topsoil placement.

6.9.3 Unsuitable Materials

At the conclusion of earthworks all surplus unsuitable materials should be removed from site or placed in designated permanent stockpiles. The size and location of such stockpiles must be approved by the Geotechnical Engineer and recorded on the asbuilt drawings.

6.9.4 Road Subgrades

Testing and formation of road subgrades will be carried out as part of the subdivision civil works package.

7 MONITORING

7.1 Settlement

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for residential building development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is to be agreed with the Geotechnical Engineer during construction.

It is the contractor's responsibility to ensure the integrity of the monitoring points is maintained during the works.

To ensure appropriate quality settlement data is collected for analysis, the following principles and procedure for the works must be adhered to:

Instrument Installation:

- Instruments must be installed on the stripped surface prior to the commencement of surcharge filling to capture the full effects of the surcharging. Partial placement of surcharge and excavation back down to install an instrument is not acceptable.
- Upon installation, the instrument locations are to be fixed with GPS.
- The RL must be recorded by precise levelling at that time.

Surcharge Loading

- Unless instructed otherwise by the Geotechnical Engineer to avoid bearing capacity failure, it is important that surcharge filling is placed to its design height and full lateral extents in its entirety in a single, rapid operation to allow for measurement of a single settlement curve.

During construction:

- It is important that the surcharge surface RL is recorded and reported together with the instrument data.
- Readings must be taken monthly or per 1m fill or pre-load lift height, whichever is more frequent.
- GPS level readings can be taken during fill and pre-load construction.

Preload height:

- Within 48 hours of full preload height being achieved, the RL must be recorded by precise levelling and the full extent of the surcharge must be surveyed and provided to the Geotechnical Engineer as soon as possible.
- Fortnightly monitoring must be undertaken unless advised otherwise by the Geotechnical Engineer.

8 ASBUILT INFORMATION REQUIREMENTS

In order to provide a Geotechnical Completion Report (GCR) certain as-built information must be provided to CMW. It is the contractor's responsibility to ensure that all of the following items are surveyed prior to placing filling. The survey of these items should therefore form a hold point in the construction sequence.

1. The location and invert of all sub surface drainage; and,
2. The depth of filling placed including all benching, undercuts, shear or fill drainage keys and temporary ponds which have been backfilled.

CMW require the following as-built information to be provided for the GCR:

1. Cut and fill depth plan (including undercuts and shear keys);

2. Final contour plan;
3. Drainage locations and inverts (surface and subsurface);
4. Drainage outlet locations (surface and subsurface);
5. Details of any defined overland flow paths;
6. Location and heights of any retaining walls and Mechanically Stabilised Earth (MSE) structures;
7. Position and extent of any geogrid layers (in plan view);
8. Material data for imported products used such as draincoils, aggregates and geofabrics as well as confirmation that products installed comply with the requirements of the project drawings and this specification; and,
9. Any settlement Monitoring Data.