

3 May 2023

GEOTECHNICAL INTERPRETIVE REPORT

MIRA MAR LANDSLIDE

**SLEEMAN AVE AND ANZAC ROAD MIRA MAR
WESTERN AUSTRALIA**

Great Southern Development Commission
Pymont House
110 Serpentine Road
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PER2021-0347AM

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1 INTRODUCTION

1.1 General

CMW Geosciences Pty Ltd (CMW) was authorised by the Department of Primary Industries and Regional Development, by way of a signed purchase order reference DPIRD2023037A, to undertake a detailed geotechnical investigation and reporting for the landslide at Sleeman Avenue, Mira Mar, in Albany, WA. As part of the reporting potential long-term remediation options are proposed..

The scope of services was set out in CMW's proposal, reference PER2021-0347 AG Rev 1, dated 10 October 2022.

1.2 Background

Residential properties located at Sleeman Avenue are impacted by a large landslide that occurred in July/August 2021 in the suburb of Mira Mar, Albany, Western Australia. Since this time the landslide has continued to move and continues to affect a number of adjacent properties.

CMW have previously completed a landside report titled "*Preliminary Geotechnical Assessment of Landslide, Sleeman Ave and ANZAC Road, Mira Mar*", reference PER2021-0347 AB Rev 2, dated 02 December 2021.

The December 2021 report which contained background information relating to the genesis of the landslide is not repeated here although reference is made to this earlier report and the observations made at that time.

In December 2022 and January 2023 CMW undertook the site work associated with a geotechnical investigation relating to the landslide which is the main subject of this report. Besides describing the scope and results of that investigation, the scope of this report is to:

- Provide an updated geotechnical model for the landslide including the hydrogeology of the landslide area;
- Investigate the geotechnical cause of the landslide drawing on available information gathered from the most recent investigation and previous investigative work;
- Investigate the potential for the landslide to enlarge and propagate and
- Provide suggestions as to possible remedial measures considering various post-remediation land-use options.

This report attempts to explain the geotechnical reasons why the landslide occurred in 2021 and continues to move. It explains the type of work needed to mitigate against future movement.

The investigation was not intended nor specially designed to investigate whether these geotechnical reasons were the result of an anthropogenic or natural trigger or a combination of the two. The intention of this report instead is to:

- Examines the available information that has arisen from the recent investigation
- Identifies landslide triggering mechanisms.

The report does not identify in detail the cause of those triggers; it is not a forensic engineering report and was not scoped to be one. The report also does not consider whom is the appropriate implementing and funding agent for the proposed remediation option.

Another type of investigation and more detailed level of analysis is required to find out the likely causes of the triggers that initiated landslide movements in the first place and that inquiry would be within the realms of a separate forensic engineering report.

Where the current studies have discovered findings that relate to past landslide movements or specific landslide triggering mechanisms, these are documented.

The field investigations discussed in this report could not be executed earlier than the summer of 2022/2023 for the following reasons:

- The need for properties on the landslide area to first be demolished and debris removed to make the site accessible and safe for the execution of the investigations. Demolition occurred in May 2022.
- The need to wait until summer months for the site to be sufficiently dry and stable for the drilling rig and support equipment to access the site. During December 2022, landslide movements were still occurring, but they were not of sufficient magnitude to prevent safe access to drill site locations.

2 SCOPE OF WORK

The following scope of work, as set out in the relevant CMW proposal, is as follows:

- Geological / geotechnical reconnaissance of the site to record surficial features at the time of the investigation.
- Facilitation of an intrusive geotechnical investigation, comprising fourteen (14) machine boreholes and a geophysics survey.
- Installation of seven (7) Vibrating Wire Piezometers (VWP) in seven of the drilled boreholes to assess the long-term trends in porewater pressure. Locations were selected both inside and outside of the landslide area to gain a representative overview of the site.
- An interpretive report, including a summary of the items listed previously.

3 FIELD INVESTIGATION

Intrusive site investigations have been undertaken in three stages between 2013 to 2022 by various engineering consultants. Investigations have been facilitated by Douglas Partners, Shirley Consulting Engineers and CMW.

Refer to the site plan, Figure 1¹ for a compiled site plan showing all investigations undertaken. Results of historic investigation results are provided in Appendix A of this report.

3.1 Previous Investigations

3.1.1 Douglas Partners

In December 2013, Douglas Partners completed an investigation for the initial sub-division of 7 Anzac Road into 7A, 7B and 7C Anzac Road. A copy of this report was made available by the City of Albany to GSDC and CMW for use in this study.

The Douglas Partners (DP) investigation comprised:

- Seven (7) Cone Penetrometer Tests with pore water measurement (CPTu), referenced CPTu 1 through to CPTu 8 (no CPTu6) undertaken to refusal, to depths between 1.32 to 8.46 m below ground level (bgl). CTPu tests were undertaken to obtain a continuous soil profile through the site.

¹ Figures are attached after the text of this report.

- Six (6) Hand Auger Boreholes (BH 1 through BH 6) to depths between 0.5 to 3.0 m bgl. Hand Auger boreholes were undertaken to observe the near surface soil profile.
- A general site walkover/ site reconnaissance.

The locations of testing associated with the 2013 DP investigation are shown on Figure 1. Note that some interpretation is required in using the data from these early investigations because the ground profile to which they refer may have moved both horizontally and vertically. In addition, soil material properties may have changed because of landsliding that has occurred since the time of the 2013 DP investigation.

3.1.2 Shirley Consulting Engineers

In August 2022, Shirley Consulting Engineers were engaged by the owners of 14 Sleeman Avenue to undertake six (6) lines of Dynamic Cone Penetrometer (DCP) Investigations, totalling 73 DCPs. This work was subcontracted to a local consultant and the results of these penetrometer tests were made available to GSDC and CMW for use in this study.

No coordinates were provided for the Shirley Consulting DCPs, and in lieu of this are inferred from a site plan provided by Shirley Consultants showing these locations and are shown on Figure 1.

CMW have used the DCP data together with information from the December 2022 site investigation to prepare contours to refusal (for the DCPs) and top of moderately weathered rock (using the CMW Borehole data) and inferred top of residual soils (base of colluvium).

The first of these contour models is shown in Figure 5 and in preparing this figure it has been inferred that the top of the moderately weathered rock is roughly the equivalent material at which refusal of a DCP would have occurred. It is recognised DCP refusal could occur on a boulder of granite in an otherwise relatively soft matrix of colluvium and as such caution must be exercised in how this figure is utilised and interpretations drawn from it. Nonetheless, Figure 5 is useful in displaying the general subsurface morphology of the landslide site.

A further figure has been prepared representing the assessed contours of the top of residual material. This is shown on Figure 6. The contours have been developed using data from both the DCP and the Dec 2022 boreholes. The shape of the contours is somewhat influenced by where the available data is located (DCPs are confined to 3 long traverses and a short traverse).

3.2 Current Investigations

3.2.1 General

CMW's scope of investigation included a geophysical investigation followed by a geotechnical investigation.

3.2.2 Geophysical Investigation

CMW subcontracted the geophysical investigation to GB Geotechnics Pty Ltd (GBG Group) who used electrical resistivity and seismic methods to investigate the landslide.

Seven (7) North trending geophysics transects, denoted N2-N8 and four (4) East trending geophysics, transects, denoted E1-E4 utilising Seismic Refraction Tomography (SRT) and Electrical Resistivity Tomography (ERT) methods were undertaken over most of the landslide footprint zone. The geophysical line transects are shown on the attached Figure 1. Refer to Appendix B for an overview of the geophysical investigation methodologies and results.

The geophysical survey was undertaken between the 13th to 15th November 2022 and preceded the borehole drilling program, the results of the geophysical investigation were used to assist with selecting the location of the boreholes and the overall understanding of the site.

3.2.3 Borehole Drilling

Fourteen (14) machine boreholes, denoted BH01 – BH15 (excluding BH02, which was not drilled) were advanced, using PQ3 diamond drilling techniques, to depths of up to 13.5 m below ground level (bgl). Target depth of the boreholes was to penetrate at least 5 m into competent rock.

The intrusive geotechnical investigation was completed between 29th November 2022 and 13th December 2022. Further details relating to the boreholes are as follows:

- Details of the borehole locations are provided in Table 1 and shown on Plate 1 below. Investigation location are also shown on the attached site plan (Figure 1). The borehole locations and elevations shown in Table 1 were provided by a licensed surveyor and have centimetre accuracy in the vertical and horizontal directions. Not the top of some of the boreholes may have moved vertically and laterally since they were surveyed due to the landslide
- Boreholes were undertaken both within the immediate landslide area and outside the current landslide footprint to provide a Geological Model for the overall site.
- U63 thin-walled tube samples were obtained in clay layers.
- The boreholes were drilled under the direction of a CMW engineering geologist who logged the boreholes in accordance with AS1726:2017.
- Engineering logs and photographs of the boreholes are included in Appendix C.

Location	Easting*	Northing*	Ground Surface* RL (m AHD)	Termination Depth (m bgl)
BH01	582902	6124699	3.7	12.0
BH03	582862	6124753	12.4	12.0
BH04	582839	6124771	18.3	10.5
BH05	582830	6124743	16.0	9.0
BH06	582837	6124719	13.5	10.5
BH07	582824	6124762	19.4	10.5
BH08	582814	6124748	19.3	9.0
BH09	582810	6124734	18.6	9.0
BH10	582808	6124722	16.5	7.5
BH11	582803	6124760	21.3	12.0
BH12	582816	6124771	20.2	10.5
BH13	582796	6124790	29.7	13.5
BH14	582772	6124749	26.4	12.0
BH15	582775	6124756	27.4	12.0

*At the time of drilling



Plate 1: Borehole location plan, CMW investigation December 2022

3.3 Borehole Installation Details

Vibrating wire piezometers (VWPs) and standpipes were installed in seven (7) of the boreholes as listed in Table 2.

Vibrating wire piezometers were installed to provide a six hourly measurement of porewater pressure at the respective location.

The depth of the VWP installation was generally targeted at the assessed interface between the colluvium and the highly weathered rock material. However, two of the VWPs installed in BH03 and BH06 were installed deeper to investigate if an elevated groundwater pressure existed in the weathered rock.

To create a specific response zone around each VWP the following installation procedure was adopted:

1. The borehole was backfilled to a nominal 1.5 m below the respective installation depth of the VWP unit, shown in Table 2.
2. The VWP was then taped to on a 20mm PVC pipe and placed down the hole.
3. Grout was pumped down the hole to a level of nominally 1.5 m above the VWP unit.
4. The grout mix comprised the following ratio by weight; 6.6 (water): 1 (cement): 0.4 (bentonite).
5. The remainder of the hole was then backfilled with the borehole arisings.

Standpipe monitoring wells were installed in six of the remaining boreholes, except in BH10 as this borehole was drilled into a built-up drill pad in the main access way to the site.

At this location, the drill pad was removed following borehole drilling to allow for future construction plant access as may be required for example to enable removal of debris that may build up against

the west sides of the residences at 7C and 7B Anzac Road. The removal of the drill pad caused the collapse of the borehole, meaning that no standpipe installation could be undertaken.

The standpipes were installed for manual dipping purposes to obtain an indication of groundwater level in the respective borehole to correlate with the VWP data. Standpipes comprised a 50 mm diameter PVC pipe installed to the depths shown in Table 2. A 3 m length of slotted PVC pipe formed the bottom section of the standpipe with the remainder of the pipe being solid.

It should be noted that a VWP records a water pressure at the specific location of the piezometer installation. The gauge responds to almost negligible volume change to record a pressure and so they are very useful in recording water pressure in low permeability materials and noting sensitivity to rainfall events. A standpipe, in contrast, records the water pressures as a column (or head) of water. It requires a relatively large volume of water to fill the standpipe so is not effective in recording short-term changes in water pressures in low permeability materials. As such the water pressure can be under-reported. Also, unless an effective seal can be formed around the standpipe, above the slotted section, the standpipe also will record any water intercepted from multiple levels within a soil profile.

Table 2: Borehole Installation details (at time of installation)

Location ID	Monitoring Well Installation Depth		VWP Installation Depth	
	(m bgl)	Toe RL (m AHD)	(m bgl)	VWP RL (m AHD)
BH01	6.00	-2.32	-	-
BH03	-	-	6.00	5.93
BH04	10.50	7.83	-	-
BH05	9.00	6.97	-	-
BH06	-	-	7.50	5.16
BH07	10.50	8.88	-	-
BH08	-	-	4.50	14.17
BH09	9.00	9.60	-	-
BH10	-	-	-	-
BH11	-	-	6.00	14.72
BH12	-	-	4.00	15.68
BH13	-	-	10.50	18.62
BH14	12.00	14.37	-	-
BH15	-	-	7.50	19.25

4 LABORATORY TESTING

4.1 General

A suite of geotechnical index tests and strength tests were carried out by Materials Consultants and E-Precision Laboratories, both NATA registered testing authorities

4.1.1 Soil Laboratory Testing Results

The results of the index testing are provided in Table 2 and include Particle Size Distribution (PSD) testing to 75 micron, Atterberg Limit testing and organic content testing. Laboratory test certificates are provided in Appendix D. The test certificates results quote the relevant standards to which the testing was undertaken.

The test results are summarised in Table 3 below:

Table 3: Soil Laboratory test results									
Borehole	Sample Depth (m)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	LS (%)	Organic Content
BH01	2.0				43	16	27	6	
BH01	4.0-4.3	0	95	5					
BH03	1.0-1.45	2	92	6					
BH03	2.3-2.8				64	16	48	11	
BH03	6.0-6.45	7	71	22					
BH04	2.3-2.8				73	25	48	11.5	
BH04	2.8-3.0				111	25	86	20	
BH05	2.5-2.8	23	41	36	56	23	33	9.5	
BH05	2.9-3.05	21	41	38	53	22	31	6.5	
BH05	3.3-3.6	36	39	25	43	28	15	3.5	
BH06	3.9-4.0	3	67	30	37	26	11	3.5	
BH06	4.0-4.2	13	37	50	58	16	42	13.5	
BH06	4.8-5.0	4	43	53	80	19	61	15	
BH06	5.2-5.5				50	18	32	6.0	
BH07	2.7-3.0	2	52	46	59	22	37	6.5	
BH08	0.7-1.0				53	20	33	6.0	
BH08	1.3-1.5	1	37	62	62	29	33	6.0	
BH08	2.5-2.65	0	16	84	57	29	28	7.0	
BH08	4.5-4.75				64	24	40	13	
BH08	2.8-3.0				74	31	43	10.5	
BH08	4.1-4.3				89	28	61	16	
BH08	4.3-4.5				86	26	60	16	
BH09	1.2-1.5				110	24	86	19	
BH09	2.4-2.65	0	34	66					
BH11	0.5-0.8	0	85	15					0.6
BH11	1.7-1.9	0	35	76	68	28	40	12.5	
BH11	1.9-2.2	0	11	89	85	36	49	10	
BH11	2.2-2.4	0	26	74	51	21	30	9	

Borehole	Sample Depth (m)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	LS (%)	Organic Content
BH11	2.4-2.6	0	82	18	NP	NP	NP	0	
BH11	2.6-2.8	0	53	47	35	17	18	8	
BH11	5.1-5.25	0	43	57	49	19	27	9	
BH11	5.25-5.4	1	42	57	57	25	32	10	
BH11	5.5-5.7	0	49	51	48	20	28	7.5	
BH11	6.6-6.75	0	52	48	43	19	24	11	
BH12	1.5-1.7	5	49	51	42	21	24	8.5	
BH12	2.6-3.0	17	38	45	53	23	30	9	
BH12	3.7-4.0	1	50	49					
BH13	3.75-4.0	13	35	52	62	29	33	10	
BH13	4.4-4.6	39	33	28	49	36	13	5	
BH13	7.0-7.3	20	52	28	65	26	39	10.5	
BH14	2.2-2.5	1	28	71	86	24	62	15.5	
BH14	3-3.3	9	57	34	43	19	24	6	
BH15	1.8-2.0	0	47	53	63	21	42	13	
BH15	2.5-2.8	0	26	74					
BH15	3.5-3.8	0	62	38					

4.1.2 Triaxial Test Suite

A suite of consolidated isotropic undrained multi-stage triaxial tests with porewater pressure measurement was completed on undisturbed clay or clayey samples obtained by thin-walled tube sampling (U63 sample tubes). Index testing was also carried out on the same tube sample to assist with understanding and interpreting the triaxial test results.

The results of the index tests are presented in Table 4 while the triaxial test results are presented in Table 5. Test certificates for the index tests and the triaxial tests are included in Appendix D. Commentary on test results are further outlined in Section 7.

Location ID	Depth from (m)	Depth to (m)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	LS (%)
BH06	4.5	4.8	6	22	72	71	34	37	15.5
BH07	3.0	3.45	2	46	52	51	26	25	10.9
BH07	4.0	4.45	1	29	70	52	29	23	12.6
BH08	3.0	3.45	0	18	82	62	35	27	13.7
BH12	3.0	3.45	2	20	77	52	26	26	12.2
BH15	3.0	3.4	0	70	29	43	27	16	6.6

Table 5: Triaxial test results											
Location	Shear Stage	Initial Conditions		Failure States							
		σ_3 (kPa)	u_o (kPa)	u_f (kPa)	Principal Effective Stresses (kPa)				Strain (%)	Shear strength parameters	
					σ'_1 (kPa)	σ'_3 (kPa)	$\frac{\sigma'_1}{\sigma'_3}$	$(\sigma'_1 - \sigma'_3)$ (kPa)		c' (kPa)	$\phi' \text{ }^\circ$
BH06 4.5-4.8	1	90	0	72	83	18	4	65	2.10	8	30
	2	140	0	108	125	32	4	93	5.06	12	26
	3	240	0	188	170	52	3	118	12.71	18	23
BH07 3.0-3.45	1	65	0	35	175	30	6	145	1.86	22	31
	2	115	0	67	232	48	5	184	4.40	26	29
	3	215	0	99	421	116	4	305	3.54	30	28
BH07 4.0-4.45	1	85	0	59	89	26	3	63	2.40	5	27
	2	135	0	94	130	41	3	89	4.52	10	22
	3	235	0	158	203	77	3	126	7.40	16	20
BH08 3.0-3.45	1	65	0	23	174	42	4	132	2.50	15	29
	2	115	0	54	229	61	4	168	4.67	27	23
	3	215	0	116	302	99	3	203	8.92	40	18
BH12 3.0-3.45	1	65	0	51	106	14	8	92	1.57	17	32
	2	115	0	94	129	21	6	108	4.13	17	31
	3	215	0	186	154	29	5	125	9.55	18	31
BH15 3.0-3.4	1	65	0	28	181	37	5	144	2.40	4	39
	2	120	0	60	283	60	5	223	4	8	37
	3	240	0	128	477	112	4	365	7	15	35

Where: σ'_1 is the major principal stress
 σ'_3 is the minor principal stress
 u is the porewater pressure
 c' is the effective cohesion
 ϕ' is the effective friction angle

5 SITE CONDITIONS

The landslide at Sleeman Avenue has undergone several phases of landslide movement resulting in changing morphology and topography. The CMW 2021 report titled *Preliminary Geotechnical Assessment of Landslide* report details the morphology of the site to December 2021, and is related to the landslide that had occurred in the preceding months. Reference to this report should be made for a detailed overview of the site conditions following the main July/August 2021 landslide and landslide movement in the following months.

In early 2023 CMW developed a Microsoft Power Point presentation titled “*Oblique Images from Drone Survey Data. Mira Mar Landslide. 27 February 2023*” as part of a technical memo titled “First quarterly displacement monitoring reporting”, reference PER2021-0347AN Rev 0, dated 29 February 2023. This presentation shows the evolution of the landslide from September 2021 to February 2023 by way of point cloud images showing an oblique view of the landslide. This presentation clearly depicts the ongoing development of the landslide. Refer to Appendix E for a copy of this presentation.

Key features of the landslide development are as follows:

- The early stages of the head scarp forming along Sleeman Avenue, occurred in 2021. Herein under this early stage of landslide formation and subsequent landsliding is referred to as the 2021 landslide in this report.
- The roof collapse of 10 Sleeman Avenue occurred by April 2022. Both 10 and 12 Sleeman Avenue were subsequently demolished (May 2022).
- There have been several phases of debris removal from the site throughout 2022. In general, the material removed was soft remoulded clayey material pushed up by the landslide and then flowed downslope as a lobe. Several large boulders of granite were pushed up and subsequently entrained in this debris lobe, effectively being buoyant in a dense matrix of soft near saturated soil. Several of these large granitic boulders have also been removed by breaking them up and taking them off site or relocating them elsewhere on site (visible in the oblique images) to prevent them from impacting the properties downslope of the main landslide.²
- In August 2022, sand filled bulka bags, weighing approximately 1.5 tonnes each were first placed at the base of the headscarp. Several rows of these bags were subsequently placed, and a large quantity of loose sand placed behind the sandbags to form a buttress to support the part of the scarp fronting Sleeman Area was undertaken³.
- The oblique images show that, apart from a small degree of headscarp recession into Sleeman Avenue, the plan footprint of the landslide has not changed significantly since the major activation in July/August 2021. The profile of the landslide has however changed, with significant vertical enlargement of the backscarp.

² Early debris removal was instigated by the down slope property owners. During 2022 CMW were subsequently commissioned by GSDC to organise further debris removal campaigns to mitigate impacts on the downslope properties. Without the removal of the debris, the lobe flowing downslope of the landslide toe would have resulted in the collapse of 7C and 7B Anzac Road with the debris lobe moving further east and infilling the undercroft parts of these properties.

³ This work was commissioned by the City of Albany in August 2022.

5.1 Landslide Morphology

CMWs *Preliminary Geotechnical Assessment of Landslide* report (CMW, 2021) records crack patterns and makes observations relating to the morphology of the landslide following the 2021 major activation of the landslide.

A “Conceptual Geological Model” based on the observed 2021 landslide profile and crack patterns has been developed to help understand the landslide, to inform analyses and ultimately to support determination of relevant remediation measures. This conceptual model utilises observations from the December 2022 ground investigation and is presented as Figure 2, attached to this report. The figure is not intended to be a specific cross section, but a conceptual representation of the morphology, landslide mechanisms and components and key features of the landslide.

One key feature of the conceptual model is a potential increase in the elevation of the rock surface towards the eastern part of the site. This rise in rock level was detected by the geophysics (refer Appendix B and Figure 3). It was also inferred from the morphology of the original landslide, whereby it appears that a subsurface profile of harder ground appears to have influenced the form of the landslide.

In particular, observations have indicated that the toe of the landslide occurs approximately 10 m west of the downslope residential properties (namely 7A, 7B and 7C Anzac Road) and the ground movement threat to those properties is currently not from the main landslide, but instead is from a debris lobe of soft near saturated remoulded clayey materials pushed up by the toe of the main landslide. This debris being pushed up from the toe of the landslide is observed to include large boulders of granite. The clayey debris with entrained boulders moves across the former ground surface downslope of the toe of the main landslide until the lobe is impeded by the walls of the downslope properties principally 7B and 7C Anzac Road.

Whilst the toe of the landslide is *currently* assessed to be upslope of the 7B and 7C Anzac Road it is recognised that the rises in rock level are likely discontinuous. Boreholes BH03 (located between 7A and 7B Anzac Road) and borehole BH06 (located close to the SW corner of 7C Anzac Road) show a relatively deep soil profile. Hence, conditions could change and so the landslide could extend further downslope thereby directly impacting the downslope properties.

Another key feature of the conceptual geological model is the presence of very large boulders of coarse-grained granite. Some of these boulders measure more than 3 m across (maximum dimension), (refer to Plate 1 below for an example). Ordinarily corestones of more intact material surrounded by weathered materials can be expected in part of the weathering profile of granites.

All boreholes except borehole BH01 encountered a bedrock and associated weathering profile that comprised igneous rock (microdiorite) that was more mafic and finer grained (medium grain size) than the granite (coarse grain size) observed in the boulders, or in the granite observed elsewhere in outcrops around Mira Mar. We have therefore inferred that the boulders observed are not the residual weathering products of material beneath their current location. Note that at borehole BH01 the rock comprised granite.

Boreholes BH13, BH14 and BH15 located in Sleeman Avenue also record the finer grained more mafic rock type (microdiorite) thus the boulders of granite encountered in the lobe close to 7B and 7C Anzac Road cannot be attributed to corestones that have been solely transported by the current landslide. They could have been transported on trucks in the past and dumped on the site, but this seems unlikely given their size as they would have been very difficult to handle and transport.

For example, some boulders are approximately 3 m x 2 m x 1 m (i.e. 6 m³ approx. 15 tonnes). Thus, it is considered likely that the boulders are the product of past higher elevation hillslope processes (landsliding) affecting a greater part of the overall hillside than the current landslide area.



Plate 1: Granite boulder removed from behind 7B Anzac Street

The presence of discontinuous rises in the bedrock surface appears to currently be limiting the downslope extents of the landslide, the presence of these rock rises or ridges may have created a geometry for extensional cracks (tension cracks) to occur. The tension cracks marked “R” on Figure 2, together with the presence of the graben present immediately after the 2021 landslide, indicate that movement likely initiated in this area allowing material to move translationally downslope. This movement created the geometry for the graben to occur. It also removed restraint from the upper part of the hillslope allowing the head-scarp to develop and the landslide to propagate. The original graben block is now less distinct having been moved laterally by further propagation of the landslide in late 2021 and throughout 2022.

No single slip surface can accommodate a landslide with the geometry observed and depicted in the attached Figure 2. As such it is necessary to have internal secondary slip surfaces (similar to those shown in Figure 2) and the result is a complex compound landslide. The crack morphology observed in late 2021 following the July/August landslide and observed and described in the CMW 2021 report supports the model shown in Figure 2, as do observations from the December 2022 boreholes. In particular, soft zones were noted in the area where the landslide geometry would tend to lead to voids (e.g., around D in Figure 2). At these locations very soft material and in some cases sand (inferred to be wash down from above) was observed.

The following interpretation can be made from the geological model:

- a) In the context of the relatively shallow slope gradients in the extension part of the slope (around R in Figure 2) high porewater pressures most likely initiated the 2021 failure and continue to be a main driving agent to instability.
- b) This area of the landslide corresponds to an area where a groundwater spring was present before the 2021 landslide occurred (refer P on Figure 2) and where piezometers installed in December 2022 show the piezometric surface is close to the ground surface despite the data being collected during summer months.
- c) It is thus inferred that the summer ground water levels are likely being fed in part from regional groundwater through a flow through the fracture rock mass. The groundwater

levels will likely be augmented by more localised flow of infiltrating rain and potentially other water sources (soakwells, leaking drains or pipes, water flow through service trench backfill etc.) and intersected by low permeability layers above the rock.⁴

- d) Groundwater levels will also be augmented through direct rainfall infiltration and run-off on the site especially into tension cracks or by surface water draining along Sleeman Avenue and flowing over the headscarp.

A sandy plateau above the site has been identified on the 1:250,000 geological map for Mt Barker-Albany which could be acting as an upper catchment area for regional groundwater (refer to Plate 2 below). The unit in this area (Czs of quaternary age) is described as Sand – white, grey or brown.

It is considered that this material is a potential source for regional groundwater flow through the fractured rock mass and could account for the high summer groundwater levels recorded and the perennial spring on the site. Other sources for water likely augment this source raising groundwater level sufficiently to create the conditions for landsliding, this will especially be the case during the wetter winter months.

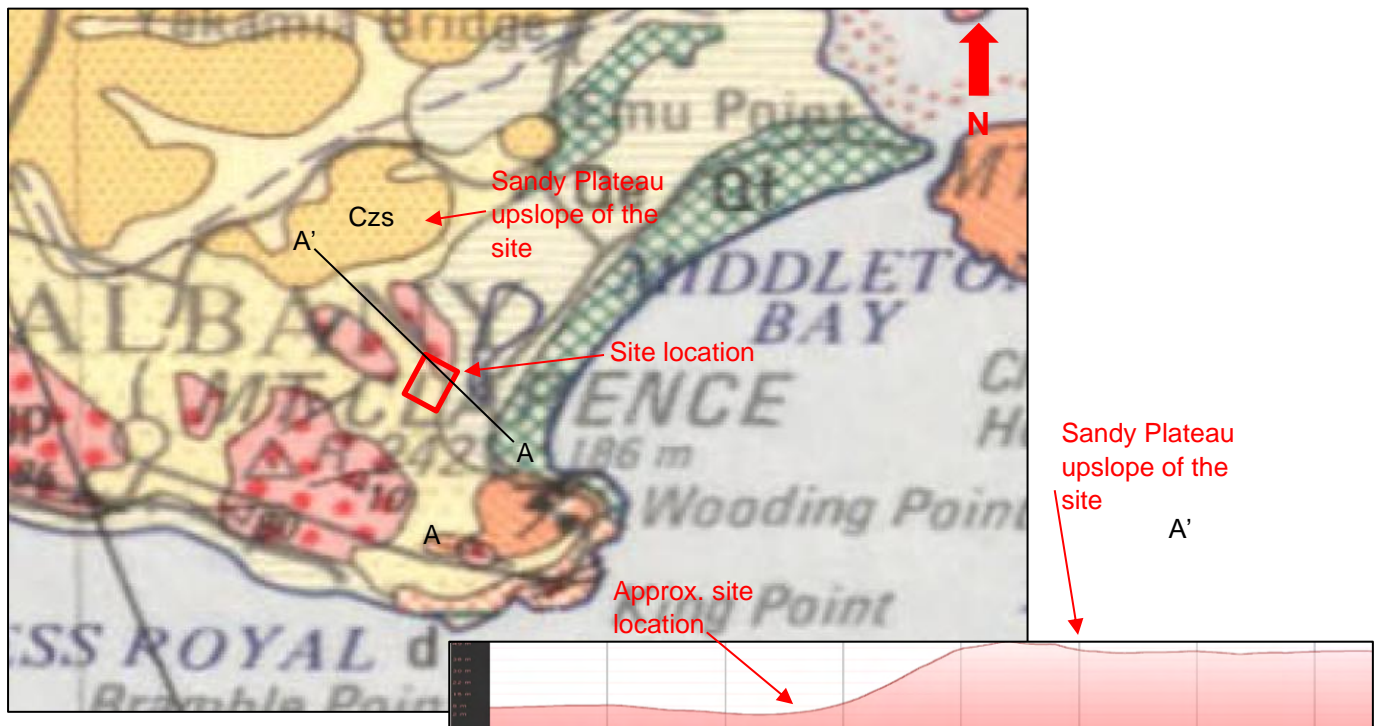


Plate 2: Extract from the 1:250,000 Mt Barker-Albany Geological Map

The key features of the conceptual model are recorded on the attached Figure 2 and have been used to direct and inform analyses present later in this report.

⁴ For instance, standing water/saturated ground has been noted in the western verge of Sleeman Avenue immediately above the headscarp of the landslide at a level that does not correspond with ground water levels in the boreholes indicated perched groundwater from a local source.

6 INVESTIGATION RESULTS

Three geological sections have been presented, Section A-A', Section B-B' and Section C-C' (Figures 4A, 4B and 4C). These geological sections relate to the cross-section lines shown on the site plan (Figure 1).

6.1 Geological Units

6.1.1 Overview

The intrusive site investigation has enabled four geological units to be identified at the landslide site:

- Fill
- Colluvium
- Residual microdiorite⁵
- Highly weathered to slightly weathered microdiorite⁶ (principally the basement rock - some soil material (extremely weathered microdiorite) is present within the otherwise highly to moderately weathered part of the profile)

Upslope of the landslide footprint, the basement rock comprises granite as noted from outcrops that can be seen in verge and public open spaces in Mira Mar and adjacent suburbs. Granite was also encountered in Borehole BH01 downslope of the landslide. It has been observed that granite boulders are present at a shallow depth within the landslide material. As the rock type is in juxtaposition with the underlying microdiorite, they cannot be a residual product of the underlying microdiorite. It is thus inferred that they must have been transported from upslope of Sleeman Avenue, indicating a minimum transport distance of around 70 m (for those reaching the bottom of the landslide) and possibly a greater distance. The boulders are therefore assessed to be part of the colluvium.

Refer to Table 6 below for the depths of the respective units encountered within each borehole. Details of the respective unit thicknesses are provided in Table 7.

Further details relating to the geological units identified above are provided in Sections 6.1.2 to 6.1.6.

⁵ Granite in borehole BH01

⁶ Granite in borehole BH01

Borehole ID	Surface elevation, Top of Fill (m AHD)	Top of Colluvium (m AHD)	Top of Residual Soil (m AHD)	Top of Microdiorite rock (m AHD)
BH01	3.6	2.7	-4.0	-5.4
BH03	11.9	10.0	8.0	4.5
BH04	17.6	16.9	14.2	13.4
BH05	15.3	14.9	12.2	11.3
BH06	12.7	11.6	8.7	7.3
BH07	18.6	18.1	15.9	13.7
BH08	18.7	18.0	14.5	14.0
BH09	18	17.4	16.2	15.3
BH10	16.5	15.7	15.6	15.0
BH11	20.7	19.8	15.0	14.6
BH12	19.7	18.4	16.1	15.6
BH13	29.1	28.0	23.4	20.0
BH14	26.3	24.8	23.4	23.1
BH15	26.8	25.4	23.4	22.8

Borehole	Layer Thickness (m)		
	Fill	Colluvium	Residual Soil
BH01	0.9	6.7	1.4
BH03	1.9	2	3.5
BH04	0.7	2.7	0.8
BH05	0.4	2.7	0.9
BH06	1.1	2.9	1.4
BH07	0.5	2.2	2.2
BH08	0.7	3.5	0.5
BH09	0.6	1.2	0.9
BH10	0.8	0.1	0.6
BH11	0.9	4.8	0.4
BH12	1.3	2.3	0.5
BH13	1.1	4.6	3.4

6.1.2 Fill

A fill layer was present at the near surface level of each borehole. This fill comprised either topsoil, crushed limestone or asphalt/road fill depending on its location.

Topsoil was present at the surface of BH01 and BH03, these boreholes were undertaken outside of the landslide footprint in the grassed area of 2 Lake Seepings Drive and 7B Anzac Road respectively.

Within the landslide footprint and the immediate surrounding area, crushed limestone pads were constructed to facilitate drilling of the boreholes on a flat surface, this is shown in the respective boreholes drilled in this area; BH04 – BH12.

BH13 - BH15 were drilled at the top of the landslide within Sleeman Ave, a layer of Asphalt and road fill were encountered within these boreholes.

6.1.3 Colluvium

Directly beneath the Fill layer Colluvium was encountered. The colluvial material was generally around 1 – 7m thick. Colluvium comprised either CLAY or Sandy CLAY material as follows:

- CLAY - Typically medium to high plasticity, pale grey and/or pale brown and firm to stiff, some layers of soft material.
- Sandy CLAY - Typically low plasticity, pale brown mottled orange brown and pale grey. The sand portion is typically fine to medium grained.

The Colluvial material is inferred as the weaker material mobilised from the current or earlier landslides.

Within the colluvial layer there is evidence of granite fabric including large boulders. It is inferred this material has previously been transported from further upslope where granite is present.

Sand lenses were present in BH11, drilled near the base of the landslide headscarp. It is possible this sand was washed into fissures and voids created by the 2021 landslide and earlier landsliding.

Within BH01 at the lower area of the site, the colluvial material encountered was SAND. Colluvium in Borehole BH01, BH03, BH04, BH10, BH13, BH14 and BH15 is considered likely to be associated with earlier landslide events.



Plate 3: BH11, saturated sand lenses present within the colluvial material.

6.1.4 Residual Soil

Beneath the colluvium, residual soil of the microdiorite bedrock of the landslide was encountered, typically, between 0.5 – 3.5m thick. The unit was described as Clayey SAND; fine to coarse grained, brown with quartz and mafic clasts. The residual soil differed from the colluvium in that it does not show signs of being transported, rather it is the direct weathering result of the lower microdiorite.

6.1.5 Microdiorite

Within the landslide area and its immediate surrounds (BH03-BH15), microdiorite, a type of rock different to granite that is common around Albany was encountered as the bedrock material.

The unit was described as typically fine to medium grained. The unit is typically highly weathered and of low strength near the top transitioning to slightly weathered/ high-very high strength at depth.

Within the landslide area the elevation of the rock is variable (approximately 4-8 m bgl). Along the flanks of the current landslide (outside of its footprint) it is generally higher.

The highly weathered part of the rock profile of the microdiorite is generally fractured and becomes less fractured with depth.

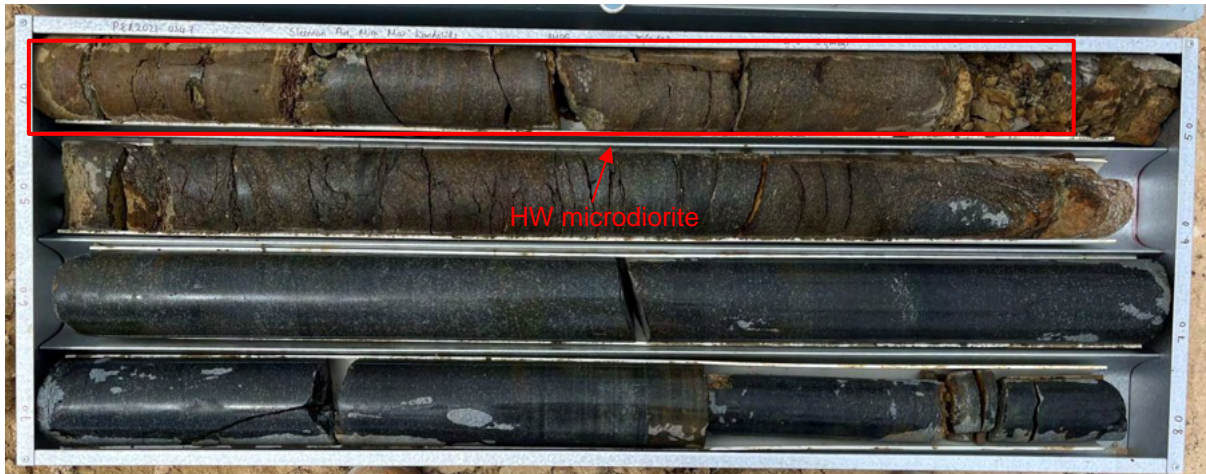


Plate 4: Highly weathered microdiorite transitioning to slightly weathered

6.1.6 Granite

Granitic bedrock was encountered within BH01, which was drilled on the flatter area closer to Lake Seppings. The granite was described as coarse-grained, highly to moderately weathered and medium strength, becoming slightly weathered with depth.

When debris was removed from against the western walls of 7B and 7C Anzac Road large quantities of granite boulders were encountered. These boulders have either been removed by an earthmoving contractor after being broken up to manageable sizes and removed from site or relocated elsewhere on site away from the downslope properties. The DCP testing undertaken by Shirley Consultants indicated refusal on likely granitic boulders or the underlying rock throughout the entire landslide area.

There is a coarse-grained granite outcrop adjacent to 7/9 Sleeman Ave. It is not clear as to whether it represents an *in situ* outcrop or an outcrop of large transported blocks. There is some alignment of faces within the outcropping granite to suggest an open joint which would support the *in situ* rock prognosis, although this is not definitive. Regardless of whether or not this is *in situ*, the microdiorite is considered likely to be a sill or dyke intruded into older granite.

6.2 Groundwater Levels and Water Pressures

Measured groundwater elevations are reported in Table 8. Ground water has only been measured since January 2023 and as such higher ground water elevations are to be expected during winter months and have not yet been recorded. Groundwater levels have been measured manually in the standpipes (denoted S/P under the detail column). Equivalent groundwater levels have been correlated from hydrostatic pressure for the boreholes with VWP installed in them.

Plate 5 below shows a representation of summer (21 February 2023) groundwater levels on a cross section through the site. It is apparent that groundwater is present at approximately the surface from 50m down the slip zone (the Sleeman Avenue being the top of the slip zone).

Table 8: Measured Groundwater Elevations

BH	Detail	Ground Level (m AHD)	Top of Casing Elevation (m AHD)	VWP Elev. (m AHD)	Date	Hydrostatic Pressure (kPa)	Dipped Level Top of Casing (m)	GW Elevation (m AHD)
BH04	S/P	17.6	18.3	-	21 Feb 23	-	1.7	16.7
BH05	S/P	15.3	16.0	-	21 Feb 23	-	0.6	15.3
BH07	S/P	18.6	19.4	-	21 Feb 23	-	2.7	16.6
BH09	S/P	18	18.6	-	21 Feb 23	-	3.3	15.3
BH14	S/P*	26.3	26.4	-	21 Feb 23	-	7.2	19.2
BH01	S/P*	3.6	3.7	-	21 Feb 23	-	0.5	3.1
BH03	VWP	11.9	12.4	5.9	23 March 23	23.8		8.3
BH06	VWP	12.7	13.5	5.2	23 March 23	74.5		12.6
BH08	VWP	18.7	19.3	14.2	23 Jan 23	16.6		15.8
BH11	VWP	20.7	21.3	14.7	23 March 23	29.3		17.7
BH12	VWP	19.7	20.1	15.7	23 March 23	21.3		17.8
BH13	VWP	29.1	29.7	18.6	23 March 23	21		20.7
BH15	VWP	26.8	27.4	19.3	23 March 23	5		19.8

* Gatic cover present

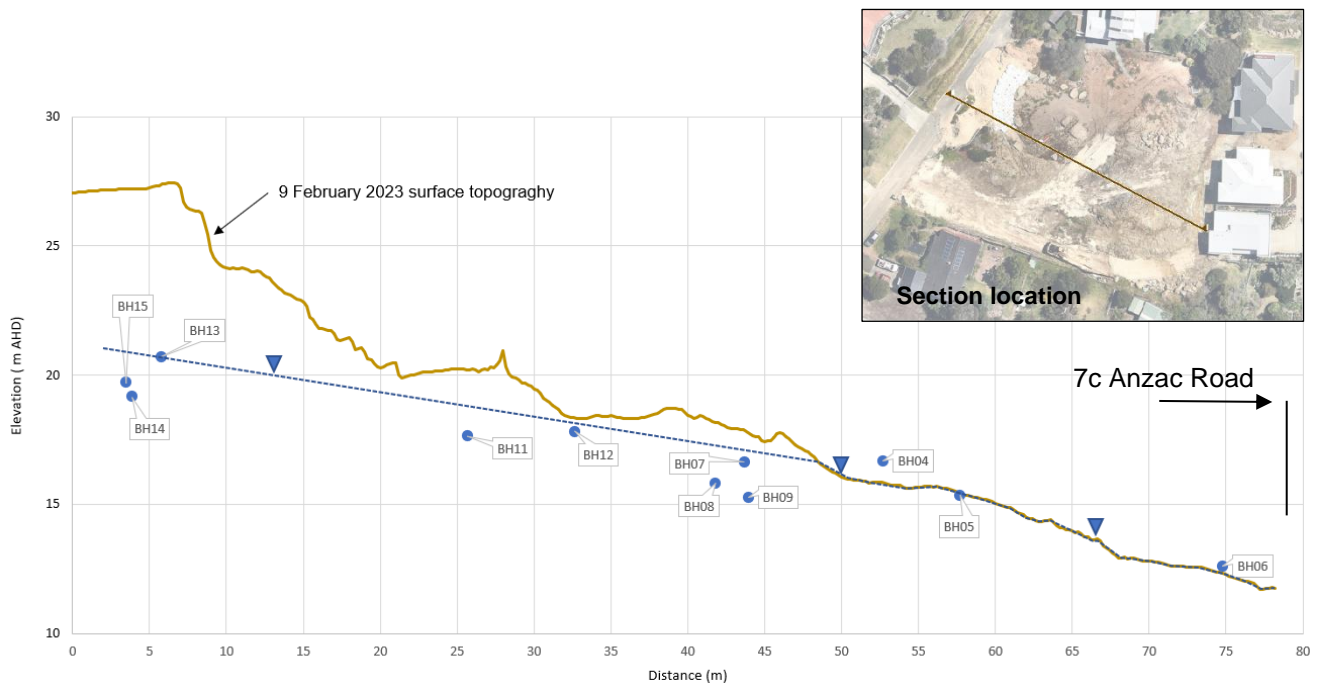


Plate 5 – Summer Groundwater Elevations (note: winter elevations are likely higher)

7 GEOTECHNICAL PROPERTIES

7.1 Fill

As indicated in Table 7, the thickness of the fill layer encountered at the respective borehole locations is relatively thin. In addition, in the case of boreholes within the landslide, the fill comprises a granular limestone layer added after significant movement of the landslide had already occurred.

In terms of assessing the stability of the landslide, the fill layer is therefore not of significance and its properties are not examined further.

7.2 Colluvium

7.2.1 Index Properties

A combined particle size distribution (PSD) curve for the colluvium layer is shown in Plate 6. A wide range of materials are indicated including clays with a percent fine of 85%; to sands with a fines content as low as 5%.

There does not appear to be any clear relationship between percent fines and depth within the colluvium layer (Plate 7).

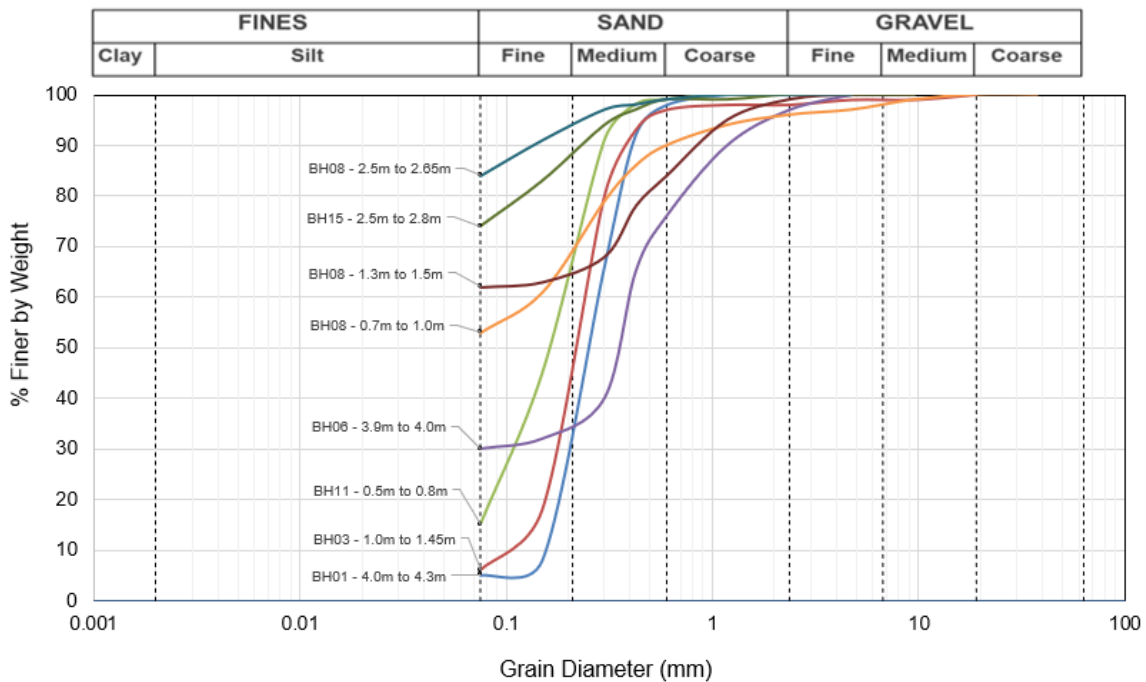


Plate 6– Particle Size Distribution Curve (Colluvium)

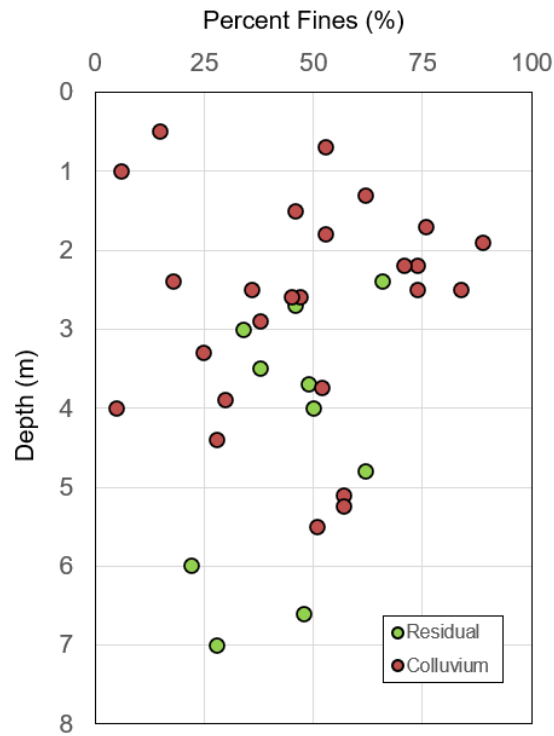


Plate 7 - Percent fines versus depth by material type

The plasticity of the clay layers within the colluvium are presented in Plate 8. About three quarters of the samples tested have a clay fraction comprising high plasticity clay.

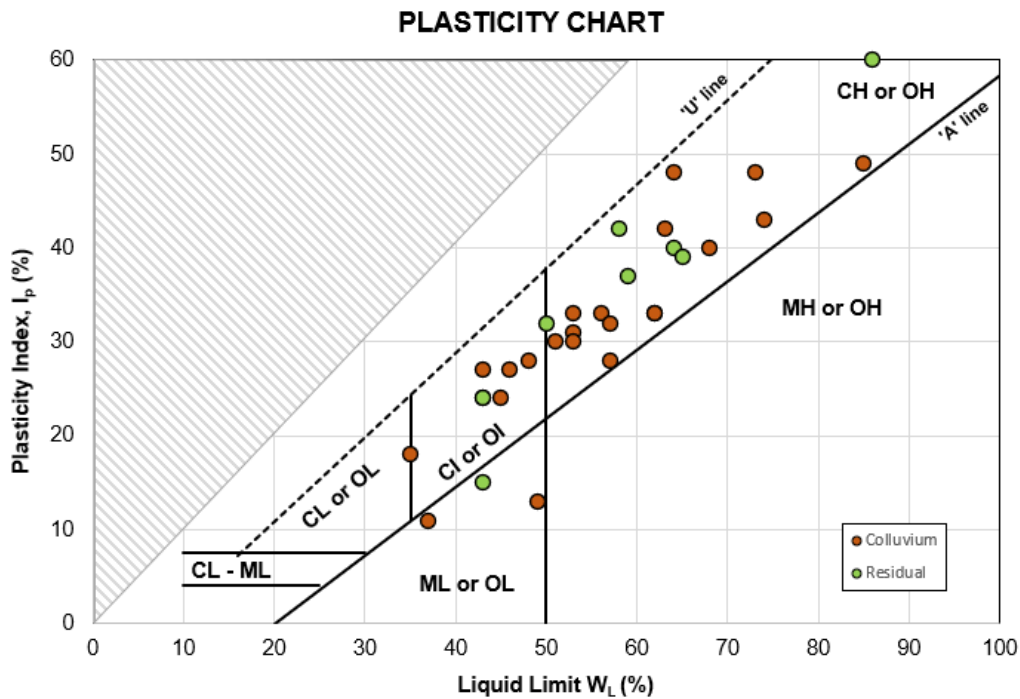


Plate 8- Plasticity Chart

A similar plot, but with mineralogy zones plotted, is shown as Plate 9. Most of the plotted points fall within the range expected for Montmorillonite and Illite clay minerals.

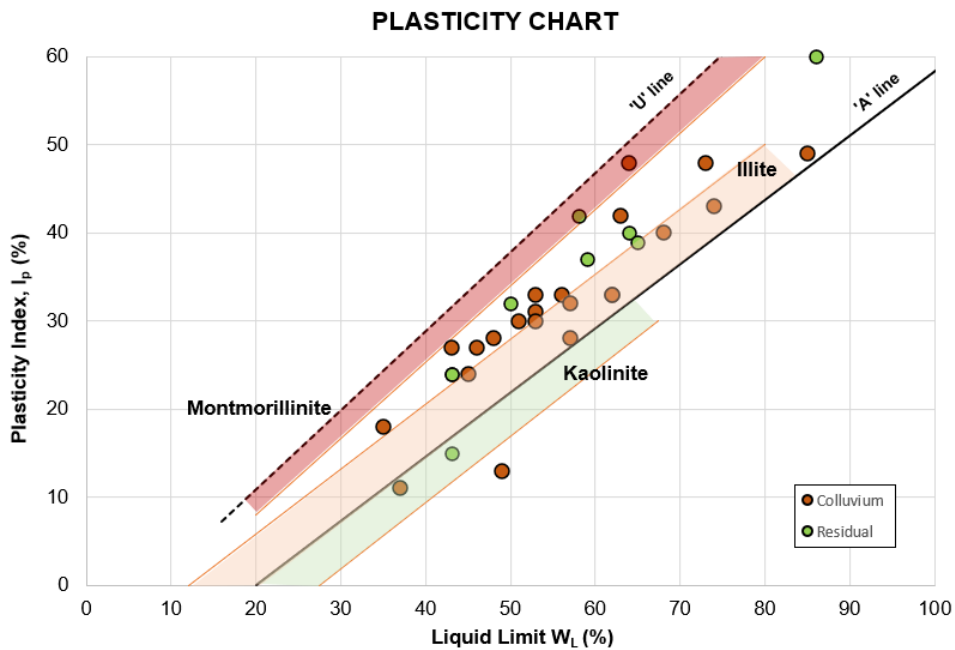


Plate 9- Plasticity chart with clay mineralogy

The difference in the inferred clay type might reflect materials derived from mafic minerals (i.e present in microdiorite) or felsic minerals (more dominant in granite). For example, clays derived from the weathering of granite rich in orthoclase feldspar (a felsic mineral) will tend to produce kaolinite. The colluvium is likely a mix of material derived from different host rocks. The residual soils should reflect the mineralogy of the underlying rocks. Note the assignment of clay mineralogy is not definitive based on petrographic methods but is solely based on typical correlations with index tests.

The Liquid Limit for clayey samples of colluvium is plotted versus depth in Plate 10. There is no clear relationship between Liquid Limit and depth indicating that the clay zones within the colluvium are heterogeneous in terms of clay mineralogy. Higher Liquid Limits are generally noted for colluvial materials than for residual materials. It is not unusual for material that was originally of residual origin but has subsequently been transported downslope as a landslide (colluvium) for Liquid Limits to increase due to the remoulding and alignment of mineral particles due to shear.

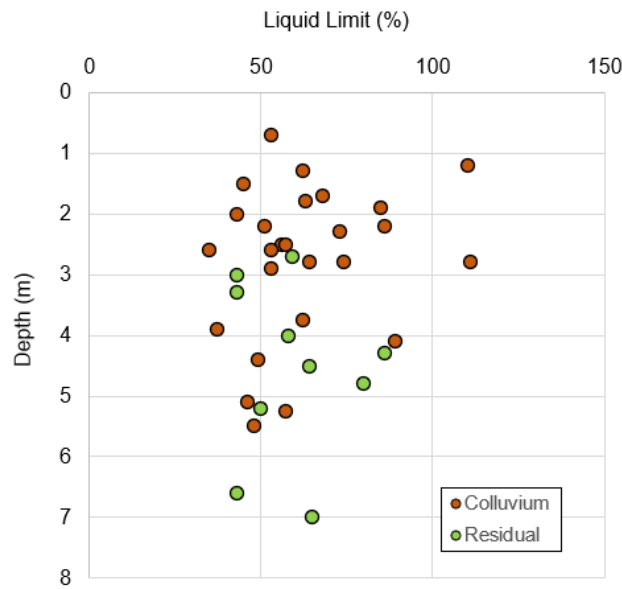


Plate 10 – Plot of Liquid Limit Versus Depth

The initial moisture content, Liquidity Index and initial void ratio of selected samples of colluvium are shown in Table 9. The liquidity index of two of the samples is negative because the natural moisture content of the samples is less than the Plastic Limit. A negative Liquidity Index is indicative of high strengths and similarly, large positive values indicate material with a low undrained strength.

Borehole	Depth Range (m)	Geological Unit	LL (%)	PL (%)	w _n (%)	LI	e _o
BH08	3 – 3.45	Colluvium	62	35	35	-0.01	0.88
BH12	3 -3.45	Colluvium	52	26	41	0.57	1.1
BH15	3-3.4	Colluvium	43	27	22	-0.31	0.57
BH06	4.5 – 4.8	Residual	71	34	31	-0.08	0.77
BH07	3 -3.45	Residual	51	26	28	0.06	0.71
BH07	4 – 4.45	Residual	52	29	35	0.27	0.89

Where: w_n is the natural moisture content
 LI is the liquidity index
 e_o is the initial void ratio

7.2.2 Shear Strength

The effective shear strength parameters obtained from the triaxial tests are shown in Table 10. A stress path plot is shown on Plate 11.

Note that the effective strengths shown in Table 10 relate to peak shear strengths. Relatively high values of effective cohesions are observed (c' > 10 kPa).

Table 10: Effective Shear Strength Parameters – Colluvium and Residual Units				
Location	Depth to Top of Residual Layer (m)	Top of Sample Depth (m)	Geological Unit	Effective Shear Strength Parameters
BH08	4.2	3	Colluvium	$c' = 28 \text{ kPa}$ $\phi' = 22^\circ$
BH12	3.6	3	Colluvium	$c' = 16 \text{ kPa}$ $\phi' = 32^\circ$
BH15	3.4	3	Colluvium	$c' = 10 \text{ kPa}$ $\phi' = 36^\circ$
BH06	4	4.5	Residual	$c' = 12 \text{ kPa}$ $\phi' = 26^\circ$
BH07	2.7	4	Residual	$c' = 11 \text{ kPa}$ $\phi' = 22^\circ$
BH07	2.7	3	Residual	$c' = 27 \text{ kPa}$ $\phi' = 28^\circ$

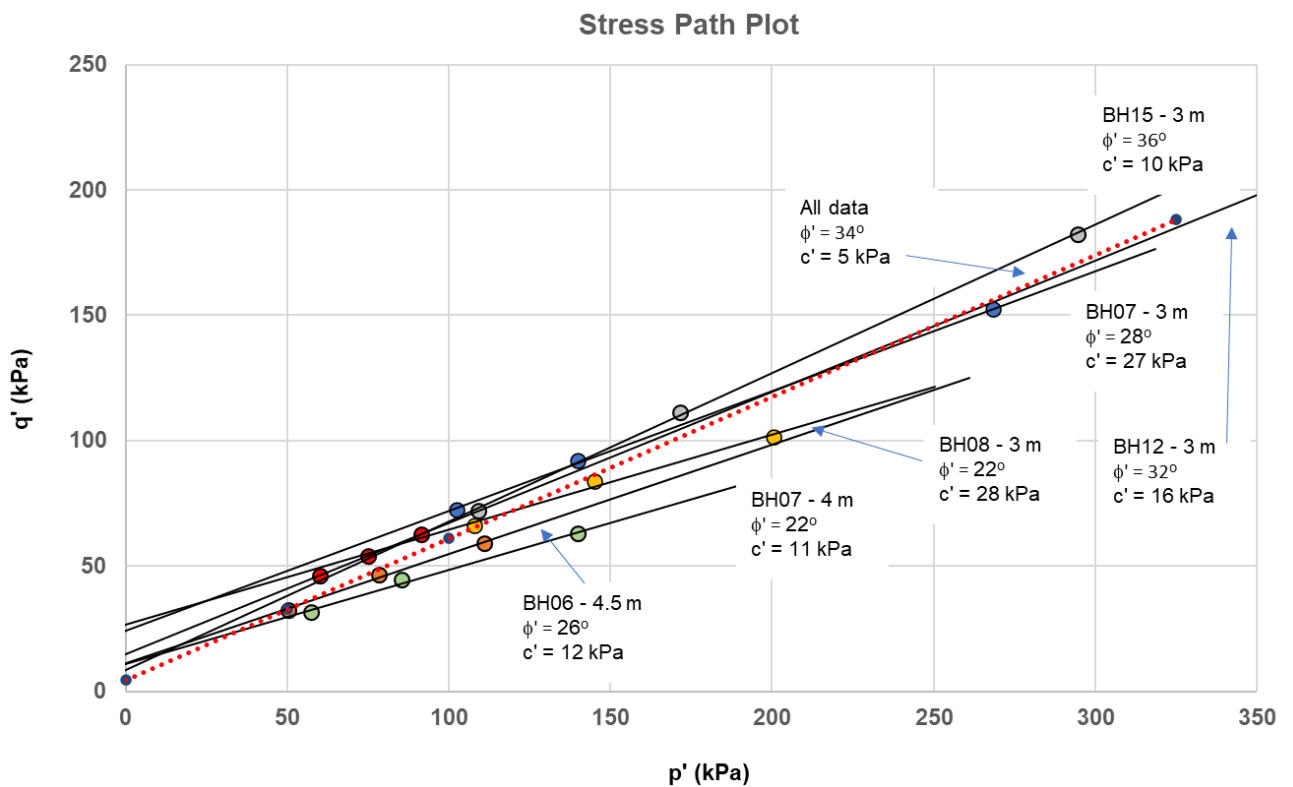


Plate 11 - Stress path plot (peak strengths)

7.3 Residual Soil

7.3.1 Index Properties

The particle size distribution curves recorded for samples of residual soils are shown on Plate 12. Most of the samples are classified as sandy clays since the fines content is typically greater than 35%.

The fines are generally of a high plasticity (Plate 8) and there is no correlation between depth and Liquid Limit and depth (Plate 10). The clay mineralogy is similar to that of the Colluvium (Plate 9).

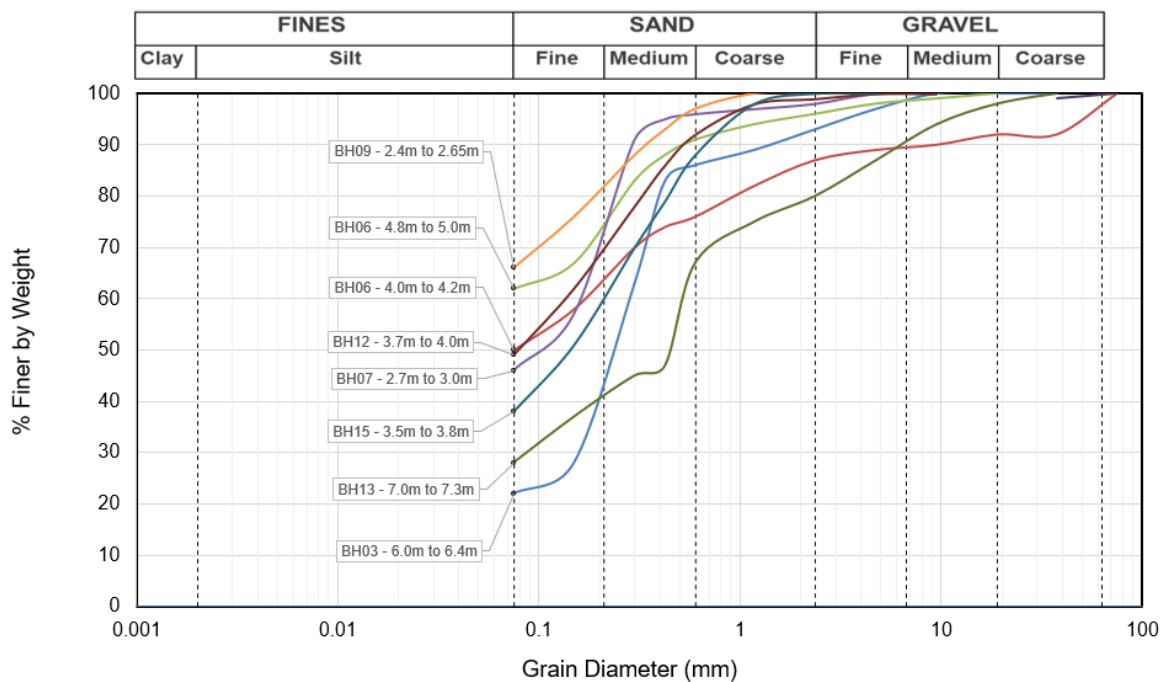


Plate 12 - Particle Size Distribution Curves (Residual Soils)

Overall, the range of Liquidity Index, natural moisture content and void ratio for the residual soil is similar to the values observed for the Colluvium (Table 9).

7.4 Shear Strength

Effective strength parameters (peak strengths) measured on residual soil samples are shown in Table 10 and on Plate 11 respectively. The effective cohesion and friction angles are similar to the values measured for colluvium.

If a combined data set is considered, using data points belonging to the colluvium and the residual soil unit, then an effective cohesion of 5 kPa and an effective friction angle of 34° is obtained (refer to Plate 11, all data line).

It is noted that it was not possible to sample and test the material where the shear surface is thought to be located. Several locations were observed in boreholes where a few centimetres of near saturated very soft clay was present. This weak material is likely at the location of one of the landslide

shear surfaces.⁷ The material tested in the laboratory likely represents the condition of the colluvium/residual soil in a relatively undisturbed or peak shear strength condition.

Landslide movement in the past, as well as more recently (2021 landslide event, and ongoing movement) has sheared the colluvium, and possibly the residual soil across significant displacements leading to a residual strength condition. It is not clear as to whether the material before the 2021 landslide was at its peak strength condition as reflected by the recent testing. It is possible that it was not, given the evidence for earlier landslide movement (CMW 2021). In any event, given large shear displacements associated with the 2021 landslide event, residual strengths now likely apply.

The likely magnitude of displacement of the landslide, since the 2021 event, is considered to have had sufficient impact on the materials on, or close to the slip surfaces, to now be considered close to their residual shear strength condition. The significance of this “post peak” loss of strength due to shearing is that the porewater pressures in the soil now required to initiate landsliding (March 2023) will be less than that required to trigger the landslide at the end of July 2021. In turn, that threshold groundwater pressure was probably less than what was required to initiate earlier landslide events. The same argument also applies to other landslide triggering mechanisms, for example loading the head of the landslide.

7.5 Shear Strength Parameters

In the case of the Mira Mar landslide, where no sudden loading or unloading has occurred (e.g as would be associated with placement of a large thickness of fill upslope or the excavation of a trench across the hillside downslope) it can be assumed that drained conditions apply and that the soil shear strength is based on an effective cohesion and an effective friction angle for analytical purposes. The term ‘drained’ or ‘effective stress’ conditions refers to the dissipation or drainage of excess pore water pressures within the matrix of the soil that can be generated through a loading or unloading regime. It does not refer to the presence or absence of external groundwater, or the drainage of such groundwater from within the landslide.

The anticipated shear strength of the soils within the mobile zone of a slope failure can be back-calculated for a known surface geometry, groundwater elevation and depth of the mobile zone.

Following the CMW geotechnical investigation fieldwork, undertaken in December 2022, ongoing landslide movements continue to occur as illustrated by the photograph included as Plate 13. This photograph was taken in the vicinity of BH08 during February 2023 and shows extensive surface cracking. Whilst landslide movements have been ongoing for some time, the observed surface cracking at this time showed that the landslide remained in a metastable condition during the period following the geotechnical investigation and that the global factor of safety was about one and possibly lower at this time.

According to Skempton, A. W. (1985). ‘*Residual strength of clays in landslides, folded strata and the laboratory*’, clayey soils exhibit a residual strength significantly lower than peak strengths. The phenomenon of residual strength occurs due to particle re-orientation on shearing. Particle re-orientation is only applicable for clay soils containing platy clay minerals and having a clay fraction exceeding about 20% to 25% (the clay fraction is that fraction of a soil sample by weight with a particle size of 2 micron or less). The residual strength (expressed as a residual effective friction angle, ϕ'_r) decreases until the clay fraction reaches about 50%. Thereafter, increases in the clay fraction makes little difference to the residual strength. Residual soil strengths can be achieved after relatively small displacements (typically less than 500 mm). Residual strengths for clays having a clay fraction of 50% or greater depend on the type of clay minerals present. The angles of residual shearing resistance of

⁷ The word ‘surface’ is expressed in plural as the landslide is complex and the movement noted cannot be accommodated by a single shear surface without a degree of secondary shear and internal remoulding.

the three most commonly occurring clay minerals are approximately 15° for kaolinite, 10° for illite and 5° for montmorillonite.

Based on the findings of Skempton and the back analysis of the landslide as of February 2023, it is likely that the residual strength of the Colluvium is being mobilised noting that:

- 1) About one-half of the colluvium samples tested have a fines content (clay and silt content) greater than 50%. Whilst the clay fraction of the samples was not measured, it is reasonable to assume that the clay fraction of these samples is above 25%.
- 2) From Plate 9, the clay mineralogy of the colluvium is indicated to be illite and possibly montmorillonite. These clay materials are associated with small residual friction angles, although any sand and silt sized particles present will increase these friction values.
- 3) To date, landslide displacements of several metres have already occurred and these movements are certainly large enough to have mobilised the residual strength of the soil within the mobile mass.

Back-analysis of the slope, based on the February 2023 slope geometry and corresponding groundwater levels, revealed that the mobilised effective shear strength within the mobile zone would need to be significantly lower than that measured in the suite of triaxial tests (Plate 11).

To achieve a factor of safety of one, the mobilised friction angle in the colluvium is about 15° while the adopted effective cohesion is zero. These parameters are roughly half of those considered to be peak shear strength parameters as recorded in the triaxial tests. The values used in the back analyses are residual shear strength parameters and are considered applicable when assessing the current landslide and remedial works to stabilise the landslide. These parameters are not considered to be applicable for areas of first-time shear, for instance for propagation of the landslide upslope of the escarpment.



Plate 13 - Photograph taken at BH08 during February 2023

7.6 Groundwater Levels

Groundwater levels prevalent during early 2023 are plotted in Plate 5. These levels are considered to be typical of summer groundwater levels with a rise in the groundwater anticipated during winter months.

The groundwater level shown in Plate 5 is adopted as a base case and is the summer groundwater level for the purposes of analysing the stability of the slope. Further sensitivity analyses have been

carried out to assess the impact of variations in groundwater levels brought about for example by winter rainfall or the implementation of subsoil drainage.

7.7 Slope Stability Cases

Various slope stability cases were assessed and are as listed in Table 11. Slope stability cases were assessed for the existing and historic ground topography, for different groundwater levels to assess the likelihood of slope failure at each slope/groundwater condition. A case using peak strength values was also analysed to illustrate how past landsliding has resulted in a loss of strength of materials. A proposed remediated slope was also analysed.

Table 11: Slope stability analysis cases			
Case	Description	Surface Topography	Groundwater Elevation
1	Existing ground profile and groundwater level. Purpose is to calculate existing factor of safety.	Feb. 2023	Feb. 2023
2	Existing ground profile and groundwater level reduced. Purpose is to demonstrate the impact of groundwater lowering on stability.as a remediation strategy.	Feb. 2023	Feb. 2023 levels. Groundwater lowered by 1 m.
3	Existing ground profile and groundwater level reduced further. Purpose is to demonstrate the impact of further groundwater lowering on stability as an enhanced remediation strategy.	Feb. 2023	Feb. 2023 levels. Groundwater lowered by 2 m.
4	Ground profile when the landslide started. Purpose is to investigate soil strength and groundwater levels giving rise to slope instability.	Sept. 2021	Feb. 2023 levels.
5	Ground profile when the slip started. Purpose of the analysis is to demonstrate the impact of a rise in groundwater levels on slope stability.	Sept 2021	Feb. 2023 levels raised by 1 m.
6	Ground profile when the slip started. Purpose of the analysis is to demonstrate the impact of a further rise in groundwater levels on slope stability.	Sept 2021	Feb. 2023 levels raised by 2 m.
7	Ground profile when the slip started. Peak Colluvium Strength. Purpose of the analysis is to demonstrate the stability of slope when peak strengths apply for the Colluvium and when groundwater levels are raised by 1 m above existing groundwater levels.	Sept 2021	Feb. 2023 levels raised by 1 m.
9	Remediated slope. Purpose of the analysis is to demonstrate that stability of the slope following remediation (conceptual option shown combining drainage of groundwater, shear keys, and gabion retaining wall.	Conceptual remediated profile	Feb. 2023 levels lowered by approximately 2 m

In terms of the analysed stability cases, the following relevant notes are outlined below.

7.7.1 Groundwater Levels

A detailed ground water seepage analysis has not been undertaken and hence various assumptions apply in terms of groundwater levels as they relate to the stability analysis.

For the case where the groundwater is lowered, it is assumed that the elevation of the groundwater on the upslope side of the landslide remains the same (as at February 2023) as this level is likely affected by regional groundwater flowing towards the slope.

In the case where the groundwater below the landslide is assumed to rise, it is assumed that the regional groundwater level can rise for instance following a prolonged period of heavy rainfall.

There may be a delay of a few days between rainfall impacting the regional groundwater table beneath the landslide whilst a shorter delay of a few minutes to hours for local infiltration of rainfall falling on the footprint of the landslide resulting in a rise in the groundwater level below the landslide.

7.7.2 Remediated Slope

Further details relating to the remediated slope are provided in the following sections of this report, but the general concept for the remediated slope includes:

- The excavation of two slots (shear keys) across the landslide running in a direction parallel to the surface contours and transverse to the landslide movements.
- The slots are excavated to the top of the residual soil. Detailed analysis of the remedial option may however show that the slots should be constructed to the level of the top of rock.
- The slots are excavated with a base width of about 3 m and have side slopes of about 30° taking into account the temporary stability of the excavation for the slot.
- The slots are backfilled with a suitable compacted granular material (sand gravel or gravelly sand).
- A gabion type wall (wire baskets filled with cobbles of rock) is constructed above the slots with compacted coarse granular backfill.
- The arrangement of gabion walls provides level terraces intended for future land use, e.g landscaping. Future use for residential construction is expected to require improvement of the underlying and highly disturbed landslide materials.

Implementation of remedial works will be difficult and will likely need to be staged. First achieving groundwater drawdown in part of the slope to enable shear keys to be built, further drains installed and ultimately retaining walls to be built. Figures 7 and 8 illustrate a concept for possible remediation.

7.8 Results of the Stability Analysis

The results of the stability analysis are provided in Table 12.

Table 12: Stability analysis cases	
Stability Case	Factor of Safety (Janbu Simplified)
Case 1: EGL, EGWL	1.064
Case 2: EGL, EGWL - 1 m	1.297
Case 3: EGL, EGWL - 2 m	1.480
Case 4: PGL, EGWL	1.143
Case 5: PGL, EGWL + 1 m	1.011
Case 6: PGL, EGWL + 2 m	0.913
Case 7: PGL, EGWL + 1 m. Peak strength Colluvium	2.890
Case 7: Remediated slope	2.226

Notes:

- EGL – existing ground level.
- EGWL – existing groundwater level
- PGL – previous ground level

Note the factor of safety (FOS) is quoted to three decimal places for reference purposes only and is not be taken as an indication of the accuracy to which the actual factor of safety is known. The above table is intended to show sensitivity to changes in groundwater level.

The slope stability analysis utilising the existing slope profile and existing groundwater (case 1) has a factor of safety of 1. This is by design since, during the summer months of 2023, ongoing slope movement was occurring indicating that a factor of safety of approximately one was applicable.

Case 1 is the back-analysed case and has been used to back-calculate the drained shear strength of the Colluvium which yields an effective cohesion of zero and an effective friction angle of 15° – refer also to the discussion under Section 7.5. This shear strength value is comprises two components: c' (effective cohesion) and ϕ' (effective angle of friction). It should be noted that other combinations of effective cohesion and friction angle could create the same equivalent drained shear strength (i.e a slightly larger value for c' and a slightly smaller value for ϕ').

The sensitivity of the back-analysis to assumed slope geometry, groundwater level etc. would change slightly if a different combination of c' and ϕ' was assigned. Nonetheless, the analyses show that lowering the groundwater table has a significant effect on the stability of the landslide to the extent that even a 1 m lowering of the groundwater table increases the factor of safety to 1.3 (Case 2) which would generally be considered a satisfactory short-term factor of safety. Lowering the groundwater level by 2 m increases the factor of safety to almost 1.5. With this level of groundwater lowering, a reasonable level of long-term stability⁸ would be achieved.

⁸ This is on the proviso that it can be demonstrated that the drainage system remains effective in maintaining groundwater drawdown even during and following major rainfall events. Due to uncertainty, it would be prudent to adopt a higher factor of safety.

Stability analyses considering the September 2021 landform and the existing groundwater level (February 2023) show that the stability of the slope within the existing landslide area would be marginal (FOS = 1.139 (Case 4)). This represents the case where landslide movements have already been initiated and the strength of the colluvium has reduced to residual values. If groundwater levels were to rise further, then the factor of safety is reduced even further (Case 5 and Case 6).

If the peak strength of the Colluvium applies and it is assumed that groundwater levels rise by around 1 m (above the February 2023 levels), then a factor of safety of nearly 3 applies (Case 7). It is possible that the shear strength at the time of the 2021 landslide was higher than the current back analysed residual values adopted (i.e. $\phi' = 15^\circ$) but less than the assessed peak values of $c' = 5$ KPa and $\phi' = 34^\circ$. On this basis it can be inferred that a significant increase in the groundwater level, of more than 1 m and possibly 2 m, was required to initiate the 2021 landslide episode.

The overall picture obtained from the slope stability analysis indicates that the pre-landslide landform may have been stable provided that peak strengths of the colluvium were applicable. The analyses show the stability of that landform is greatly reduced and becomes marginal if movement occurs and the strength of the colluvium is reduced to residual strengths. How that transition occurs is the subject of a further forensic engineering investigation, although the analyses show it can be achieved through a relatively small increase in the groundwater level.

The results of the remediated landform (Case 9) illustrate that if a remediation option similar to that analysed was adopted it could be effective in the long term if it included a means of permanently and effectively lowering the groundwater level to the base of the colluvium.

8 DISCUSSION

8.1 Position of the Failure Surface

The inferred location of the slip surface is shown on Figure 2 and is inferred to be located at the base of the Colluvium. This observation is based on the inspection of the core following borehole drilling wherein it was observed that the residual soil contained generally material of a high strength without weak zones.

8.2 Potential for Ongoing Movement

Given the degree of movement displayed on the landslide area, since the July/August 2021 landslide, and the observation that, even in summer, movement is still active (refer Plate 13) movement of the landslide is likely to remain ongoing until remedial works can improve the stability.

Materials on the slip surface will have been gradually reducing in strength from a peak shear strength condition to (or towards) a residual shear strength condition with each major landslide episode. It is likely that there has been a significant “post peak” reduction in the shear strength of materials along the main slip surface of the landslide because of the July/August 2021 landslide and ongoing movement.

8.3 Potential for Landslide to Enlarge

8.3.1 Flanks

The northern and southern flanks of the landslide are shown through monthly LiDAR surveys (refer Appendix E). Figure 5 shows the refusal depth of DCPs (top of weathered rock/core stones/competent strata) and Figure 6 (inferred top of residual soil) both shown that the landslide is located over a shallow valley shaped depression in the rockhead. It is estimated, from the contours represented on Figure 5, that this depression is up to about 3 m deep. This subsurface profile seems to have had some level of control in not allowing the landslide to develop significantly laterally (refer

Appendix E). Nonetheless there is potential for slight lateral enlargement of the landslide to occur. This could occur on the northern flank through the collapse or retrogression of the steep scarp that is immediately next to the southern side of the house at 14 Sleeman Avenue.

8.3.2 Headscarp

Upslope retrogression of the landslide has been occurring since the landslide activated in July/August 2021. Movement of the main landslide has increased the height of the headscarp (refer Appendix E) leaving a very steep headscarp with the potential to collapse. Continual upslope headscarp recession can be expected until such time the landslide is stabilised and the headscarp supported by earthworks or retaining structures. In the current condition there is not only the potential for headscarp collapse but, if perched groundwater was to occur immediately behind the headscarp, for upslope enlargement of the landslide as a whole.

8.3.3 Downslope of landslide toe

There is some indication that localised areas of higher-than-average rock head might be controlling the landslide morphology with the current landslide appearing to daylight about 10 m west/upslope of the house at 7B and 7C Anzac Road. These areas of higher rockhead are not apparent from the DCP data (Figure 5) but crack patterns and compression features from the landslide study undertaken in Spring 2021 (CMW 2021) indicate a level of resistance to movement immediately to the west of 7A Anzac Road.

The results of the geophysical study undertaken in 2022 also indicate two north northeast -south southwest trending intermittent ridges of rock that might have a level of control on whether the landslide daylights downslope. It is also possible that the ground water surface may be slightly depressed beneath the foundation of 7B and 7C Anzac Road and that their retaining walls and foundations provide a level of resistance that is currently encouraging the landslide to daylight to the west. These properties are significantly affected by the landslide as material pushed up by the landslide forms a debris lobe that flow downslope towards the houses and, from time to time, must be removed or it would push over and through the walls of the house.

The potential for even more serious downslope propagation of the landslide cannot be discounted and both boreholes BH03 and BH06 exposed significant thickness of soil, including colluvium further confirming this potential. Significantly lowering the ground water table across the landslide would significantly reduce the risk of downslope propagation and would also slow or arrest the accumulation of material that contributes to the debris lobe.

8.4 Long term-remediation measures

The primary measure to stabilise the landslide and mitigate future movement is the substantial drawdown of the groundwater across the landslide area. It is considered that the groundwater table is being recharged from a fractured rock aquifer in the underlying igneous rocks, and will also likely be augmented by rainfall infiltration/runoff finding a rapid route into the ground through open cracks etc. The groundwater table beneath the landslide will require, on average, between 1 and 2 m of drawdown. This drawdown depth may need to be greater at the drain location to account for less effective drawdown occurring between drains. It is envisaged that two deep sumps (each about 3- 4 m deep) will need to be constructed immediately south of the house at 7C Anzac Road and that a series of deep French drains will need to radiate outwards from the sump upslope into the landslide.

Disposal of the water from this deep sump off site will pose a challenge due to its depth and it being downslope of the existing drainage easement and may require land purchase, new drainage easements construction of a deep storm drain and, if this is not feasible, a pump system may be required to remove water from one of two proposed deep sumps.

Figures 7 and 8 illustrate a concept for remediation including the incremental installation of French drains and the provision of two deep sumps. One to collect water and one to act as a sediment trap.

The French drains will need to be backfilled with free-draining materials and might be made wider than is strictly necessary to install the pipe so that the ground backfill will also help stabilise the landslide by replacing soft saturated materials of low shear strength with free draining granular materials with a high internal friction angle.

There is a risk that the drainage sump of drains in the immediate vicinity will get destroyed before sufficient drainage measures are installed to prevent further movement of the landslide. To prevent this, it is envisaged that the granular backfill to the sump will extend upslope by about 15 m to create a stable shear key. Such a shear key feature would tend to force any ongoing landslide movement to daylight further upslope.

It should be expected that some initial drains might get damaged shortly after installation by future landslide movements until a critical quantum of drain installation has been achieved to substantially arrest further movement allowing further installation of drains.

In addition to installation of drains a number of granular shear keys, excavated through the colluvium and extending into the highly weathered microdiorite, will help reinforce the slope and provide a stable foundation on which to build a series of relatively low height gravity retaining walls to ultimately buttress and support the escarpments fronting the eastern edge of Sleeman Avenue and the southern side of 14 Sleeman Avenue. It is envisaged that 2 or 3 walls, each up to about 2 m high, formed in gabions or similar might be built.

The type of remedial works described is considered suitable for stabilising the landslide for use as a future public open space.

To restore the landslide for future residential use is more involved:

1. The building footprints will need to be clearly defined, all disturbed landslide materials under the future building footprints removed and replaced with compacted granular material. There are significant potential risks with this operation, at this will involve removing material close to the steep scarp face immediately next to 14 Sleeman Avenue. Thus, this scarp might need to first be stabilised, using soil nails and shotcrete or similar, prior to excavating the disturbed landslide material in front of the scarp and possibly installing further soil nails as the excavation exposes a further face beneath the area already soil nailed.
2. Retaining walls will need to be built to accommodate vehicular access onto each lot.
3. Drains to lower the groundwater within the landslide will need to be positioned so that they are not disturbed by the footings, surface trenches or other features of the future houses.
4. All storm drainage and surface water will need to be taken off site.

8.5 Concept Design of the Remediated Slope

With the foregoing general consideration in mind, a concept design for the remediated slope is shown on Figure 7 and Figure 8.

The principal elements of the remediation concept are as follows:

1. Subsoil drains orientated near perpendicular to the slope contours radiating outwards from one of two sumps located downslope of the landslide area. The subsoil drains are installed to the base of the colluvium (base of drain at a depth of around 4 m).
2. The first slope drains into a second slump which acts as a sediment trap before draining via a buried pipe possibly leading into the Lake Seppings area and the City stormwater collection network. Further comments regarding site drainage are provided in Section 8.6.

3. Two shear keys are proposed that are designed to stabilise the slope through friction over their base area and through their ability to drain the slope. Drainage of the shear keys is via the above subsoil drains that penetrate them; and which are located at their base.
4. A triangular-shaped buttress area is located between the sump and the first shear key. The purpose of this area is to provide additional stabilisation of the landslide through base shear and to provide a further means of groundwater drainage.
5. A system of low gabion retaining walls are proposed in a terraced arrangement within the area of the existing head scarp. The height of these walls is limited to about 1 m for safety reasons and to potentially avoid the requirement for parapet barriers or the like.

Construction of the remediated concept may be difficult and time consuming adopting a construction sequence as follows:

1. The sump area should be constructed first followed by the radial system of subsoil drains.
2. Subsoil drain construction will be via short incremental sections as it will not be possible to open long sections of trench due to expected trench side slope stability issues and due to the risk of further destabilising the landslide.
3. Next, the triangular buttress area should be constructed. This area will likewise have to be created by progressively excavating small incremental areas and working upslope and outwards from a starting point at the sump area.
4. The shear keys will similarly be excavated incrementally. Excavation of the shear keys will intersect the already installed radial subsoil drains which will complicate their construction.
5. Excavation of the shear key in the vicinity of 14 Sleeman Ave will require further consideration as to the requirement to further stabilise the side of the excavation facing this property as outlined previously in Section 8.4.

It is expected that some damage to drains will occur during installation as a result of ongoing landslide movement and replacement of damaged component will be necessary. Once a sufficient quantum of drainage works are in place ongoing landslide movement is expected to be substantially reduced in magnitude and the implementation of further works should be less problematic but will still require incremental construction to mitigate the risk of initiating movement. Indicative sequencing of the sumps and drains to form the initial buttress is illustrated on Figure 7. This is conceptual and will be subject to detailed design and may also change as a result of observations made and events during execution.

8.6 Challenges to Execute Remedial Work

To design and successfully execute the long-term remedial works certain criteria and challenges need to be addressed and clarified. These are listed below:

1. **Future land use.** Will the site be used for future residential usage or public open space. This decision feeds into the nature of the work required to remediate the landslide. Residential usage will have additional requirements that may delay the implementation of a whole site solution.
2. **How to get water off site.** To dewater the landslide area requires lowering of the groundwater table by subsoil drains and a deep sump. This water will likely accumulate in a sump downslope of the existing draining easement and possibly at a level that cannot drain under gravity into the City of Albany's existing stormwater drainage network. To advance resolution of this challenge, it is recommended that a Civil Engineering consultant with specialisation in storm drainage be commissioned to work with the City of Albany on drainage solutions and to review options, need for new easements, gravity and potential pump systems as well as incorporation of future surface water drainage collection into the system. This

consultant would need to be engaged to investigate the requirement for any groundwater abstraction/disposal permits required for the proposed long-term dewatering/drawdown of the groundwater table across the footprint of the landslide.

3. **Access to facilitate the works.** Significant temporary access works may well be required to facilitate safe and efficient construction of the finalised remediation scheme.

9 CLOSURE

This report has been prepared for use by Great Southern Development Commission in relation to providing the landslide at Mira Mar. It presents the results of a geotechnical investigation designed to identify the mechanisms that resulted in the landslide and the type of works needed to stabilise the land. It does not contain a fully analyses or designed remediation option but presents a conceptual remediation option. It should be noted that mitigation and remedial works to landslides are rarely immediately effective and damage can get worst before improvement is realised.

No other warranty, expressed or implied, is made as to the professional advice included in this report. Use of this report by parties other than Great Southern Development Commission and their respective consultants and contractors is at their risk as it may not contain sufficient information for any other purposes.

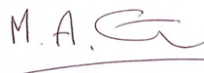
Any third party interpreting and acting upon the information provided in this report should be aware that:

- it may not be aware of the risks and difficulties associated with mitigating impacts resulting from the landslide;
- some remedial works are likely to be sacrificial in nature;
- temporary works may be required to protect adjacent assets;
- strict monitoring of health and safety protocols are required when remediating landslide sites; and
- they may not have been party to all correspondence, discussions, data collection outside of this report that would inform their understanding of the issue.

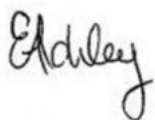
For and on behalf of CMW Geosciences Pty Ltd



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Project Engineering Geologist



reviewed by
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Distribution: 1 copy to Great Southern Development Commission (electronic)
Original held by CMW Geosciences Pty Ltd



FIGURES

Figure 1 – Site Investigation Location Plan

Figure 2 – Geological Model

Figure 3 – Ridges in Bedrock Surface

Figure 4 – Geological Sections Plan

Figure 4a – Geological Section, A-A'

Figure 4b – Geological Section, B-B'

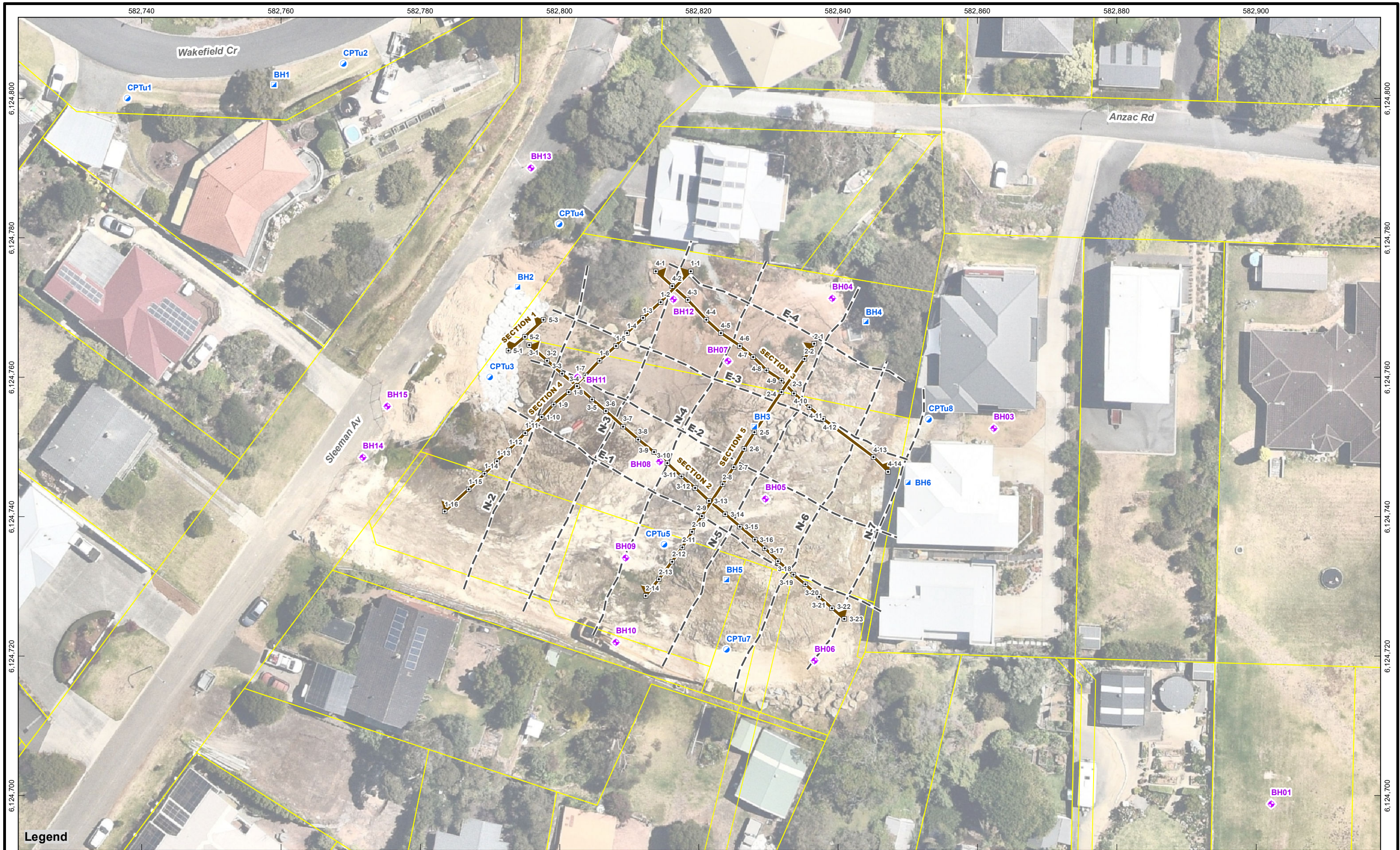
Figure 4c – Geological Section, C-C'

Figure 5 – Contour Plan showing top of rock

Figure 6 – Contour Plan showing top of residual material

Figure 7 – Conceptual Drainage and Stabilisation Works

Figure 8 – Conceptual Remedial Works Cross Section



Legend

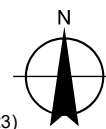
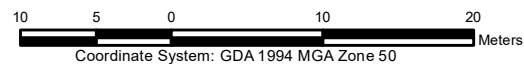
TEST LOCATION, OWNER

- ◆ BOREHOLE (CMW, 2022)
- CONE PENETROMETER (DOUGLAS PARTNERS, 2013)
- ▲ HAND AUGER BOREHOLE (DOUGLAS PARTNERS, 2013)
- DCP SURVEY LOCATION (SHIRLEY CONSULTANTS, 2022)

- GEOPHYSICS SURVEY LINE (GBG GROUP 2022)
- ▲ SECTION LINE

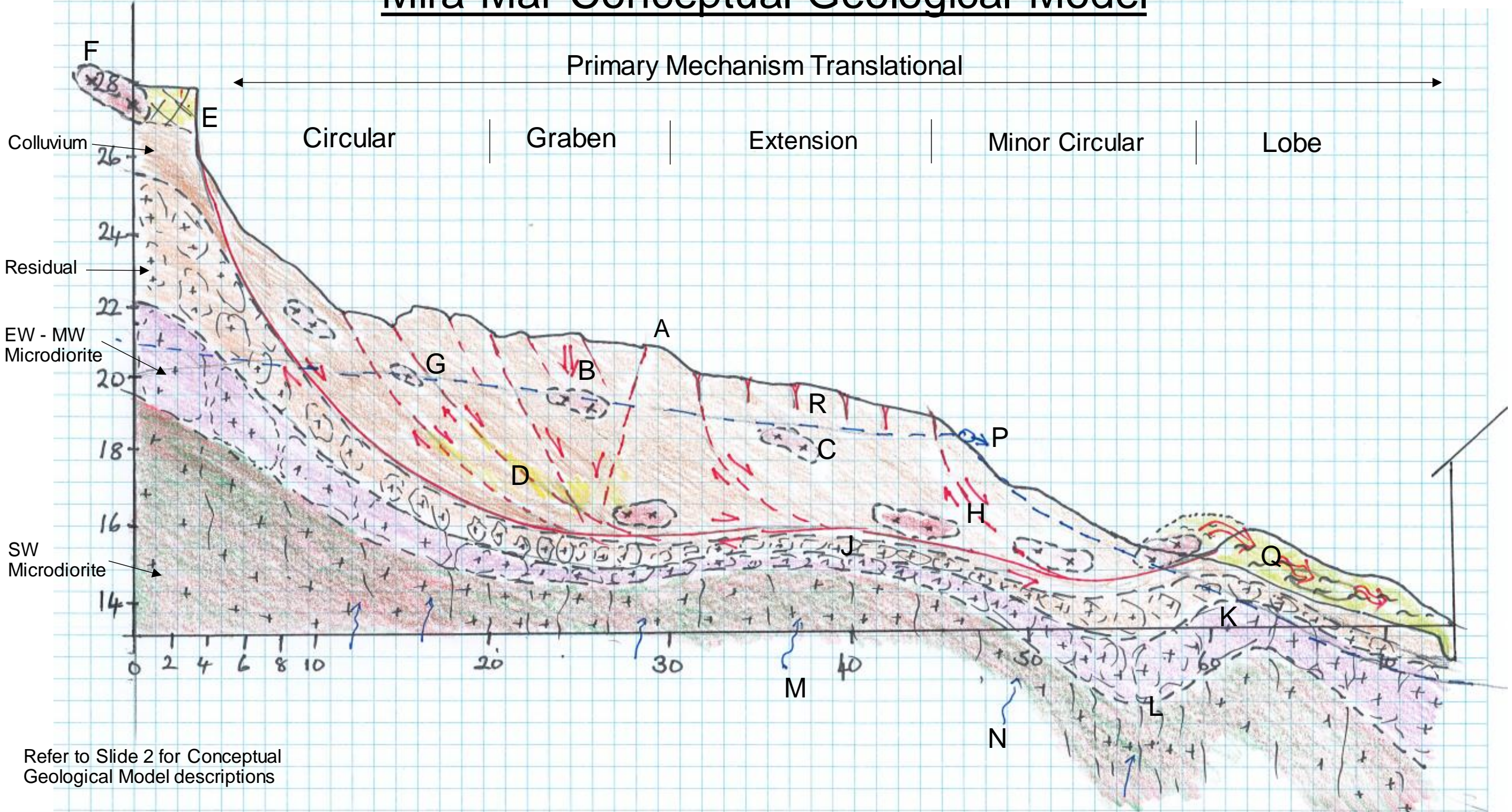
NOTES

1. DATA SOURCED FROM CLIENT
2. AERIAL PHOTOGRAPHY SOURCED FROM @NEARMAP (February 2023)



CLIENT:	GREAT SOUTHERN DEVELOPMENT COMMISSION	COMPILED:	NR	PROJECT:	PER2021-0347
PROJECT:	SLEEMAN ROAD, ALBANY	CHECKED:	MAT	FIGURE:	1
TITLE:	GEOTECHNICAL TEST LOCATIONS	REVISION:	A	SCALE:	1:500
		DATE:	3/04/2023	SHEET:	A3 L

Mira Mar Conceptual Geological Model



Conceptual Geological Model Descriptions

A: Obsequent Scarp (indicate of a graben)

B: Graben (initially primarily vertical movement- the graben block has since moved laterally)

C: Boulders of coarse grained granite, differing from rock-type the underlying bedrock (microdiorite), indicating that they have been transported from upslope by gravity processes or tipped on the site . Tipping seems unlikely due to large size of some blocks (c. 4 m³)

D: For the landslide to form some internal distortion must occur. The mismatch in geometry towards the head of the landslide likely creates voids (interpretation, observation around garage of No12 Sleeman Avenue) and some of these (former) voids appear to have been infilled with sand washed down from above (observation from boreholes).

E: Head scarp (some fill present).

F: Coarse grained granite boulders (presumably slid down from upslope see note C)

G: Internal slip planes to accommodate distortion of the overall landslide.

H: Slip plane associated with secondary sliding in this area.

J: Local rises in bedrock surface detected by geophysics (refer Figure 3) but inferred from 2021 landslide and crack morphology (CMW 2021 report)

K: Local rises in bedrock surface detected by geophysics (refer Figure 3) but inferred from 2021 landslide and crack morphology (CMW 2021 report)

L: Change in rockhead, more weathered material in this location (possibly due to greater degree of fracturing).

M: Groundwater from upstream catchment, feed from fracture flow as well as direct infiltration into cracks etc.

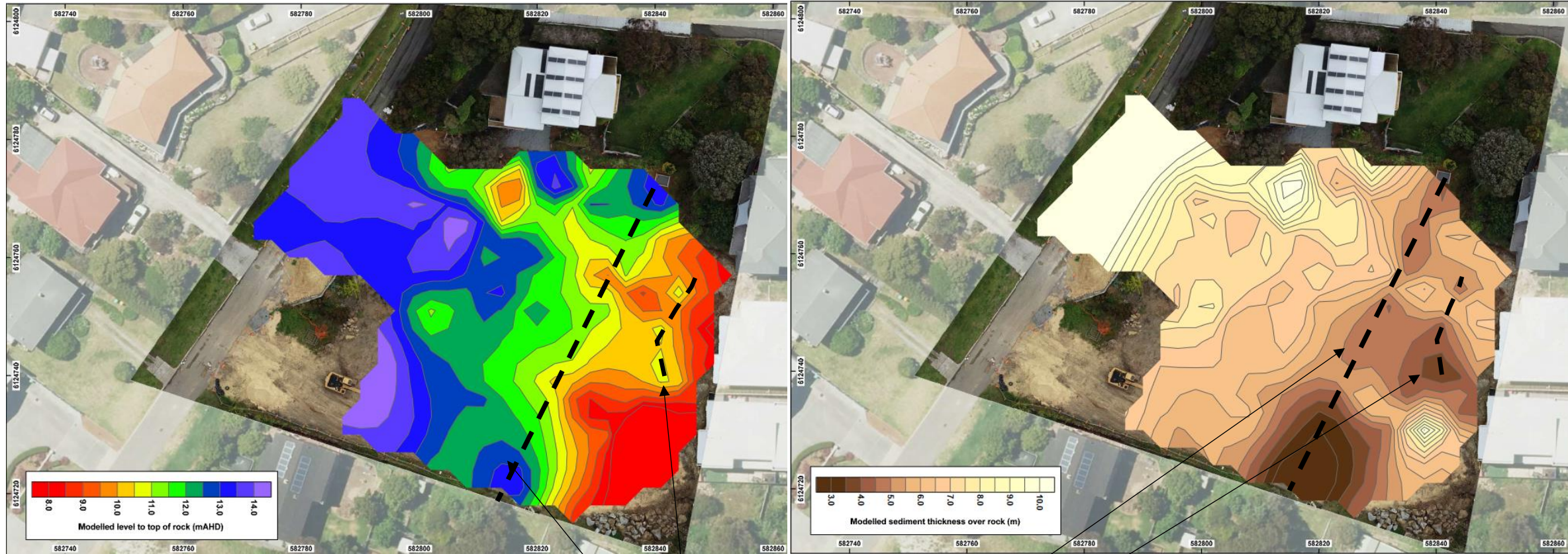
N: Groundwater from upstream catchment, feed from fracture flow as well as direct infiltration into cracks etc.

P: Pre-landslide spring (remains as spring)

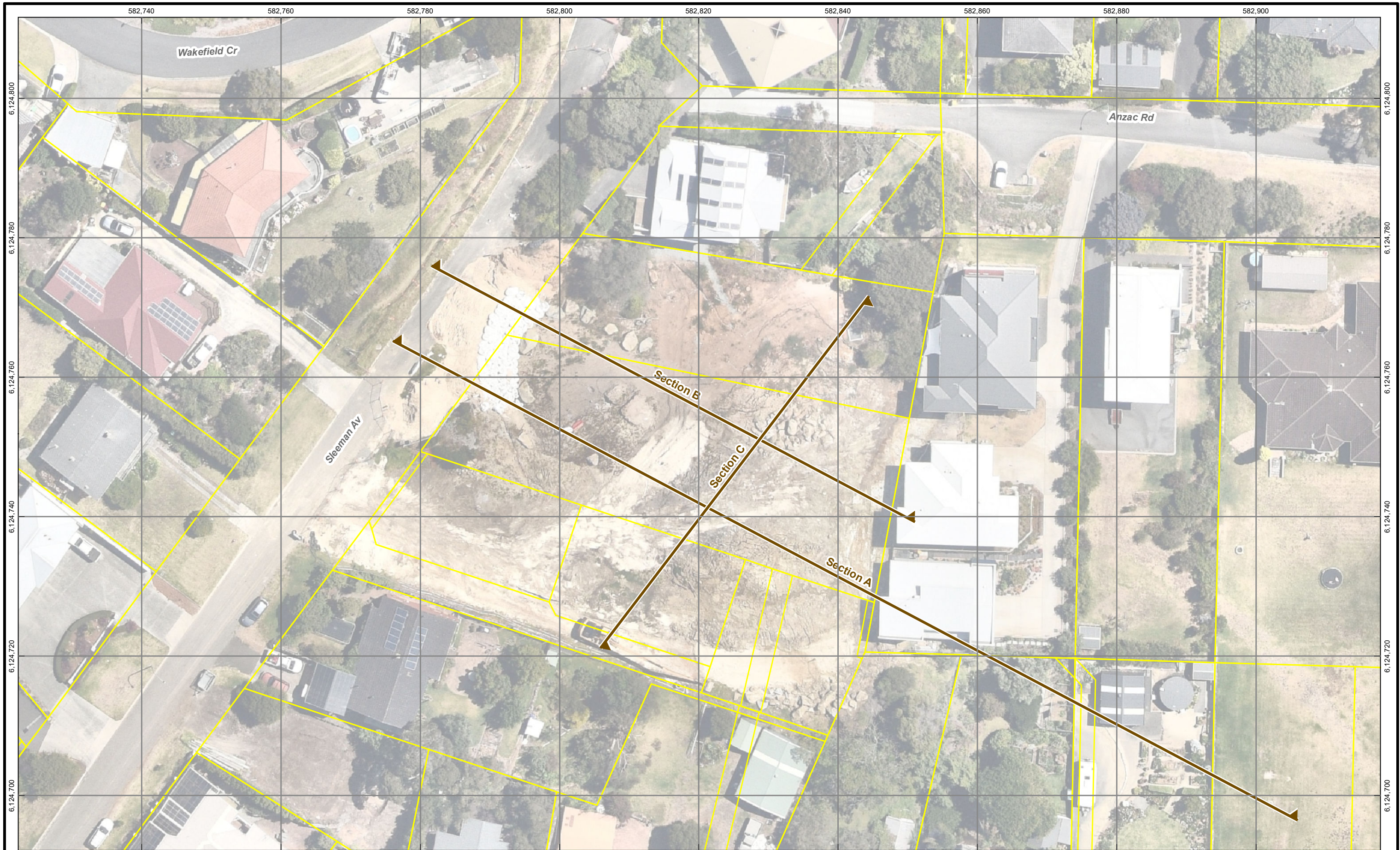
Q: Debris lobe, near saturated and remoulded material transported as a flow downslope from toe of landslide

R: Tension cracks previous observed in this area infer a zone of extension which matches with the rise in bedrock surface and areas of high groundwater (relative to ground level).

Figure 3 – Ridges in Bedrock surface depicted from geophysics

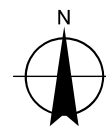


Ridges within Bedrock Surface



NOTES

1. AERIAL PHOTOGRAPHY SOURCED FROM ©NEARMAP (February 2023)



Coordinate System: GDA 1994 MGA Zone 50



CLIENT:	GREAT SOUTHERN DEVELOPMENT COMMISSION	
PROJECT:	SLEEMAN ROAD, ALBANY	
TITLE:	SURFACE PROFILE - SECTION LINES	

COMPILED:	NR	PROJECT:	PER2021-0347
CHECKED:	IA	FIGURE:	4
REVISION:	A	SCALE:	1:500
DATE:	31/03/2023	SHEET:	A3 L

Section A – A'

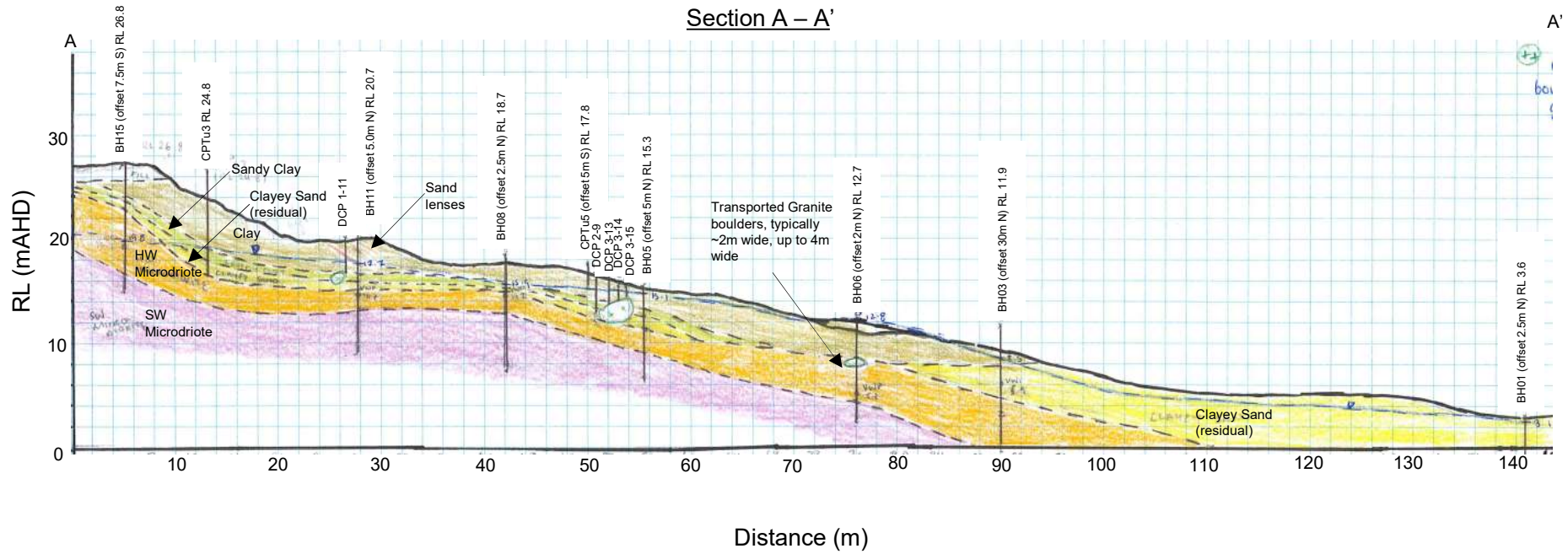


Figure 4A

Section B – B'

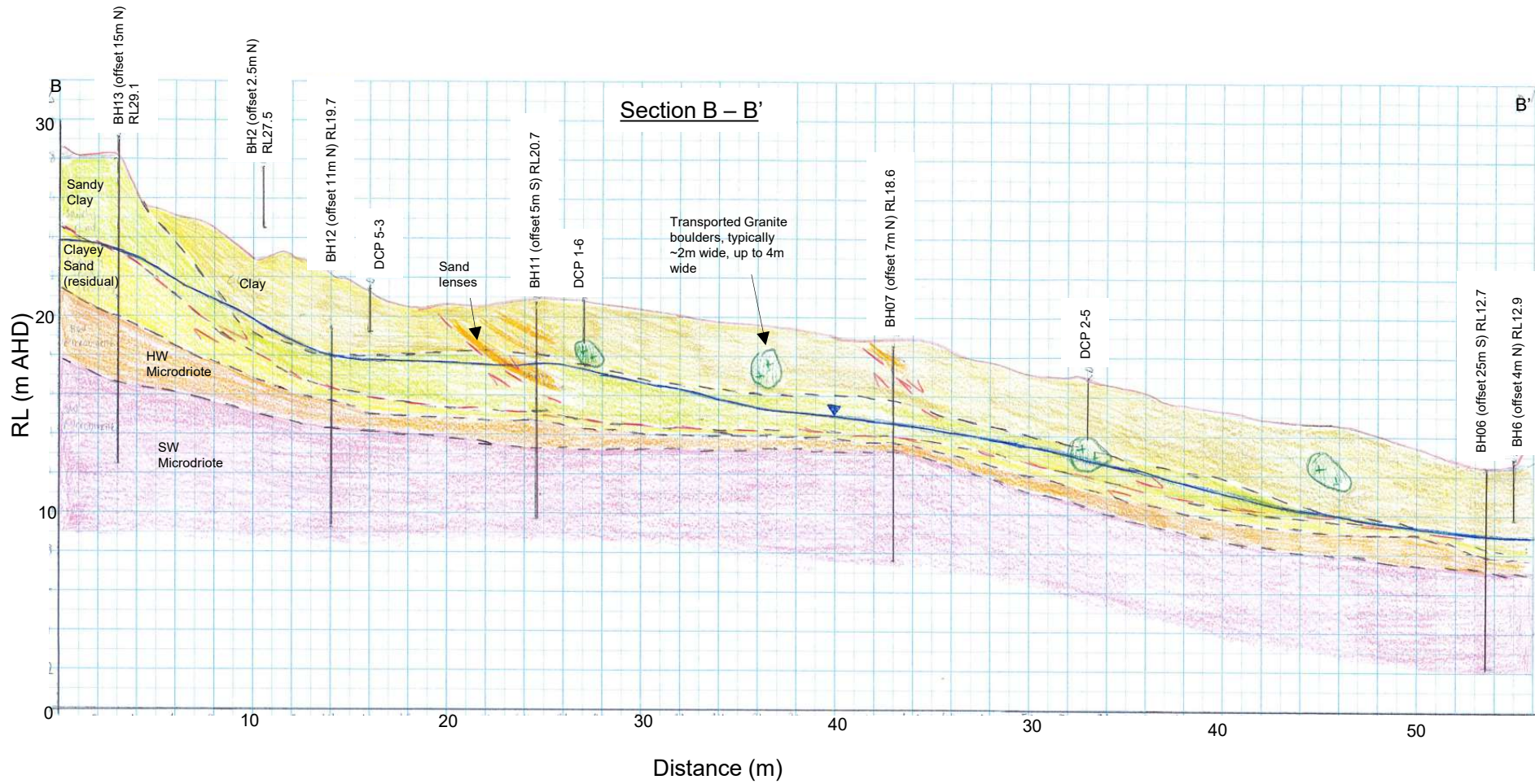


Figure 4B

Section C – C'

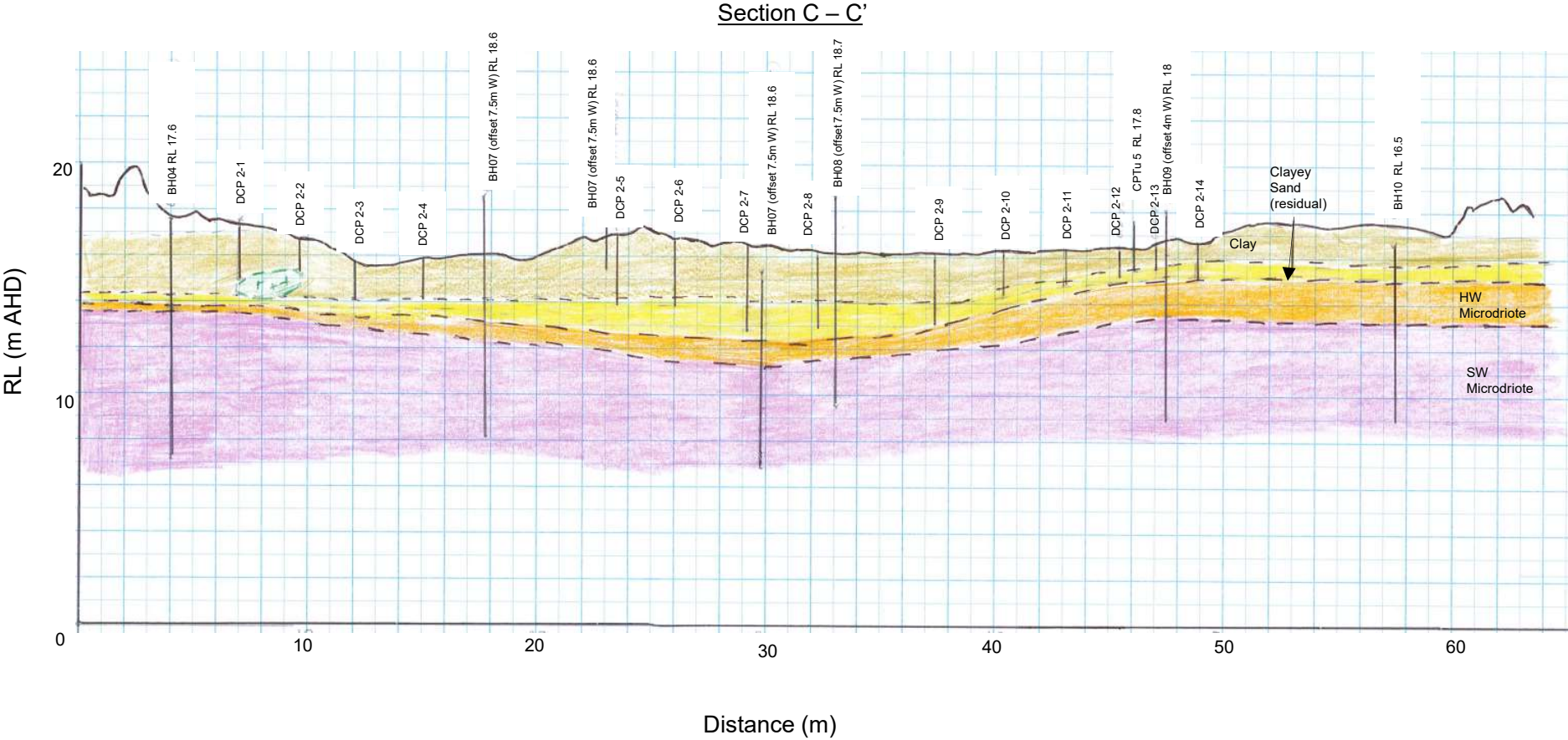


Figure 4C



Legend

— TOP OF MW ROCK (m AHD)

TOP OF MW ROCK (m AHD)

6.9 - 10.0
10.0 - 13.0
13.0 - 16.0
16.0 - 19.0
19.0 - 22.0
22.0 - 23.3

TEST LOCATION, OWNER

◆	BOREHOLE (CMW, 2022)
●	CONE PENETROMETER (DOUGLAS PARTNERS, 2013)
■	HAND AUGER BOREHOLE (DOUGLAS PARTNERS, 2013)
□	DCP LOCATION (SHIRLEY CONSULTANTS, 2022)
□	TEST LOCATION NOT USED IN SURFACE (ONLY LOCATIONS INSIDE LIDAR SURVEY EXTENT ARE CONSIDERED)

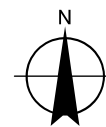
---	GEOPHYSICS SURVEY LINE (GBG GROUP 2022)
▲	SECTION LINE (REFER CMW FIGURE 2)
---	BOUNDARY OF LIDAR SURVEY

NOTES

1. BOREHOLE INTERPOLATED DEPTH TAKEN AS THE TOP OF MODERATELY WEATHERED ROCK.

10 5 0 10 20 Meters

Coordinate System: GDA 1994 MGA Zone 50



CLIENT: GREAT SOUTHERN DEVELOPMENT COMMISSION	COMPILED: NR	PROJECT: PER2021-0347
PROJECT: SLEEMAN ROAD, ALBANY	CHECKED: MAT	FIGURE: 5
TITLE: SURFACE OF TOP OF ROCK	REVISION: C	SCALE: 1:500
	DATE: 5/04/2023	SHEET: A3 L



Legend

— TOP OF RESIDUAL MATERIAL (m AHD)

TOP OF RESIDUAL MATERIAL (m AHD)

8.8 - 12.0
12.0 - 15.0
15.0 - 18.0
18.0 - 21.0
21.0 - 24.0
24.0 - 25.7

TEST LOCATION, OWNER

◆	BOREHOLE (CMW, 2022)
●	CONE PENETROMETER (DOUGLAS PARTNERS, 2013)
■	HAND AUGER BOREHOLE (DOUGLAS PARTNERS, 2013)
□	DCP LOCATION (SHIRLEY CONSULTANTS, 2022)
□	TEST LOCATION NOT USED IN SURFACE (ONLY LOCATIONS INSIDE LIDAR SURVEY EXTENT ARE CONSIDERED)

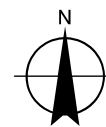
--- GEOPHYSICS SURVEY LINE (GBG GROUP 2022)

▲ SECTION LINE (REFER CMW FIGURE 2)

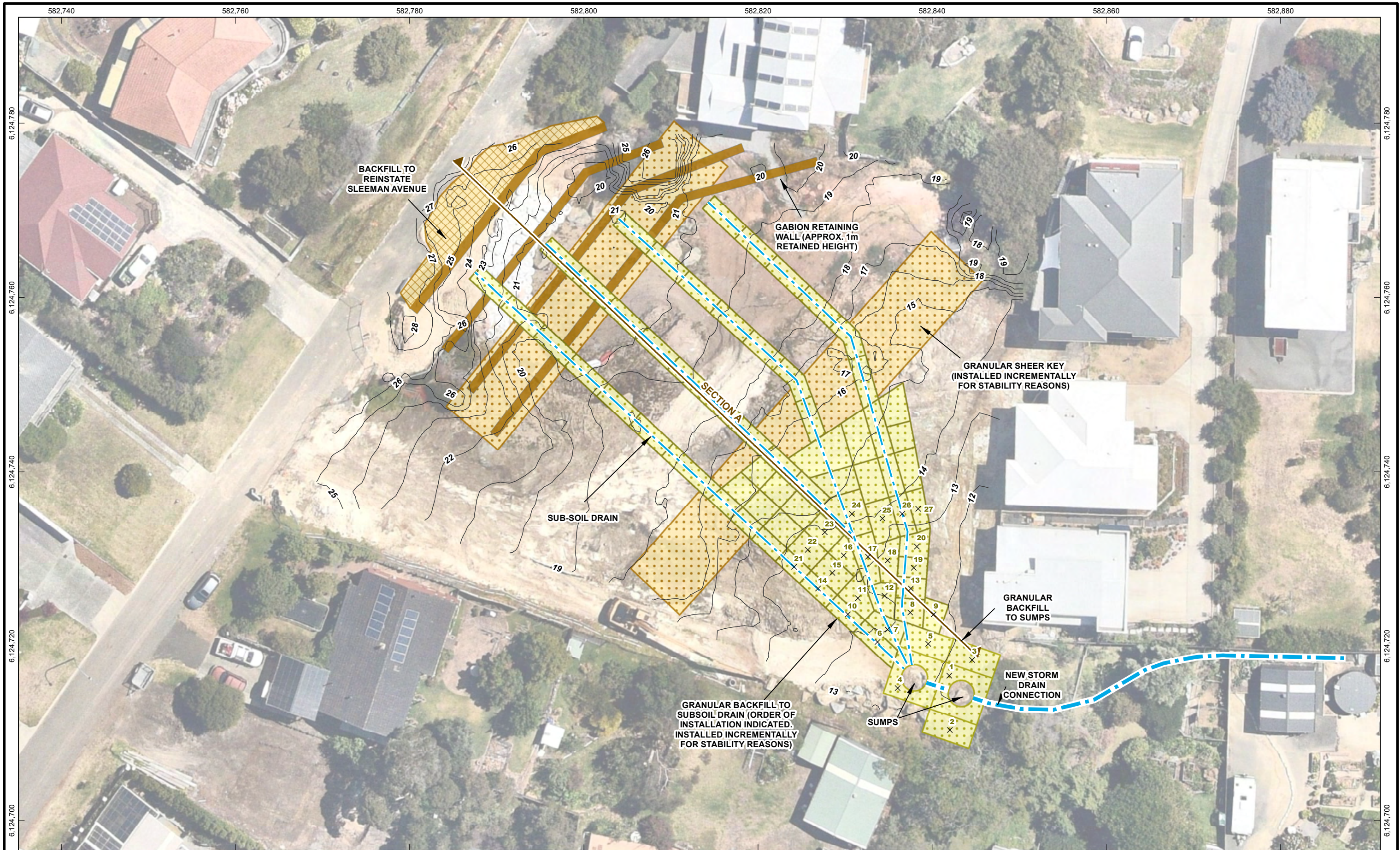
--- BOUNDARY OF LIDAR SURVEY




10 5 0 10 20 Meters

Coordinate System: GDA 1994 MGA Zone 50



CLIENT: GREAT SOUTHERN DEVELOPMENT COMMISSION	COMPILED: NR	PROJECT: PER2021-0347
PROJECT: SLEEMAN ROAD, ALBANY	CHECKED: MAT	FIGURE: 6
TITLE: SURFACE OF TOP OF RESIDUAL MATERIAL	REVISION: C	SCALE: 1:500
	DATE: 5/04/2023	SHEET: A3 L



- Legend**
-  GABION RETAINING WALL (APPROX. 1m RETAINED HEIGHT)
 -  GRANULAR SHEER KEY (INSTALLED INCREMENTALLY FOR STABILITY REASONS)
 -  BACKFILL TO REINSTATE SLEEMAN AVENUE

NOTES

1. DATA SOURCED FROM CLIENT
2. AERIAL PHOTOGRAPHY SOURCED FROM @NEARMAP (February 2023)

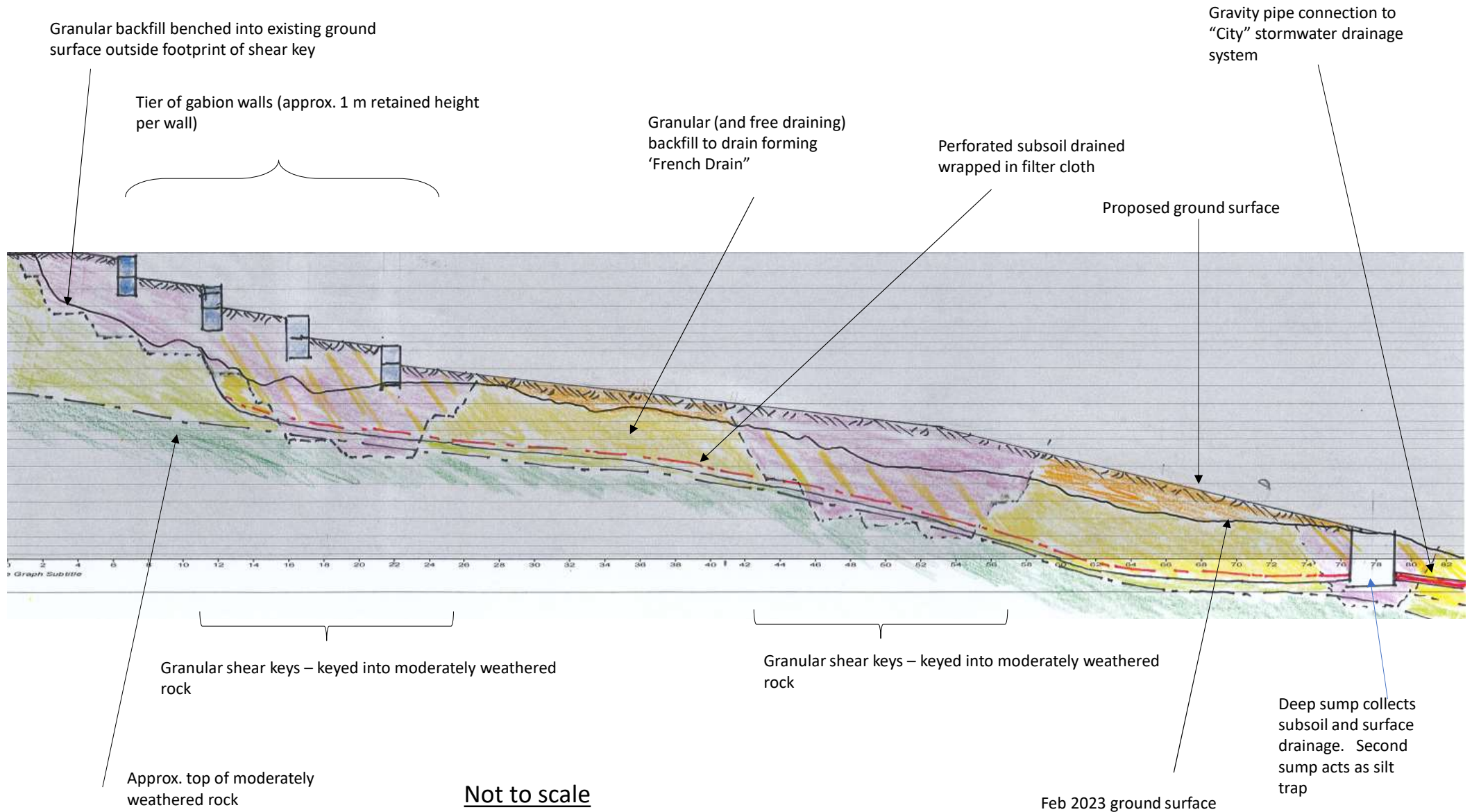


Coordinate System: GDA 1994 MGA Zone 50



CLIENT: GREAT SOUTHERN DEVELOPMENT COMMISSION	COMPILED: NR	PROJECT: PER2021-0347
PROJECT: SLEEMAN ROAD, ALBANY	CHECKED: MAT	FIGURE: 7
TITLE: CONCEPTUAL DRAINAGE AND STABILISATION WORKS	REVISION: A	SCALE: 1:400
	DATE: 20/04/2023	SHEET: A3 L

Figure 8 - Cross-section through conceptual remediation works



APPENDIX A

Historical Investigation Results

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 37.2

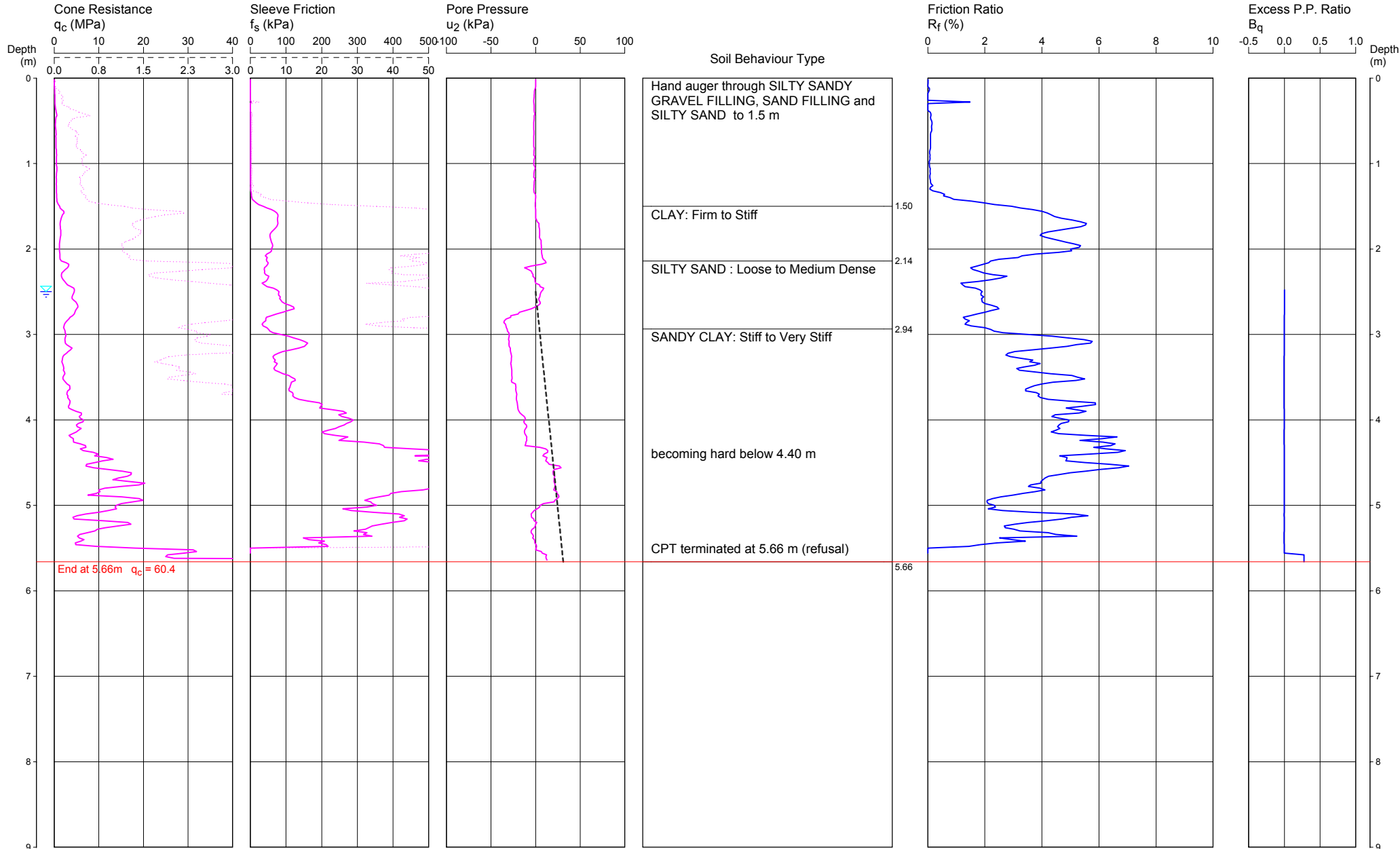
COORDINATES: 0582738 6124800

CPT1u

Page 1 of 1

DATE 5/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT1u.CP5
Cone ID: EC04 Type: Probedrill

Water depth after test: 2.50m depth (measured)

ConePlot Version 5.9.1
© 2003 Douglas Partners Pty Ltd

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 34.6

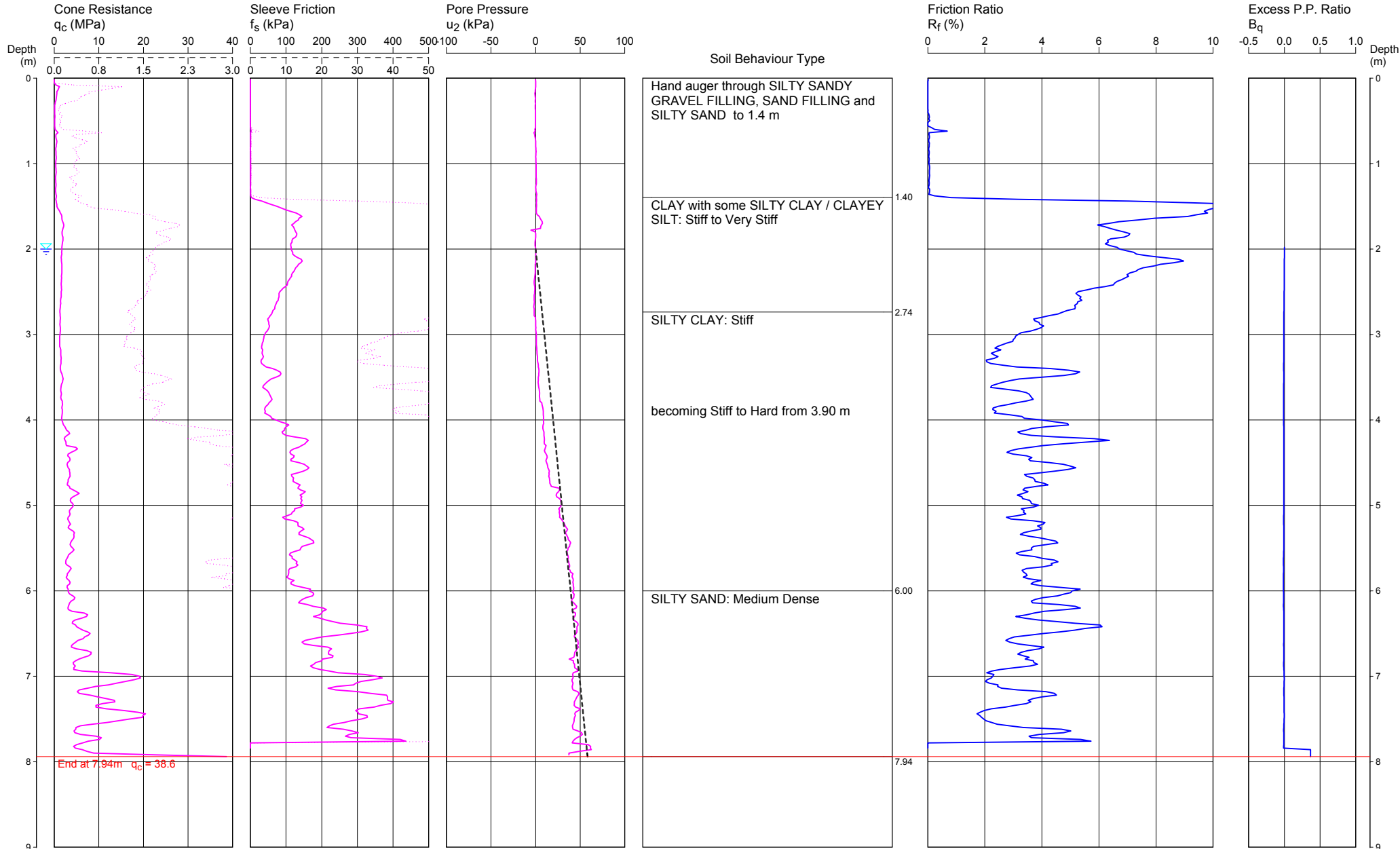
COORDINATES: 50 582769 6124805

CPT2u

Page 1 of 1

DATE 5/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT2u.CP5
Cone ID: EC04 Type: Probedrill

Water depth after test: 2.00m depth (measured)

ConePlot Version 5.9.1
© 2003 Douglas Partners Pty Ltd

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 24.8

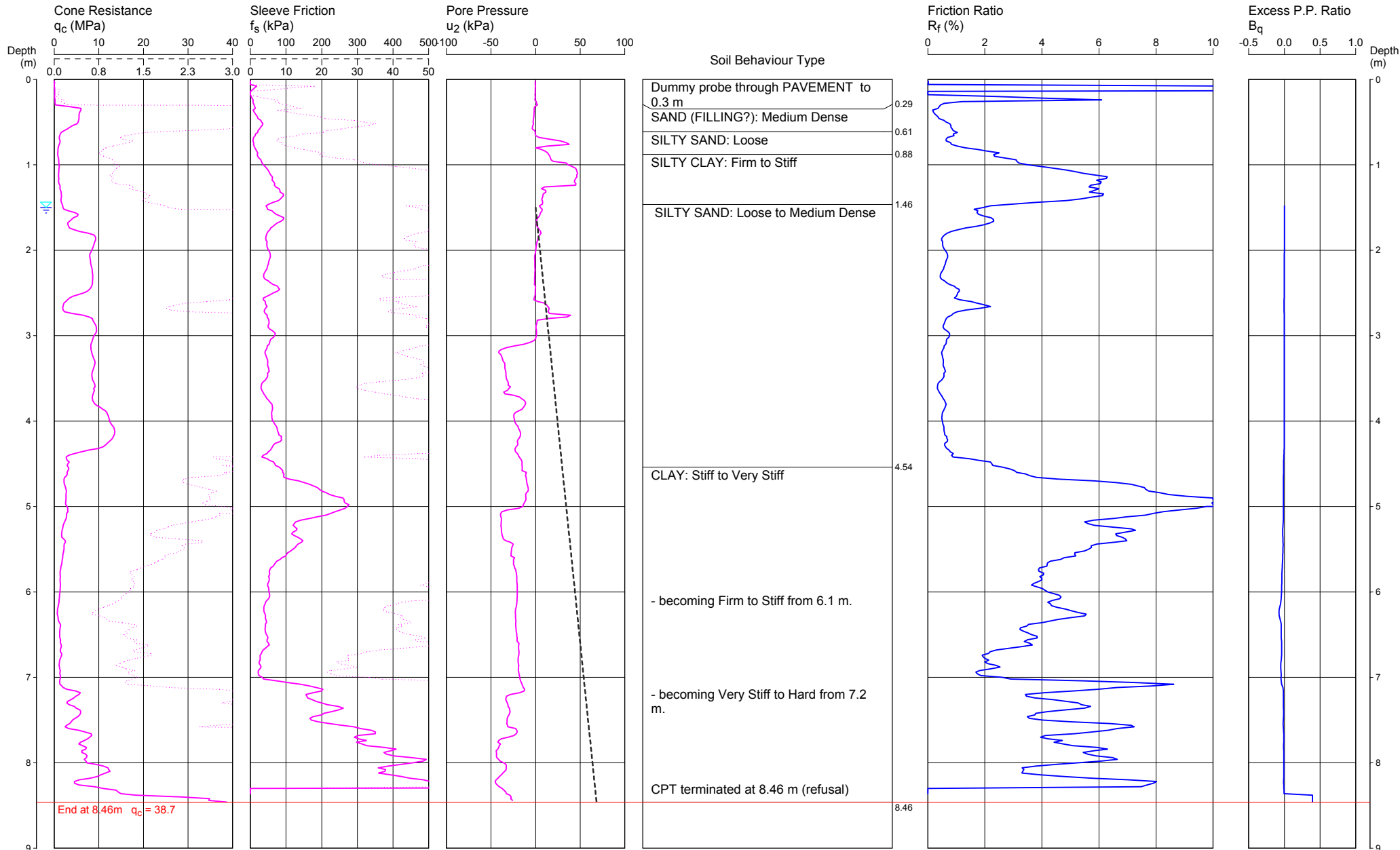
COORDINATES: 50 582790 6124760

CPT3u

Page 1 of 1

DATE 5/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT3u.CP5
Cone ID: EC04 Type: Probedrill

Water depth after test: 1.50m depth (measured)

ConePlot Version 5.9.1
© 2003 Douglas Partners Pty Ltd

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 27.4

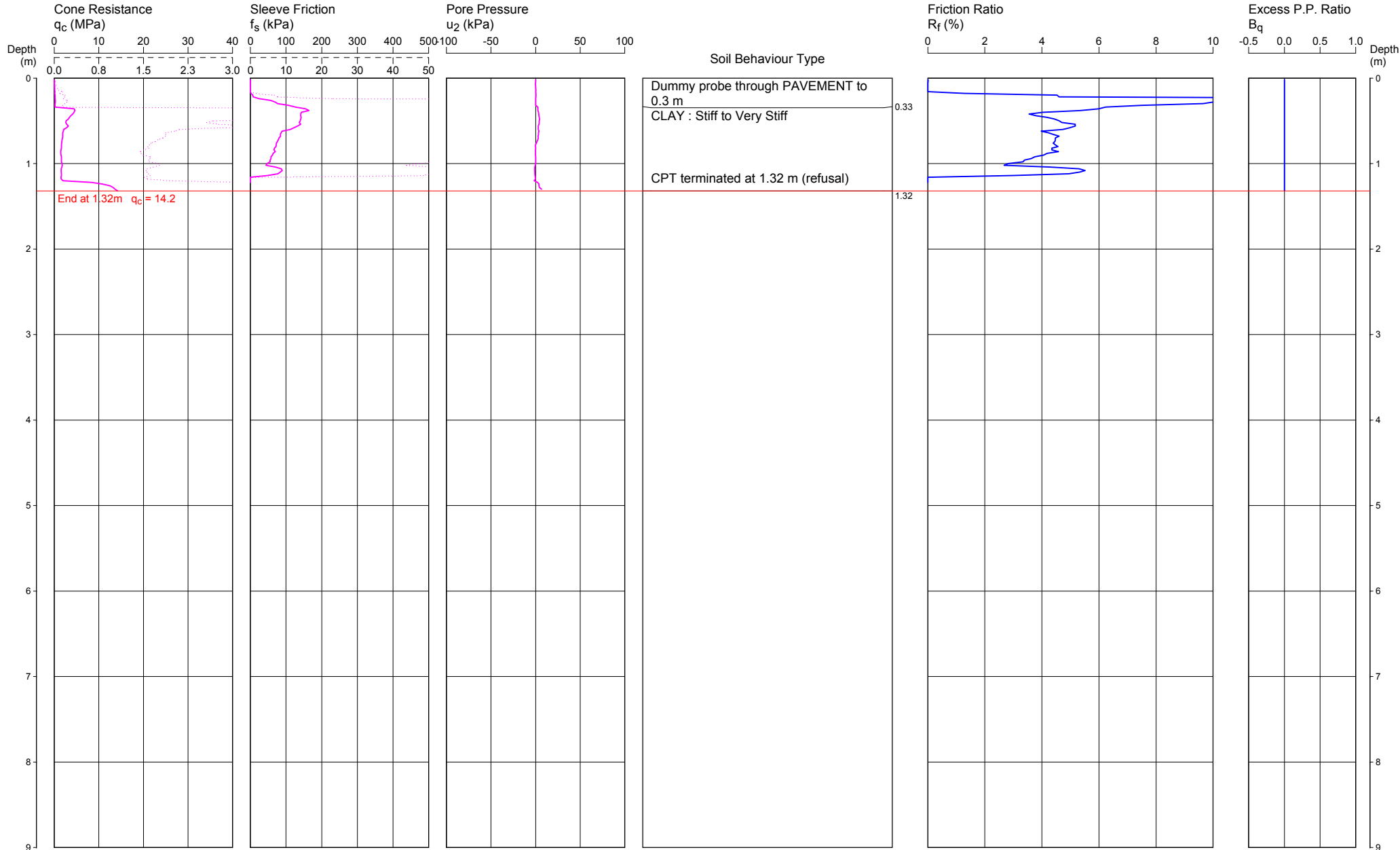
COORDINATES: 582800 6124782

CPT4u

Page 1 of 1

DATE 5/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT4u.CP5
Hole dipped following test. Hole dry to 1.3 m depth. Cone ID: EC04 Type: Probedrill

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 17.8

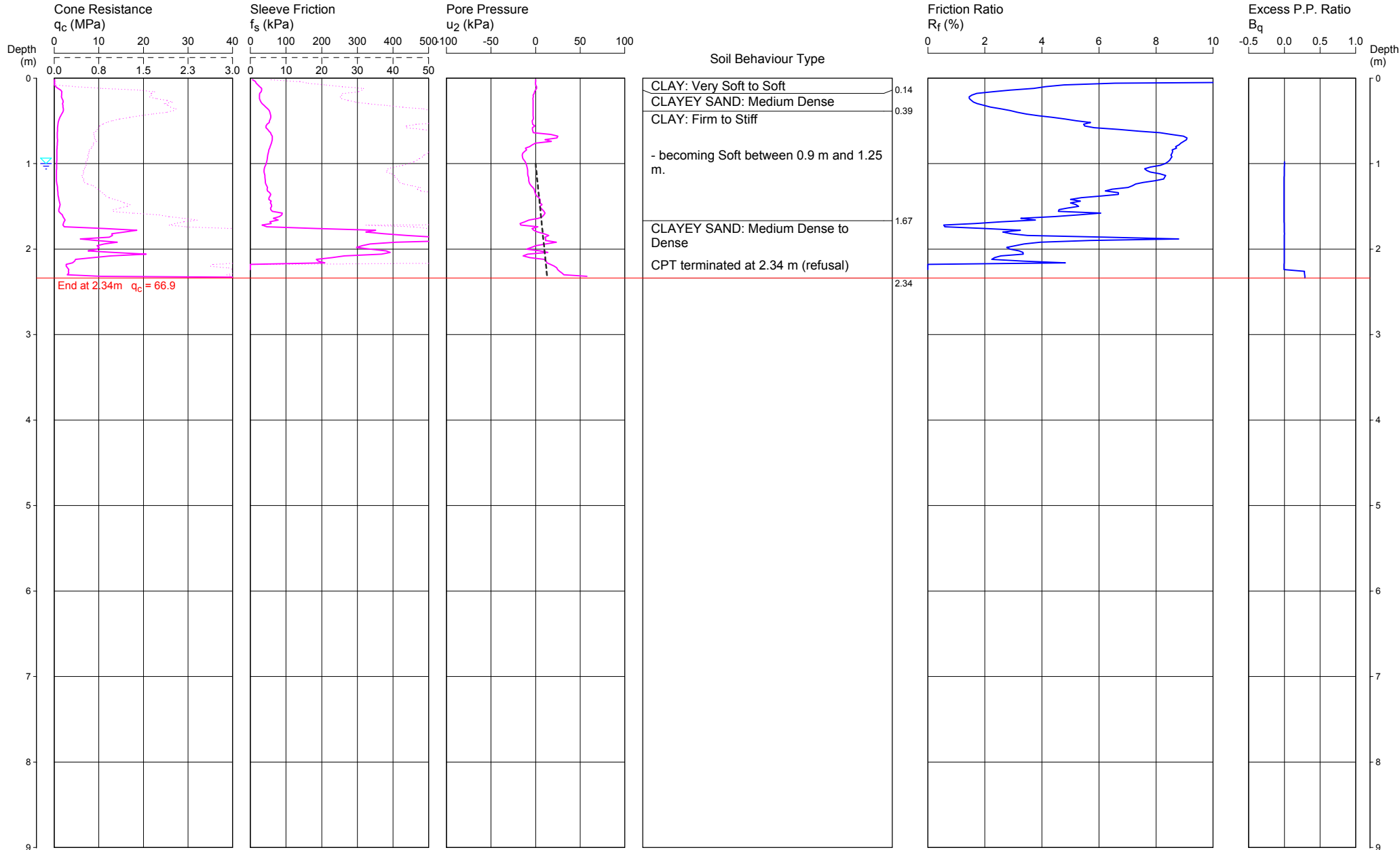
COORDINATES: 50 582815 6124736

CPT5u

Page 1 of 1

DATE 6/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT5u.CP5
Cone ID: EC04 Type: Probedrill

Water depth after test: 1.00m depth (measured)

ConePlot Version 5.9.1
© 2003 Douglas Partners Pty Ltd

CPT6u NOT UNDERTAKEN DUE TO ACCESS RESTRICTIONS

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 14.2

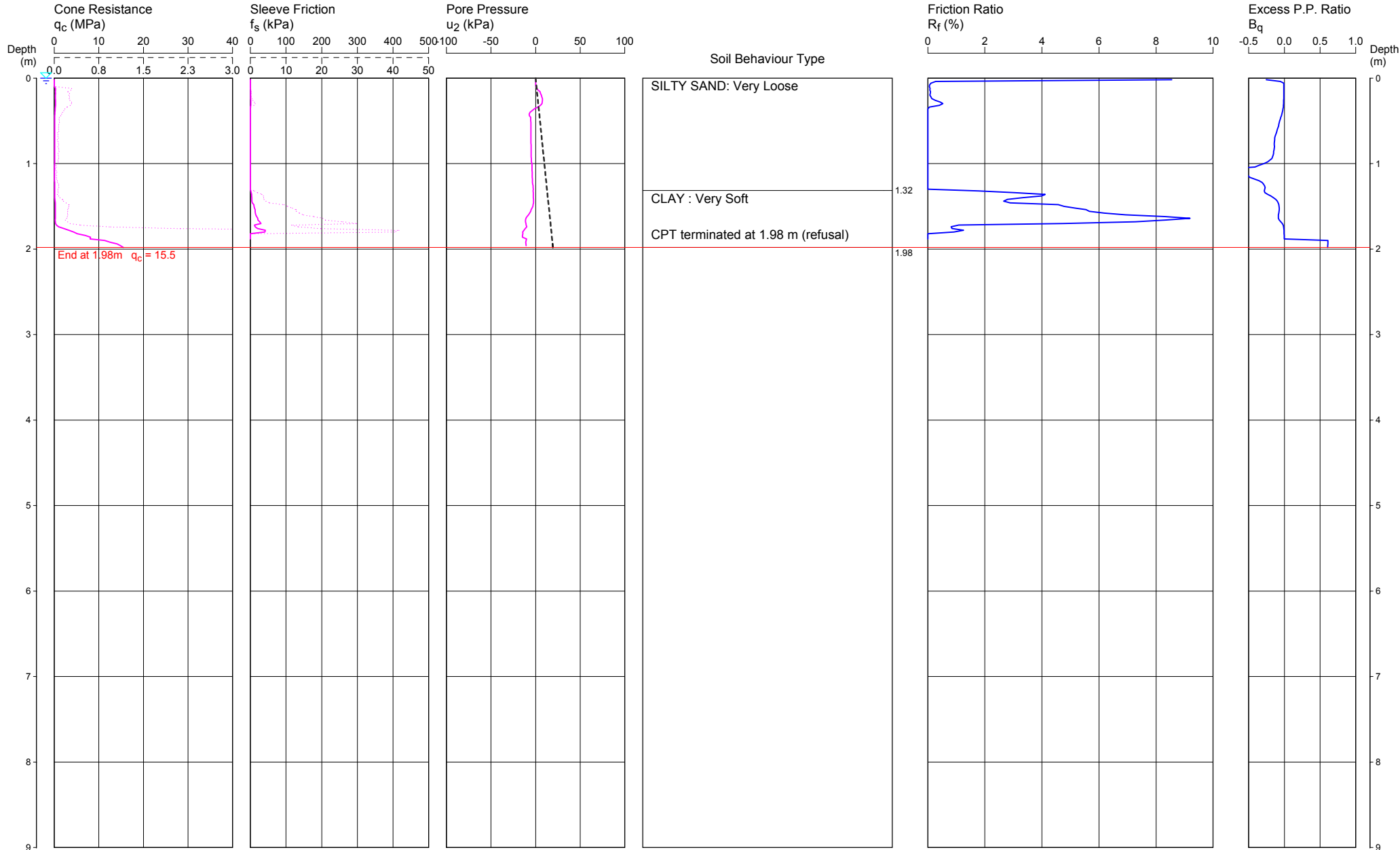
COORDINATES: 50 582824 6124721

CPT7u

Page 1 of 1

DATE 6/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT7u.CP5
Cone ID: EC33 Type: Probedrill

Water depth after test: 0.00m depth (measured)

ConePlot Version 5.9.1
© 2003 Douglas Partners Pty Ltd

PIEZOCONE PENETRATION TEST

CLIENT: City of Albany

PROJECT: 7 Anzac Road

LOCATION: Albany, WA

REDUCED LEVEL: 13.3

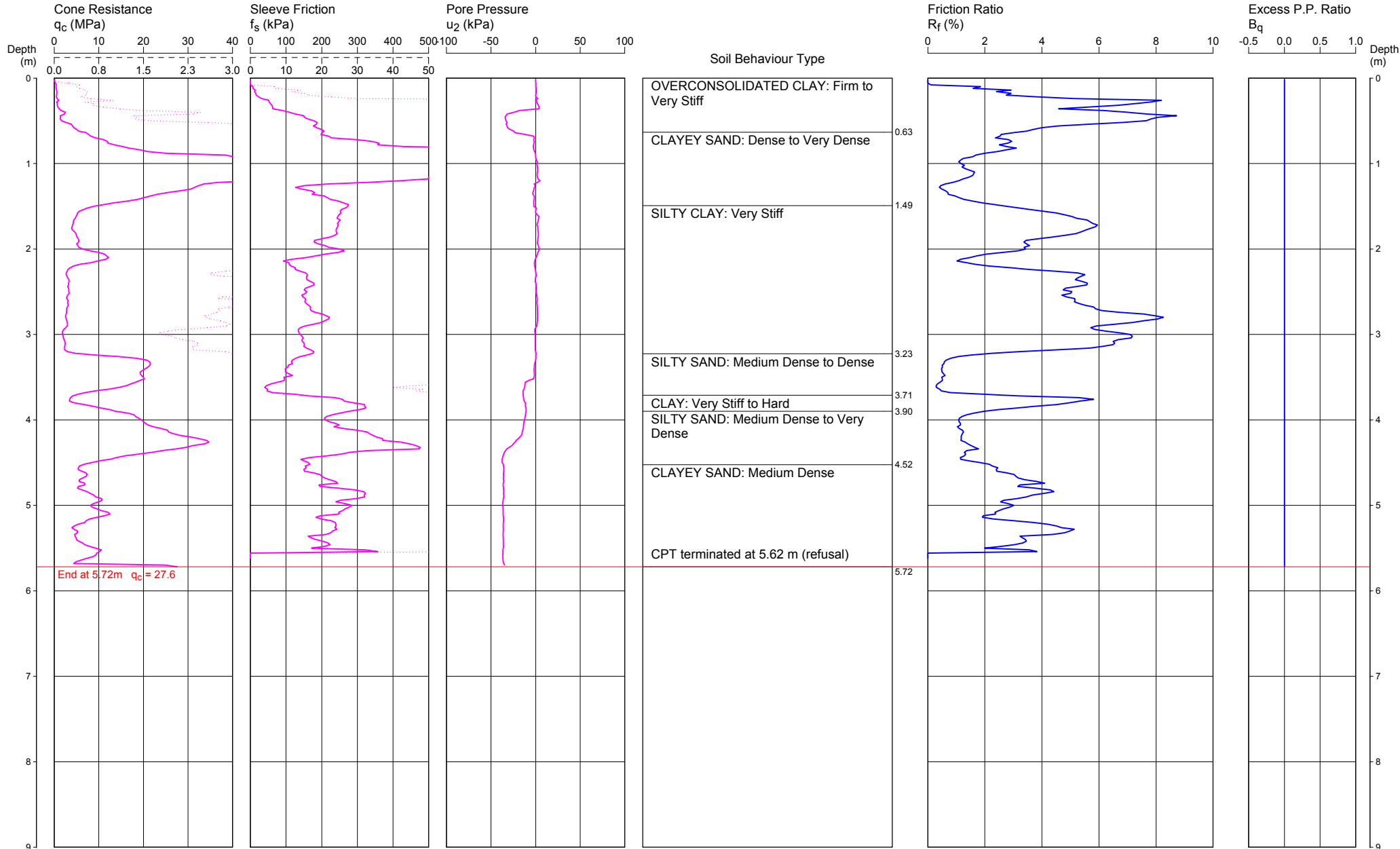
COORDINATES: 50 582853 6124754

CPT8u

Page 1 of 1

DATE 6/12/2013

PROJECT No: 82195



REMARKS: * Surface level interpolated from survey plan provided by the client. File: P:\82195 Albany, 7 Anzac Road\Field\82195 - CPT8u.CP5
Hole dipped following test. Hole dry to 3.0 m depth. Cone ID: EC33 Type: Probedrill

BOREHOLE LOG

CLIENT: City of Albany
PROJECT: 7 Anzac Road
LOCATION: Albany, WA

SURFACE LEVEL: 35.3 m AHD*
EASTING: 582759
NORTHING: 6124802
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 82195
DATE: 5/12/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.05	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained silty sand topsoil, with a trace of rootlets, dry.	[Cross-hatch pattern]							
		FILLING (SILTY SANDY GRAVEL) - orange-brown, fine to coarse sized silty sandy gravel filling, with some cobbles, dry. Gravel is laterite.	[Cross-hatch pattern]							
	0.5	FILLING (SAND) - dark brown, fine to medium grained sand, with some fine to medium sized laterite gravel and silt, moist.	[Cross-hatch pattern]	D	0.6					
	0.7	FILLING (SAND) - grey mottled dark brown, fine to medium grained sand, with some silt and nodules of clay and a trace of charcoal, moist.	[Cross-hatch pattern]							
	1									
	1.2	SAND - grey, fine to medium grained sand, with some silt, moist.	[Dotted pattern]							
		- becoming wet from 1.7 m.		D	1.8					
	2									
	2.1	SILTY SAND - dark grey, fine to medium grained silty sand, wet.	[Vertical line pattern]							
							▼ 05-12-13			
	2.7	SANDY CLAY - grey mottled light brown, medium to high plasticity sandy clay, moist.	[Diagonal line pattern]	D	2.8					
	3	Bore discontinued at 3.0m (Target)								

RIG: 110 mm diameter hand auger

DRILLER: CC

LOGGED: CC

CASING:

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: Static groundwater level observed at 2.4 m following test.

REMARKS: Location coordinates are in MGA94 Zone 50. * Surface level interpolated from survey plan provided by the City of Albany.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: City of Albany
PROJECT: 7 Anzac Road
LOCATION: Albany, WA

SURFACE LEVEL: 27.5 m AHD*
EASTING: 582794
NORTHING: 6124773
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 82195
DATE: 5/12/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
27	0.05	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained silty sand topsoil, with a trace of rootlets, dry.		D	0.9					
		FILLING (GRAVELLY SAND) - light brown, fine to coarse grained gravelly sand filling, with some silt, moist. Gravel is fine to coarse sized laterite.								
		- cobble at 0.4 m.								
	0.7	FILLING (CLAYEY SAND) - brown mottled dark brown, medium to high plasticity, fine to coarse grained clayey sand, moist.								
	0.8	FILLING (SILTY SAND) - dark brown, fine to medium grained silty sand, with some medium to coarse sized gravel, clayey sand nodules and fragments of glass, moist.								
1	1.1	SANDY CLAY - dark brown mottled orange-brown, high plasticity sandy clay, moist.		1.2						
20	1.4	SILTY SAND - dark brown, fine to medium grained silty sand, moist.		1.6						
25		- becoming grey-brown mottled dark brown with some weakly cemented sand nodules from 2.4 m.		2.7						
		- becoming dark brown from 2.6 m.								
3	3.0	Bore discontinued at 3.0m (Target)								

RIG: 110 mm diameter hand auger

DRILLER: CC

LOGGED: CC

CASING:

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50. * Surface level interpolated from survey plan provided by the City of Albany.

SAMPLING & IN SITU TESTING LEGEND


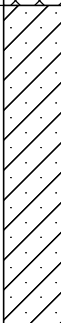
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: City of Albany
PROJECT: 7 Anzac Road
LOCATION: Albany, WA

SURFACE LEVEL: 17.7 m AHD*
EASTING: 582828
NORTHING: 6124753
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 82195
DATE: 6/12/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)									
				Type	Depth	Sample	Results & Comments		5	10	15	20						
	0.05	<p>TOPSOIL (SAND) - dark brown, fine to coarse grained sand topsoil, with some silt and a trace of rootlets, moist.</p> <p>FILLING (SAND) - loose to medium dense, light brown, fine to coarse grained slightly gravelly sand, with a trace of silt, moist. Gravel is laterite and sandstone.</p> <p>- becoming very loose to loose from 0.45 m.</p> <p>- becoming grey-brown, with some fine to medium sized gravel and silt from 0.7 m.</p> <p>- becoming medium dense from 0.9 m.</p>																
	1.2	<p>SANDY CLAY - grey mottled brown and red-brown, medium to high plasticity sandy clay, with a trace of medium sized gravel, moist.</p>		B	1.5													
	1.95	Bore discontinued at 1.95m (Slow dig on sandy clay)																

RIG: 110 mm diameter hand auger **DRILLER:** CC **LOGGED:** CC **CASING:**

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50. * Surface level interpolated from survey plan provided by the City of Albany.

Sand Penetrometer AS1289.6.3.3
 Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: City of Albany
PROJECT: 7 Anzac Road
LOCATION: Albany, WA

SURFACE LEVEL: 17.2 m AHD*
EASTING: 582844
NORTHING: 6124768
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 82195
DATE: 6/12/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1	0.25	FILLING (SILTY SANDY GRAVEL) - orange-brown, fine to coarse sized silty sandy gravel, moist. Gravel is laterite.	[Cross-hatch pattern]							
		FILLING (SAND) - light grey, fine to medium grained sand filling with a trace of silt, moist.	[Cross-hatch pattern]							
		- becoming light yellow-brown from 1.0 m.	[Cross-hatch pattern]	D	0.7					
	1.2	SILTY SAND - dark brown, fine to medium grained silty sand with some clay, moist.	[Dotted pattern]	D	1.3					
	1.4	SANDY CLAY - grey mottled brown and red-brown, medium to high plasticity sandy clay with a trace of medium sized gravel, moist.	[Diagonal lines pattern]	D	1.6					
	1.8	Bore discontinued at 1.8m (Slow dig on sandy clay)								

RIG: 110 mm diameter hand auger **DRILLER:** CC **LOGGED:** CC **CASING:**

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50. * Surface level interpolated from survey plan provided by the City of Albany.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



BOREHOLE LOG

CLIENT: City of Albany
PROJECT: 7 Anzac Road
LOCATION: Albany, WA

SURFACE LEVEL: 15.2 m AHD*
EASTING: 582824
NORTHING: 6124731
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 82195
DATE: 6/12/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
15.2	0.15	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained silty sand, topsoil with a trace of rootlets, moist.		D	0.3					
	0.5	SILTY SAND - dark brown, fine to medium grained silty sand, moist. - becoming grey-brown and wet from 0.4 m.								
	0.5	Bore discontinued at 0.5m (Refusal on cobble/boulder)								
	1									
	2									
	3									

RIG: 110 mm diameter hand auger

DRILLER: CC

LOGGED: CC

CASING:

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: Location coordinates are in MGA94 Zone 50. * Surface level interpolated from survey plan provided by the City of Albany.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)





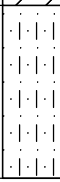
Douglas Partners
 Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: City of Albany
PROJECT: 7 Anzac Road
LOCATION: Albany, WA

SURFACE LEVEL: 12.9 m AHD*
EASTING: 582850
NORTHING: 6124745
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 82195
DATE: 6/12/2013
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.1	FILLING (CLAYEY SAND) - grey-brown, medium plasticity fine to coarse grained clayey sand, moist to wet.								
		SANDY CLAY - light grey mottled orange-brown and red-brown, medium to high plasticity slightly gravelly sandy clay, moist. Gravel is fine to medium sized quartz.		B	0.5					
		- with a trace of fine to medium sized gravel, becoming dry to moist from 0.8 m.								
	1									
		- becoming grey mottled orange-brown and moist.								
				D	1.5					
	2									
		- becoming grey mottled orange-brown and red-brown and moist from 2.0 m.								
				D	2.4					
	2.6									
		SILTY SAND - brown mottled grey, fine to medium grained silty sand, wet.		D	2.8			▼ 06-12-13		
	3									
	3.0	Bore discontinued at 3.0m (Target)								

RIG: 110 mm diameter hand auger

DRILLER: CC

LOGGED: CC

CASING:

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: Static groundwater level observed at 2.6 m following test.

REMARKS: Location coordinates are in MGA94 Zone 50. * Surface level interpolated from survey plan provided by the City of Albany.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	≻	Water seep	S	Standard penetration test
E	Environmental sample	≻	Water level	V	Shear vane (kPa)

APPENDIX B

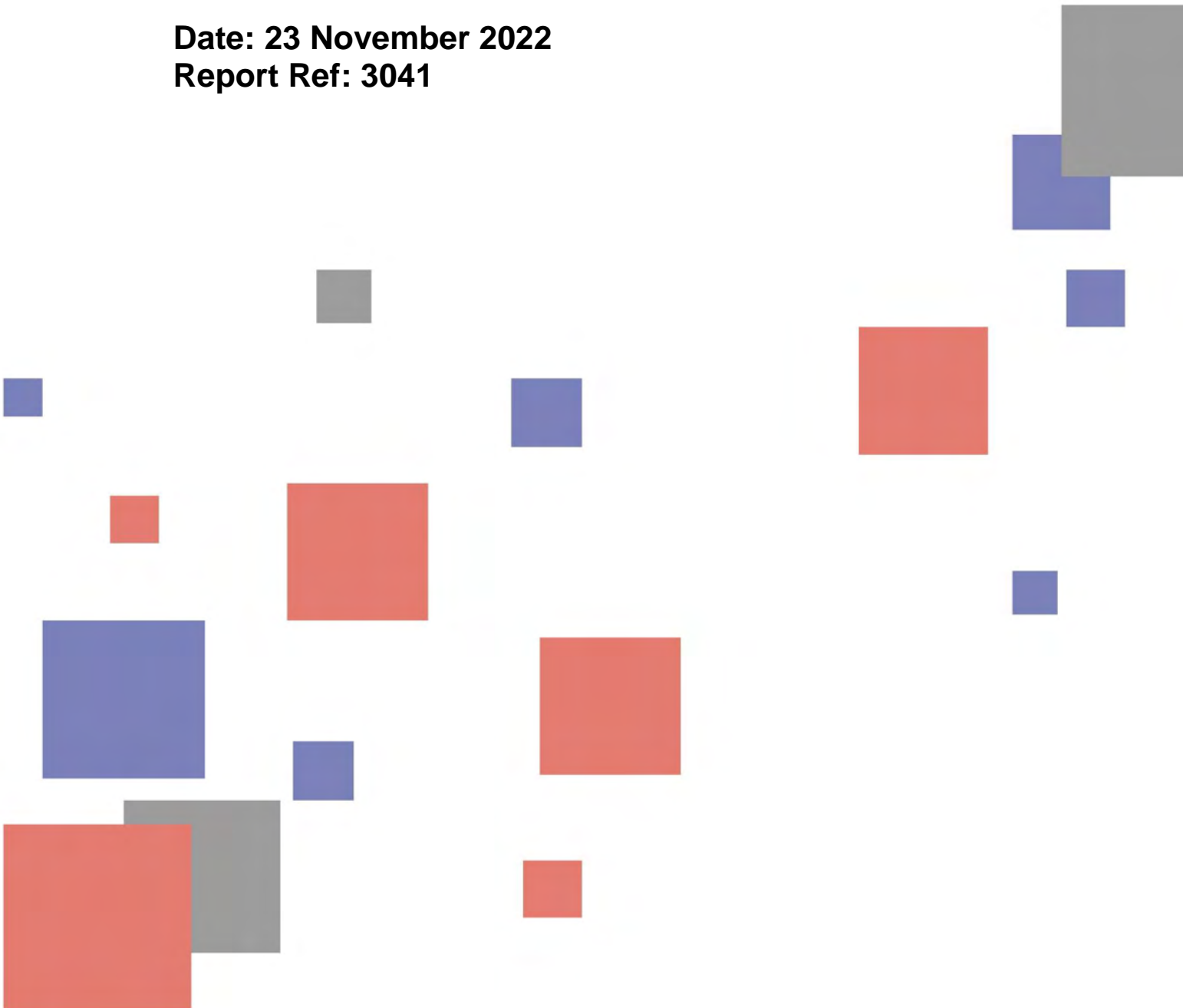
Geophysical Survey Results

Report

Geophysical Subsurface Investigation at Landslide Site.

8-12 Sleeman Avenue Mira Mar WA.

**Date: 23 November 2022
Report Ref: 3041**



DOCUMENT HISTORY

DETAILS

Project number	3041
Document Title	Geophysical Subsurface Investigation at Landslide Site
Site Address	8-12 Sleeman Avenue Mira Mar, Western Australia
Report prepared for	CMW Geosciences

STATUS AND REVIEW

Revision	Prepared by	Reviewed by	Date issued
0	Andrew Spyrou	Baqir Al asadi	23 November 2022

DISTRIBUTION

Revision	Electronic	Paper	Issued to
0	1	0	Richard David, CMW Geosciences

COMPANY DETAILS

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1 INTRODUCTION

At the request of CMW Geosciences (CMW), GBG Group carried out a geophysical subsurface investigation at 8-12 Sleeman Avenue Mira Mar Western Australia. The geophysical investigation forms part of a broader scope geotechnical investigation being carried out by CMW to assess the subsurface ground conditions beneath the site of a landslide.

During the investigation, ground geophysical methods were utilised including Seismic Refraction Tomography (SRT) and Electrical Resistivity Tomography (ERT) along 11 specified transects totalling approximately 600m of profiling. The objective of the investigation was to obtain a subsurface model of the site including the depth to granite bedrock which is overlain by boulders of transported granite and soil.

2 INVESTIGATION SITE

The geophysical investigation was carried out along 11 transects as specified by CMW (yellow lines in Figure 1). Geophysical data was not acquired along proposed transect N-1 due to steep topography along this alignment making safe data acquisition not possible.

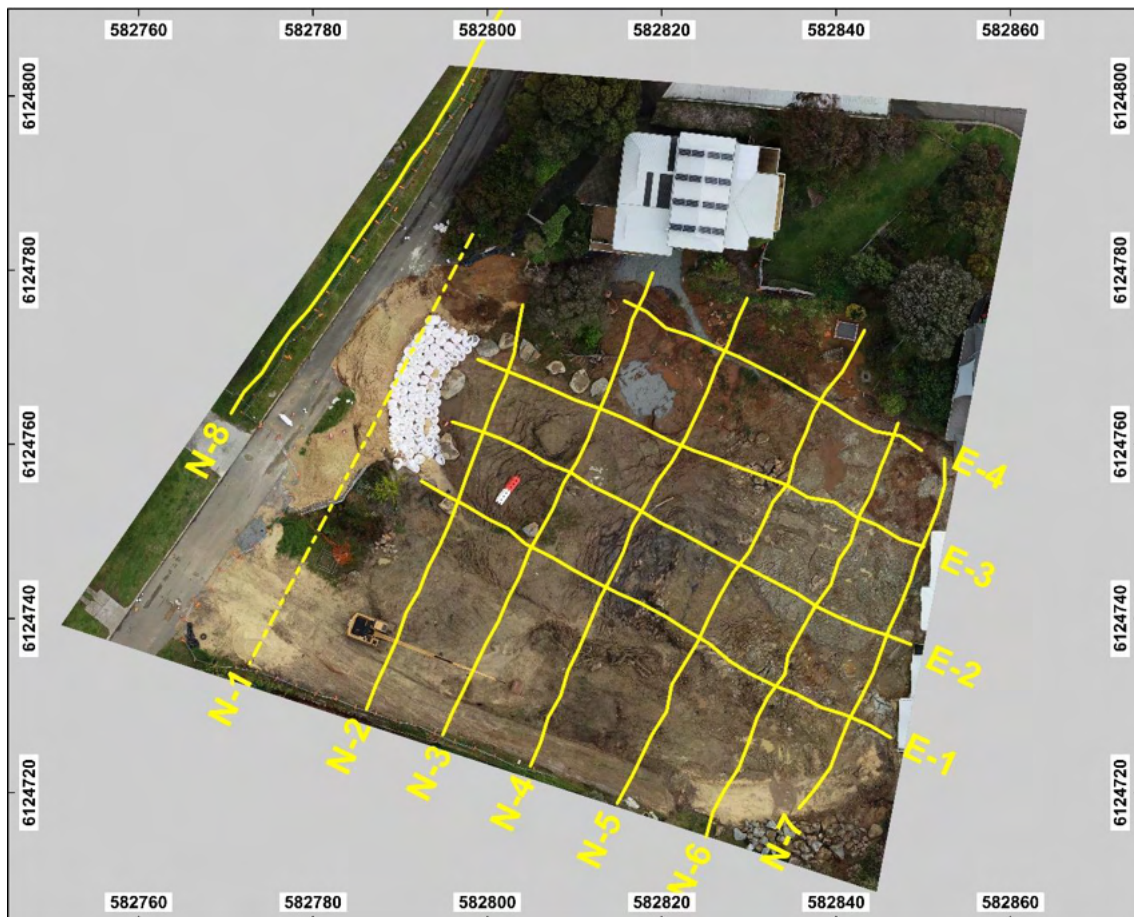


Figure 1: Acquired geophysical transects (yellow solid lines) and proposed transect where data acquisition was not possible (yellow dashed line). Aerial imagery from CMW.

Surface conditions within the site were generally suitable for SRT and ERT data acquisition and consisted of cleared ground with wet clay and granite boulders, and debris from the demolition of the buildings previously occupying the site. Topography was decreasing to the south-east (perpendicular to Sleeman Ave) with a slope of approximately 1:6. Photographs showing the typical site conditions are shown in Figure 2.



Figure 2: Typical site conditions within the geophysical investigation area.

3 GEOPHYSICAL DATA ACQUISITION & PROCESSING

The geophysical investigation site work was carried out over 3 days from the 13 to 15 November 2022 by a qualified geophysicist and field assistant from GBG Group. Geophysical data was acquired using the SRT and ERT methods along 11 transects, details of which are shown in Table 1 below.

Table 1: Geophysical Transect Coordinates (GDA2020, MGA Zone 50)

ID	Start Coordinate		End Coordinate		Length (m)
	North	East	North	East	
N-1	<i>Not acquired due to steep topography</i>				
N-2	6124729.6	582786.1	6124776.0	582804.1	51
N-3	6124726.6	582794.9	6124779.7	582819.0	60
N-4	6124723.1	582805.0	6124776.7	582829.8	60
N-5	6124718.8	582814.9	6124773.1	582843.3	63
N-6	6124714.9	582825.1	6124762.4	582847.1	54
N-7	6124718.2	582835.8	6124758.3	582852.4	45
N-8	6124763.6	582770.6	6124813.4	582803.5	60
E-1	6124726.3	582846.2	6124755.8	582792.4	63
E-2	6124737.0	582848.6	6124762.6	582796.0	60
E-3	6124748.2	582850.0	6124769.7	582798.9	57
E-4	6124759.3	582849.8	6124776.5	582815.7	39

3.1 SEISMIC REFRACTION TOMOGRAPHY

SRT data was acquired using a Geode (Geometrics) multi-channel seismograph connected to an array of up to 24 geophones set at 3m increments resulting in a maximum array length of 69m. Seismic energy was generated at multiple source points using stacked sledgehammer impacts onto a metal base plate. SRT acquisition parameters are provided in Table 2.

Table 2 – SRT Acquisition Parameters

Acquisition Parameter	Value
Geophone spacing	3 m
Max no. of geophones	24
Geophone centre frequency	10 Hz
Record length	150 ms
Sample interval	0.032 ms
Source stacks	5
Max. source points per spread	7

The SRT dataset was processed using Rayfract (v3.35, Intelligent Resources Inc.) which utilises 2D Wavepath Eikonal Traveltime (WET) tomography on the first arrival travel times to model the seismic compressional (P-) wave velocity distribution of the subsurface as 2D cross-sections along the acquired transects.

Inversion of SRT data assumes an increase in P-wave velocity with depth. In the presence of a velocity inversion (hard over soft material) the data may be truncated due to the refracted signal being unable to penetrate into a lower density material (as defined by Snell's Law), or a higher than expected velocity may present in the modelled data below an isolated hard layer. In the case where an isolated hard layer is identified in geotechnical logs, deeper P-wave velocities should be used with caution.

3.2 ELECTRICAL RESISTIVITY TOMOGRAPHY

ERT data was acquired using a FlashRES-Universal resistivity system (ZZ Resistivity Imaging) connected to an array of up to 24 electrodes set at 3m increments. Data was acquired using a pre-programmed automated control sequence that controlled which pair of electrodes along the array were used for current injection with the resulting potential difference measured across multiple electrode pairs. ERT acquisition parameters are provided in Table 3.

Table 3 – ERT Acquisition Parameters

Acquisition Parameter	Value
Electrode spacing	3 m
Max no. of electrodes	24
Array type	Wenner / Schlumberger
Injection on/off time	0.6/0.1 s
Survey voltage	120 V

The ERT dataset was processed using EarthImager 2D (v2.4.4, AGI Software). The raw data was imported with topographic data, then filtered to remove spurious values and plotted to generate apparent resistivity pseudo-sections. The pseudo-sections were then inverted using the smoothness-constrained least-squares technique for multiple iterations to model the electrical resistivity distribution of the subsurface material along each transect.

3.3 SPATIAL POSITIONING

Spatial positioning of the acquired geophysical transects was achieved using a S631 (Hemisphere) GNSS receiver with Atlas satellite corrections. An accuracy of +/-0.2m is expected for both vertical and horizontal components.

Coordinates of the geophysical transects have been provided in GDA2020, MGA zone 50 for horizontal component and Australian Height Datum (mAHD) for vertical component.

4 RESULTS AND INTERPRETATION

4.1 PRESENTATION OF RESULTS

The results of the geophysical investigation carried out at 8-12 Sleeman Avenue Mira Mar WA are provided in Appendix A to B of this report as follows:

Appendix A – Site Maps

- **3041-01.** Site map showing extent of acquired geophysical transects
- **3041-02.** Site map showing contoured level (mAHD) to top of modelled rock
- **3041-03.** Site map showing contoured thickness (m) of sediment over modelled rock

Appendix B – Interpreted SRT and ERT Sections

- **3041-04.** Geophysical Transect N-2
- **3041-05.** Geophysical Transect N-3
- **3041-06.** Geophysical Transect N-4
- **3041-07.** Geophysical Transect N-5
- **3041-08.** Geophysical Transect N-6
- **3041-09.** Geophysical Transect N-7
- **3041-10.** Geophysical Transect N-8
- **3041-11.** Geophysical Transect E-1
- **3041-12.** Geophysical Transect E-2
- **3041-13.** Geophysical Transect E-3
- **3041-14.** Geophysical Transect E-4

4.2 SEISMIC REFRACTION TOMOGRAPHY

The modelled seismic P-wave velocity distribution of the subsurface material in metres/second has been generated as contour sections for each transect. The sections provide information on the subsurface material condition with increasing velocity an indication of increasing material hardness as shown in the equations below.

$$\text{Seismic P-wave velocity} \quad V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$

where; K = Bulk modulus
 G = Shear modulus
 ρ = In-situ material density

Interpreted material classification sections have been generated by demarcating the seismic velocity sections into several classes representing various material types. Note: these sections have been based on an uncalibrated dataset. In order to ascertain material type and condition definitively and to calibrate the geophysical datasets, intrusive testing by way of logged boreholes is recommended. Four classes have been interpreted as follows:

- **Class P.1** – very high P-wave velocity ($3500 \leq V_p$). Representing the highest seismic velocities modelled during the investigation, this class is interpreted as high strength rock including slightly weathered to fresh GRANITE.
- **Class P.2** – high P-wave velocity ($2000 \leq V_p < 3500$). This class is interpreted as medium to high strength rock including moderately weathered GRANITE.
- **Class P.3** – moderate P-wave velocity ($750 \leq V_p < 2000$). This class is interpreted as either very low strength rock including extremely to deeply weathered GRANITE or residual soil.
- **Class P.4** – low P-wave velocity ($V_p < 750$). This class is interpreted as loose to moderately compact sediment including SAND, CLAY and SILT with possible GRANITE boulder inclusions.

4.3 ELECTRICAL RESISTIVITY TOMOGRAPHY

The modelled electrical resistivity distribution of the subsurface material in Ohm.metres has been generated as contour sections for each transect. The dominant factors affecting the bulk electric resistivity of natural subsurface material are:

- Porosity and permeability
- Degree of saturation – the fraction of pore space / fractures filled with fluid
- Fluid type including salt content – the composition of the fluid filling the pore spaces / fractures
- Presence of clays with moderate to high cation exchange capacity (CEC)

The modelled resistivity values for this investigation ranged from near 0 to 2500Ωm (1-3.4 in log scale). This represents a wide range of resistivity values suggestive of various material types and conditions. Of all the geophysical properties of subsurface materials, electrical resistivity is the most variable with individual rock and soil types ranging over several orders of magnitude. As such using the ERT method as a diagnostic for specific subsurface material type is generally not possible.

Interpreted material classification sections have been generated by demarcating the electrical resistivity sections into several classes. Note as with the seismic sections these have been based on an uncalibrated dataset. Four classes have been interpreted based on variations in material porosity and permeability ranging from high resistive, low permeable/porous material typical of fresh or slightly weathered GRANITE through to low resistive, highly permeable/porous material typical of saturated sediment including SAND, CLAY and SILT.

4.4 TOP OF ROCK CONTOUR MAPS

Contour site maps have been generated from the seismic velocity material classification sections by digitising and gridding the 2000m/s contour representing the interpreted top of moderately weathered rock along each of the transects. Two contour site maps have been provided:

- Contoured level (mAHD) to top of modelled rock (weathered GRANITE) ranging from 3.4mAHD to 14.9mAHD.
- Contoured thickness (m) of sediment overlying modelled rock ranging from 1.8m to 15.4m.

The following limitations should be considered when analysing the provided site contour maps. The maps should only be used to assess the broad changes in interpreted geology beneath the site due to the spacing between the individual transects. Variations in level/depth to rock occurring in between the transects will not be represented in the maps. Furthermore the level/depth to rock is only accurate along the individual transects and due to interpolation between data points, the accuracy off the transect lines is indeterminable.

5 PROJECT SUMMARY AND RECOMMENDATIONS

A geophysical subsurface investigation has been carried out at 8-12 Sleeman Avenue Mira Mar as part of a landslide site assessment being carried out by CMW. During the investigation a geophysical dataset was acquired using the SRT and ERT methods. The acquired geophysical dataset were processed, analysed, and interpreted to obtain subsurface information within the site including the depth to rock and overlying sediment thickness.

The results of the geophysical investigation have been presented as cross-sections showing the interpreted depth and condition of the subsurface material relating to material hardness via modelled seismic P-wave velocity and material porosity/permeability via modelled electrical resistivity. From the interpreted sections, contoured site maps showing the broad changes in level to top of rock and overlying sediment thickness have been presented.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of seismic and electrical signals. At the time of the investigation, calibration and ground truthing of the geophysical results with intrusive geotechnical testing has not been carried out. The findings in this report represent the professional opinions of the authors, based on experience gained during previous similar investigations.

We trust that this report and the attached drawings provide you with the information required. If you require clarification on any points arising from this geophysical investigation, please do not hesitate to contact the undersigned on 08 9354 6300.

For and on behalf of
GBG GEOTECHNICS (AUSTRALIA)



ANDREW SPYROU
Operations Manager, Western Australia / Senior Geophysicist

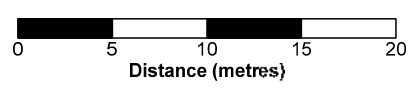
APPENDIX A – INVESTIGATION SITE MAPS



Legend

- Acquired geophysical transect
 - Seismic Refraction Tomography
 - Electrical Resistivity Tomography
- - - Geophysical transect not acquired due to steep terrain

NOTES
 Drawing to be used in conjunction with Report 3041.
 Map Projection GDA2020 MGA Zone 50.
 Aerial image from CMW Geosciences drone survey and MetroMap.

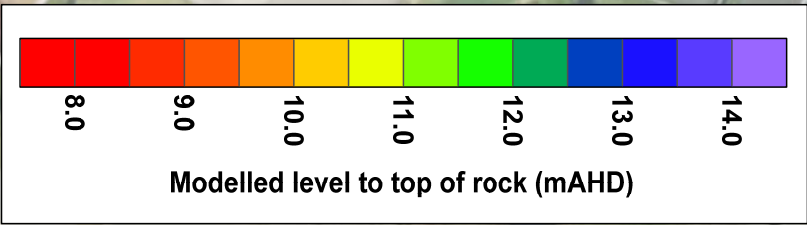
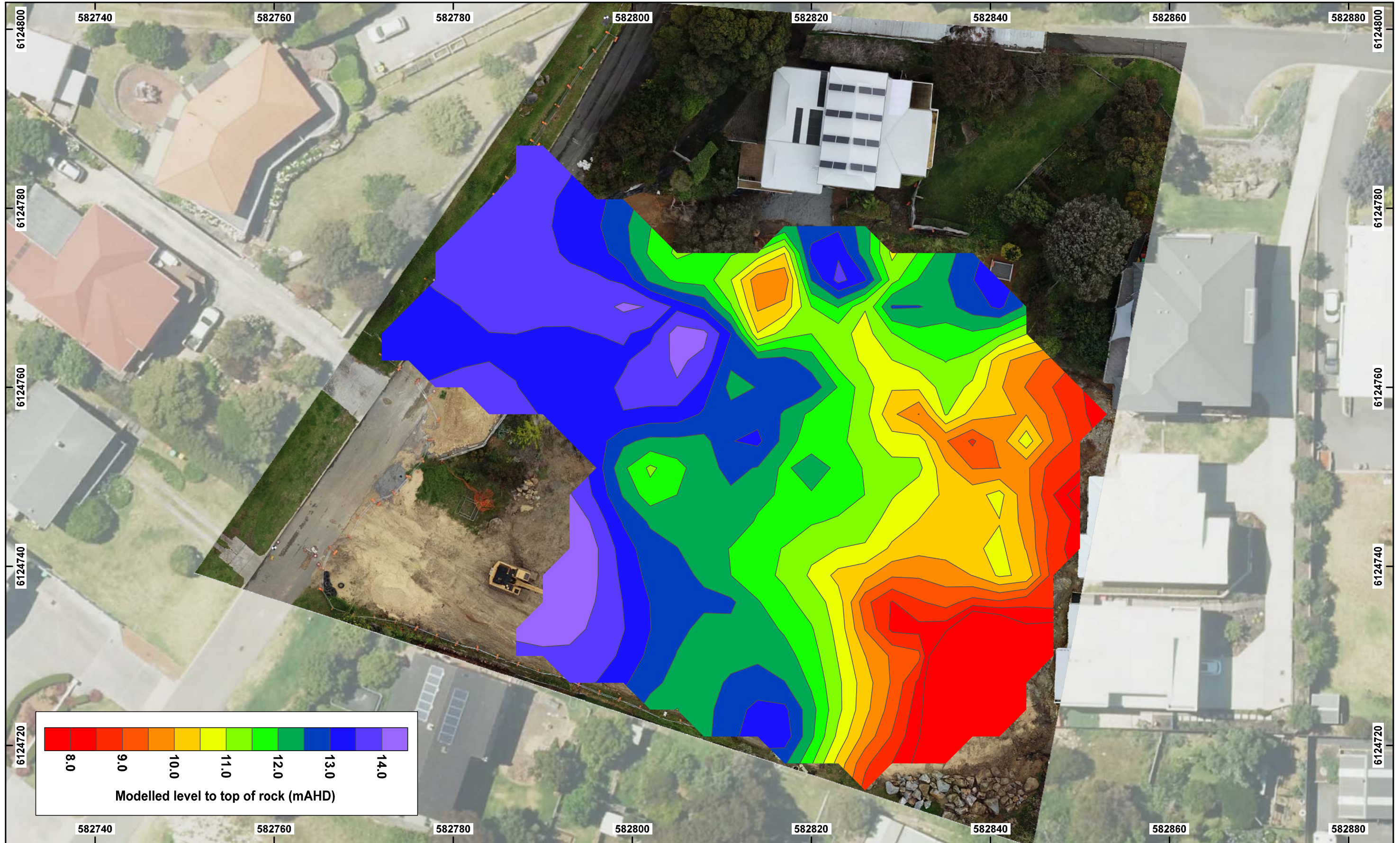


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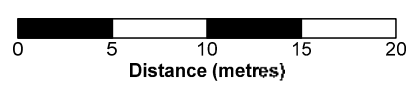
CMW GEOSCIENCES

GEOPHYSICAL SUBSURFACE INVESTIGATION
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA

G B Geotechnics (Australia) Pty Ltd
 ABN: 77 009 550 869
 Phone: 08 9354 6300
 Email: info@gbgoz.com.au
 Web: gb-group.com.au

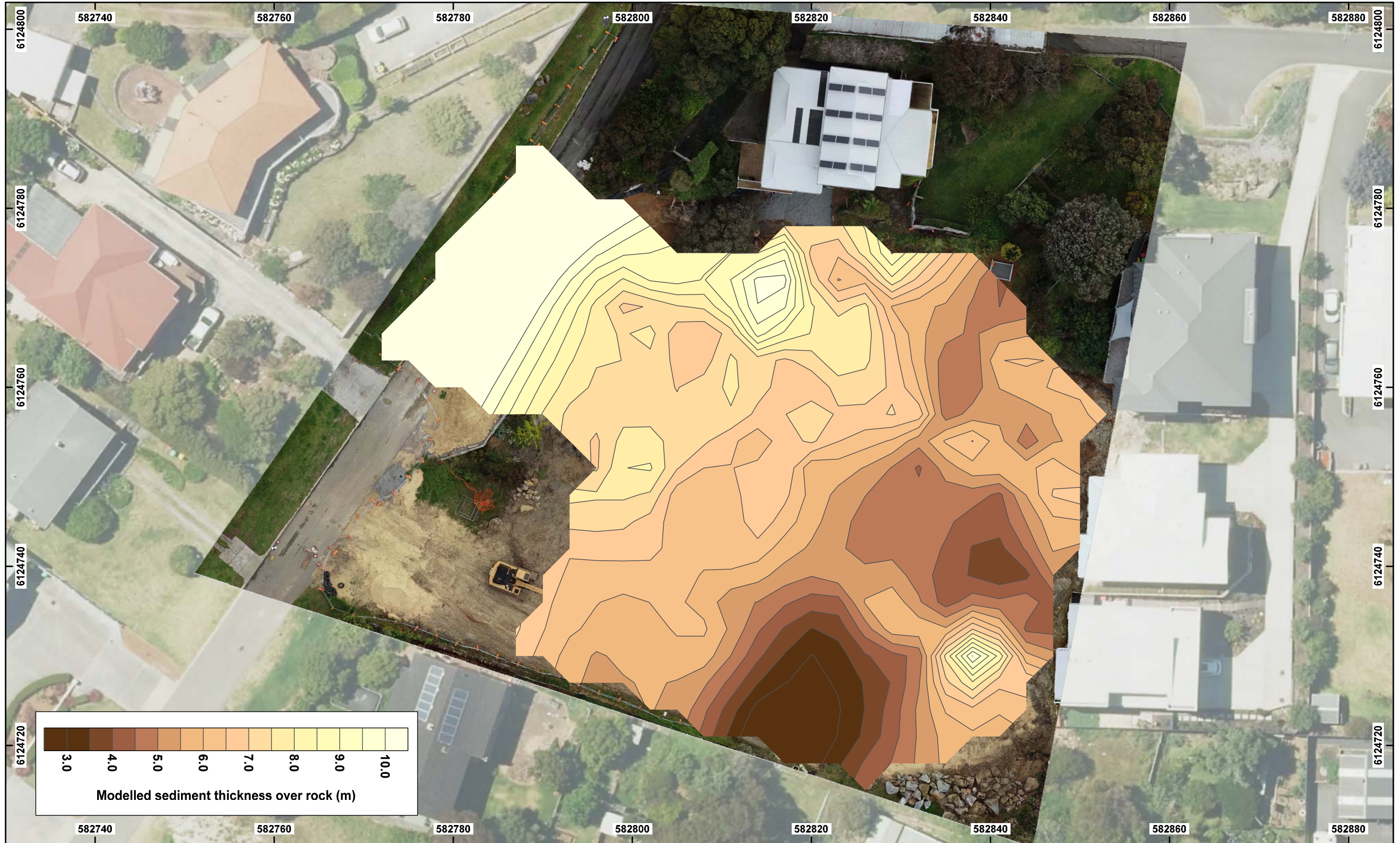


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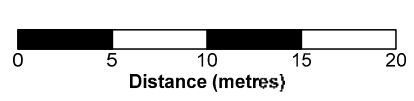


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CMW GEOSCIENCES
GEOPHYSICAL SUBSURFACE INVESTIGATION
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA



NOTES
 Drawing to be used in conjunction with Report 3041.
 Map Projection GDA2020 MGA Zone 50.
 Aerial image from CMW Geosciences drone survey and MetroMap.

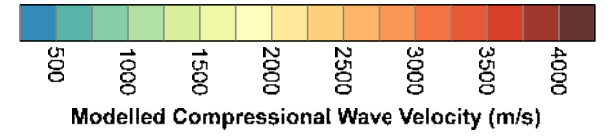
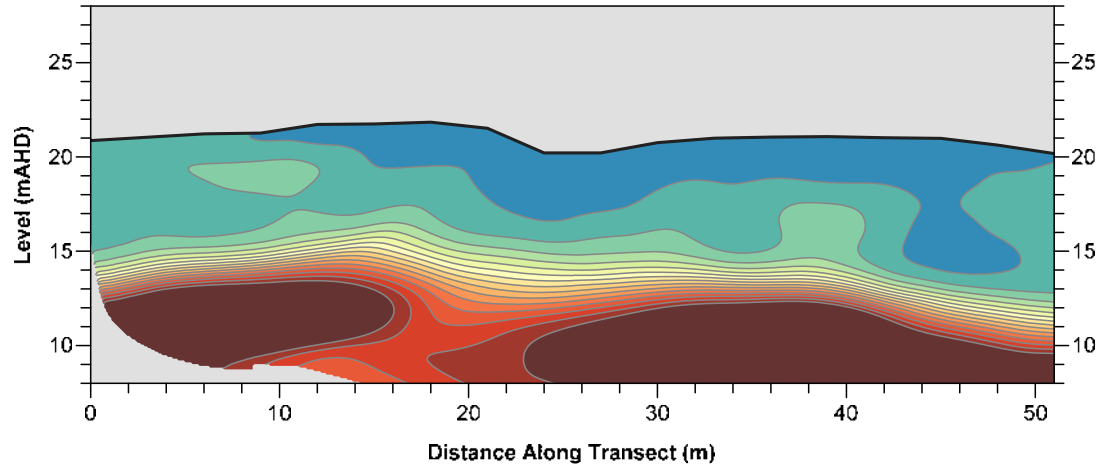


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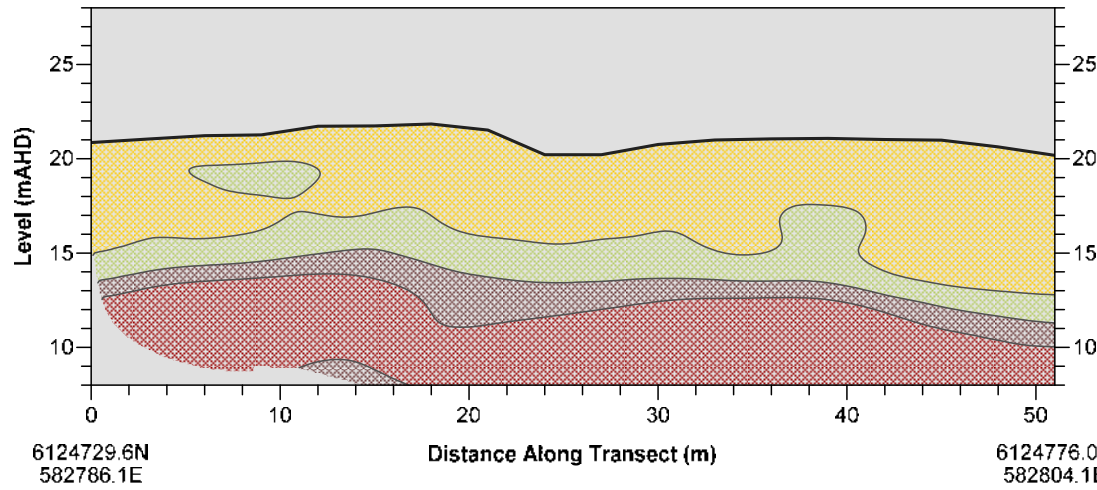
CMW GEOSCIENCES
GEOPHYSICAL SUBSURFACE INVESTIGATION
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA

TRANSECT N-2

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



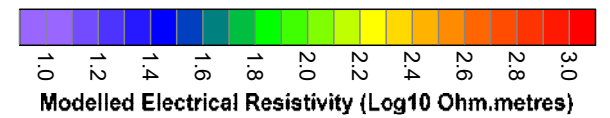
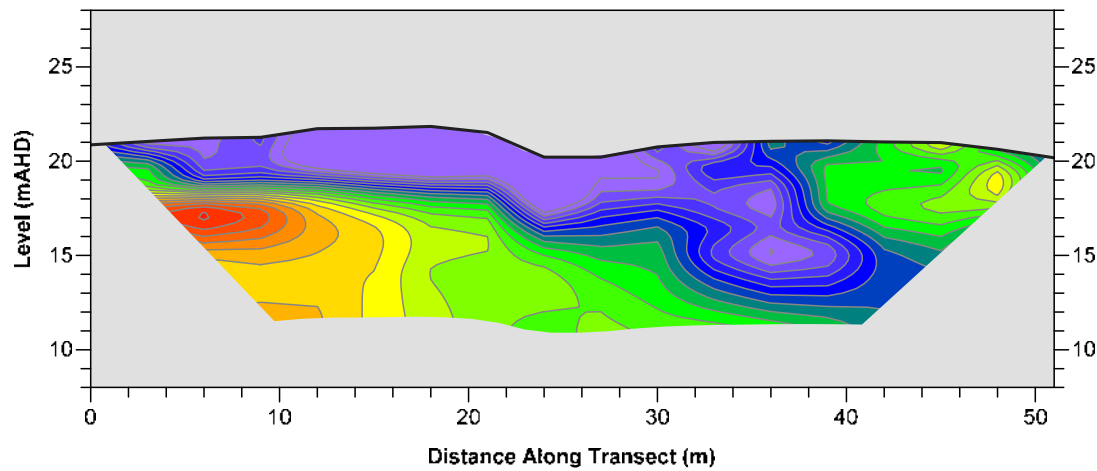
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

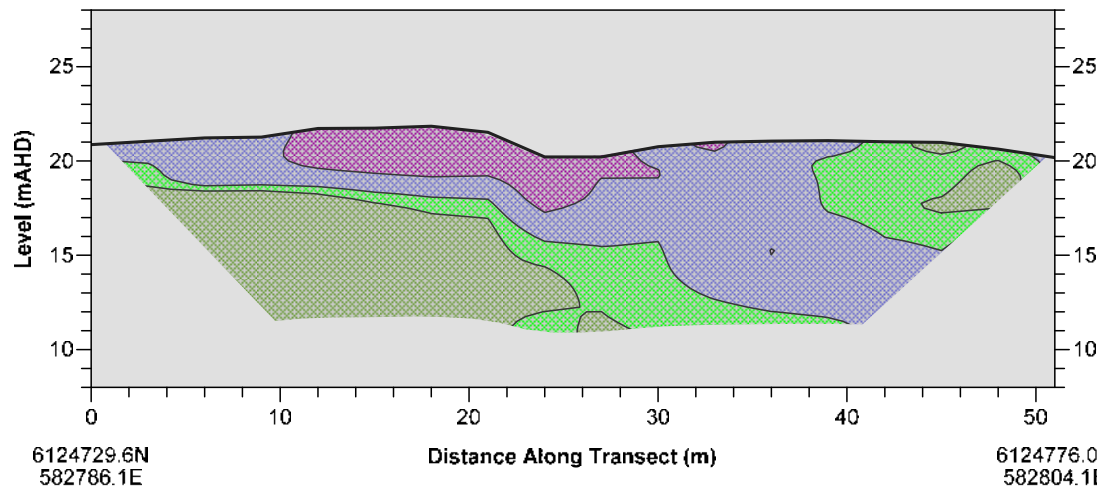
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582786.1E

6124776.0N
582804.1E

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

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582786.1E

6124776.0N
582804.1E

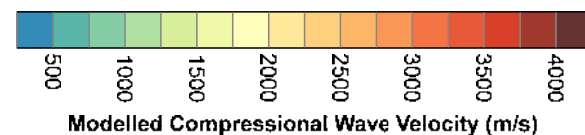
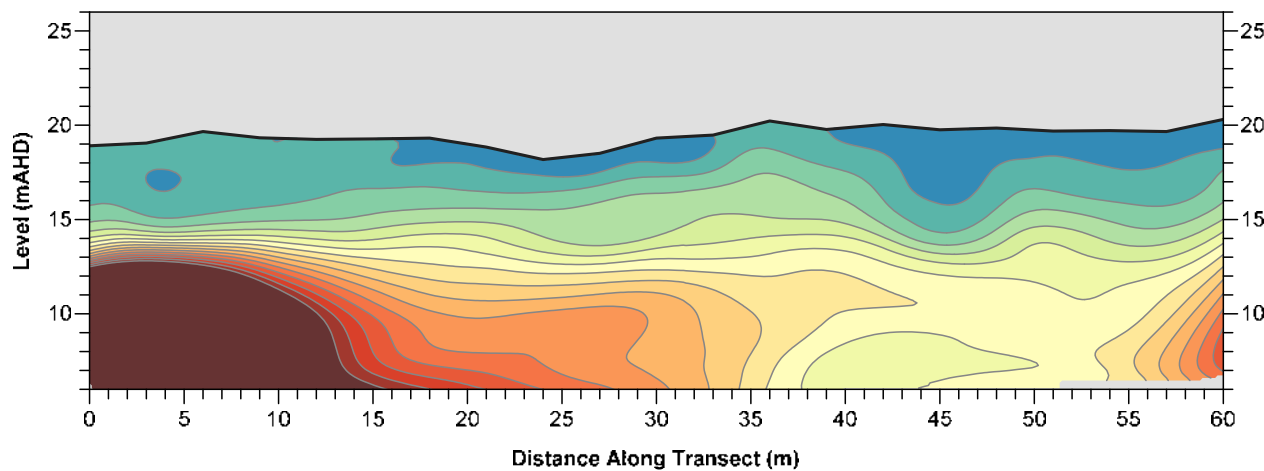
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
Drawing to be used in conjunction with Report 3041.
Map Projection in GDA2020, MGA Zone 50.
Elevation in mAHD.

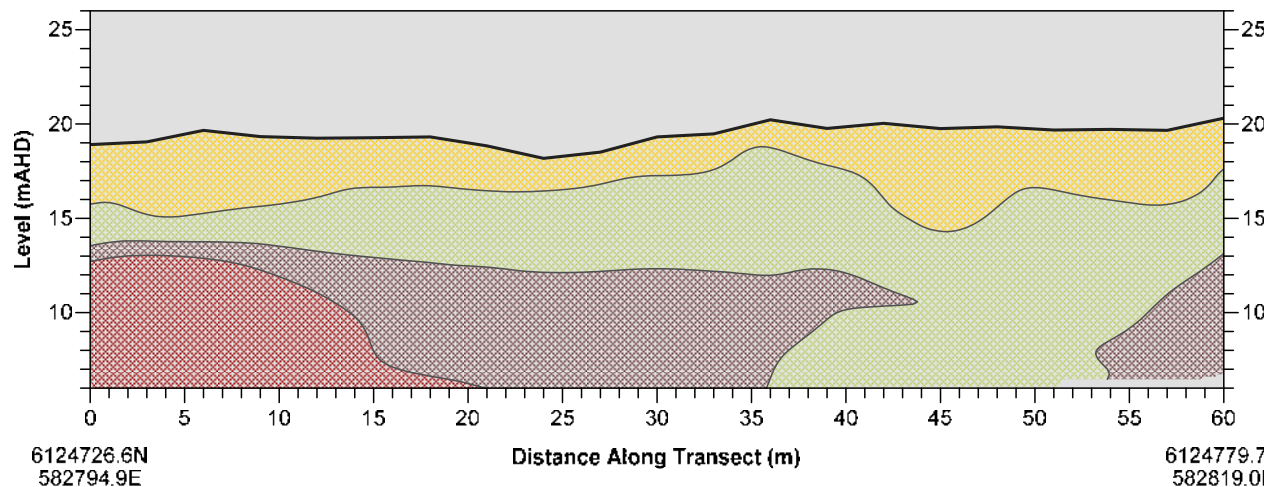
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	Drawing	3041-04	Revision	0

TRANSECT N-3

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



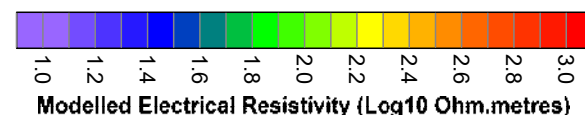
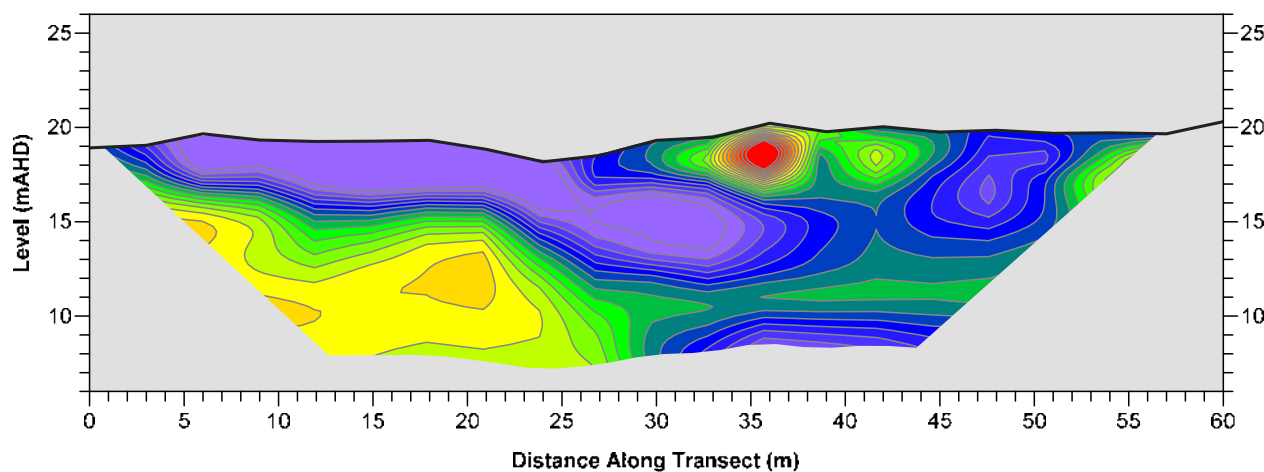
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



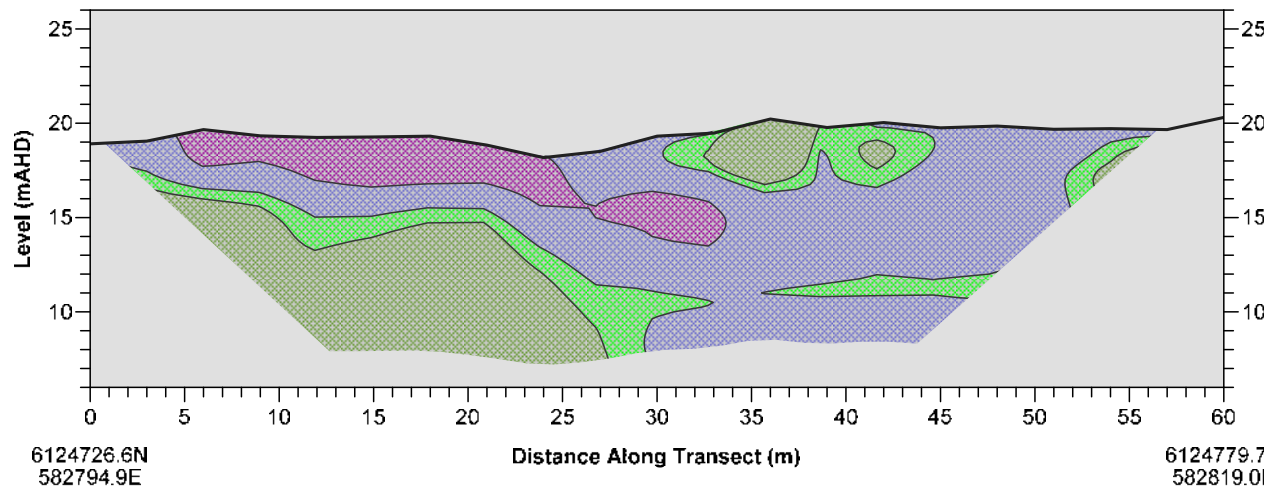
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3250 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

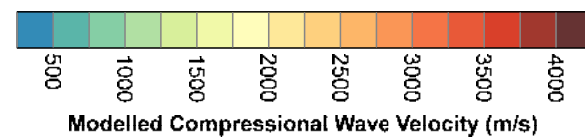
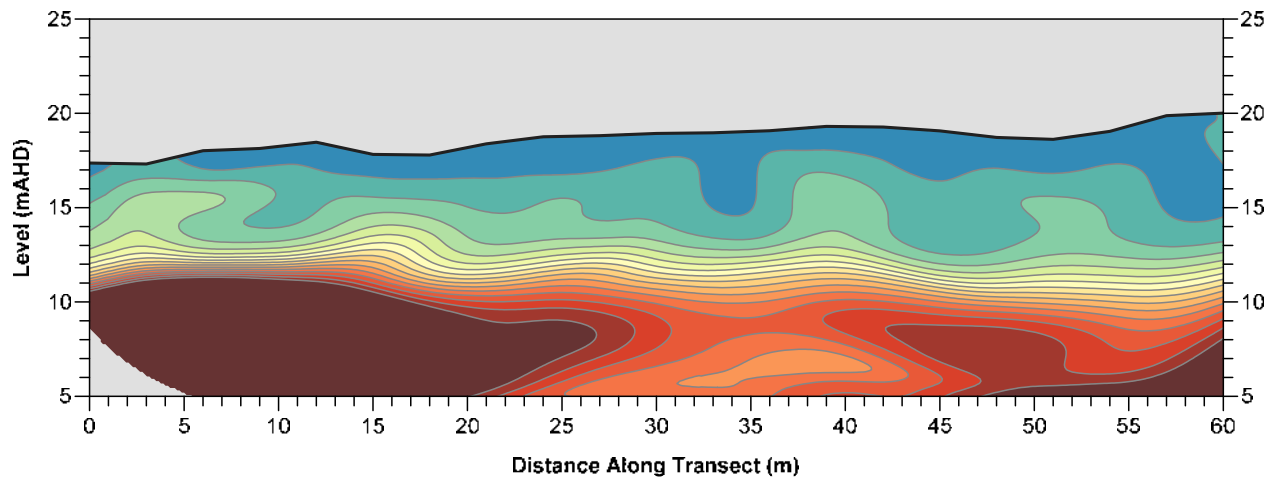
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
Drawing to be used in conjunction with Report 3041.
Map Projection in GDA2020, MGA Zone 50.
Elevation in mAHD.

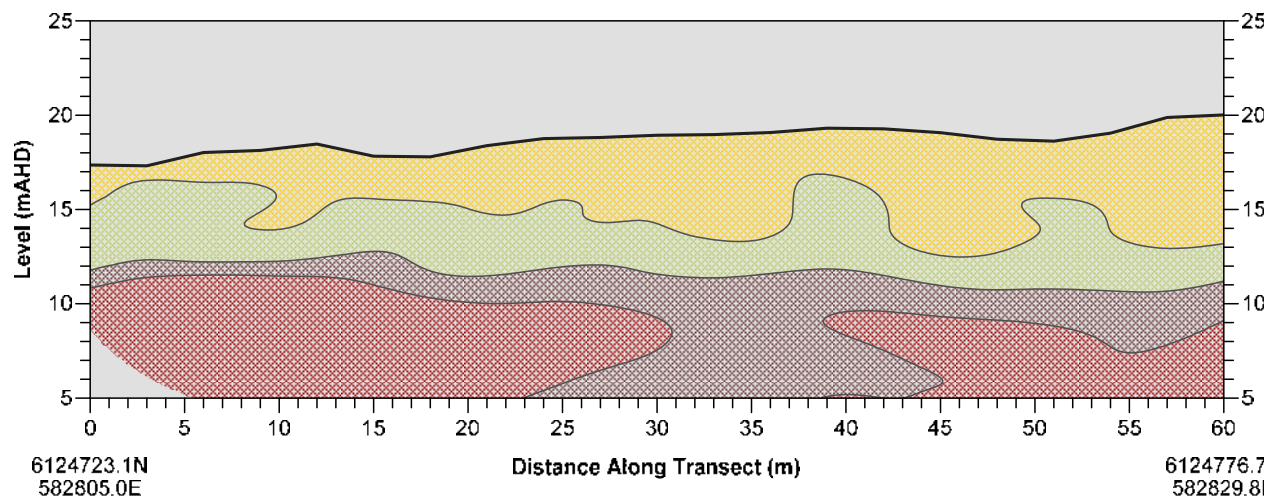
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TRANSECT N-4

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



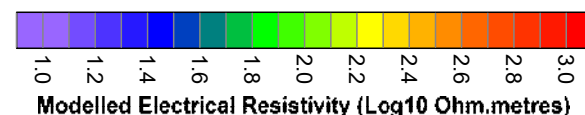
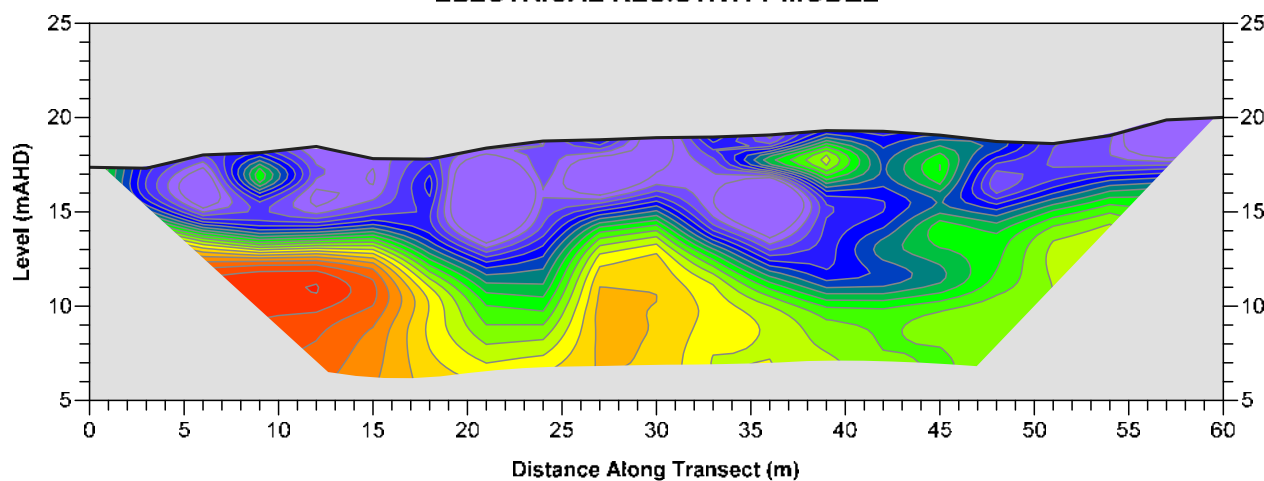
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



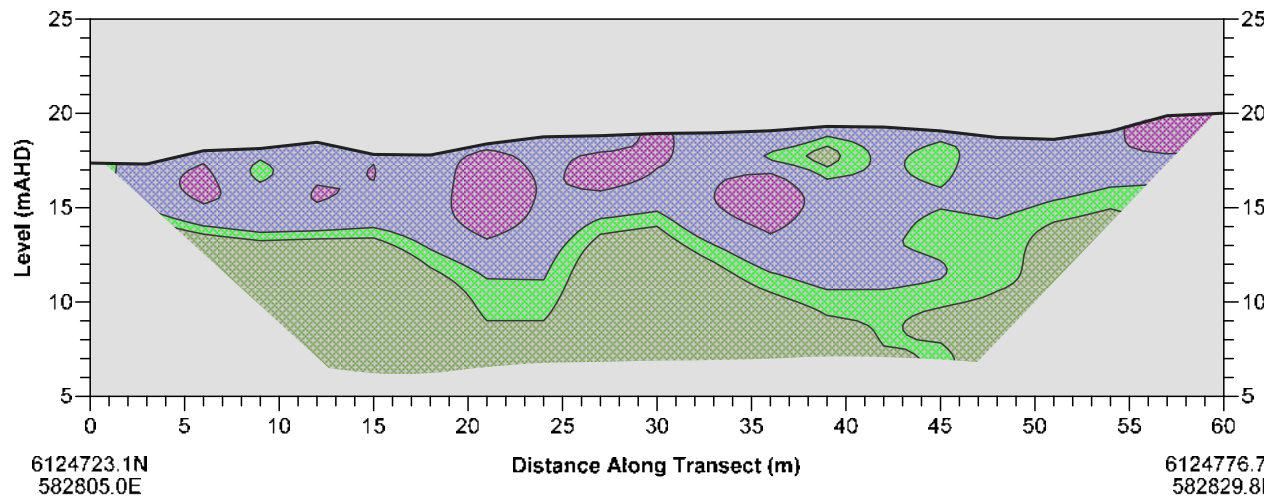
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

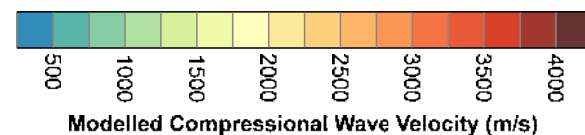
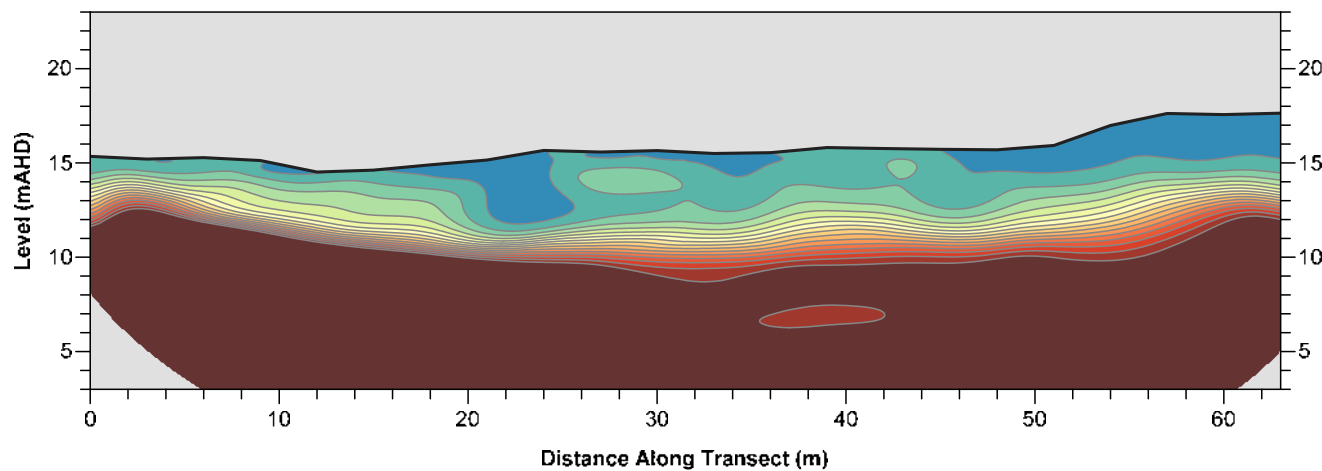
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
 Drawing to be used in conjunction with Report 3041.
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 Elevation in mAHD.

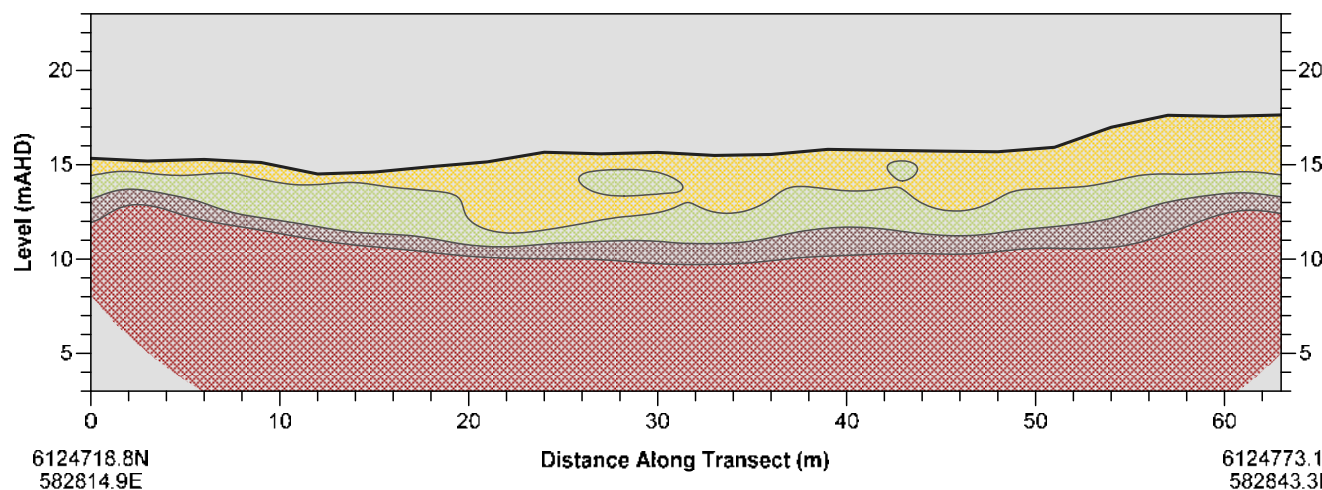
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8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA		Drawing	3041-06	Revision	0

TRANSECT N-5

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



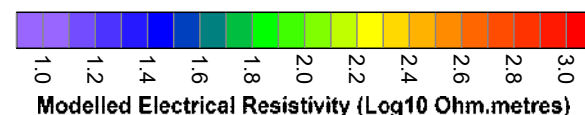
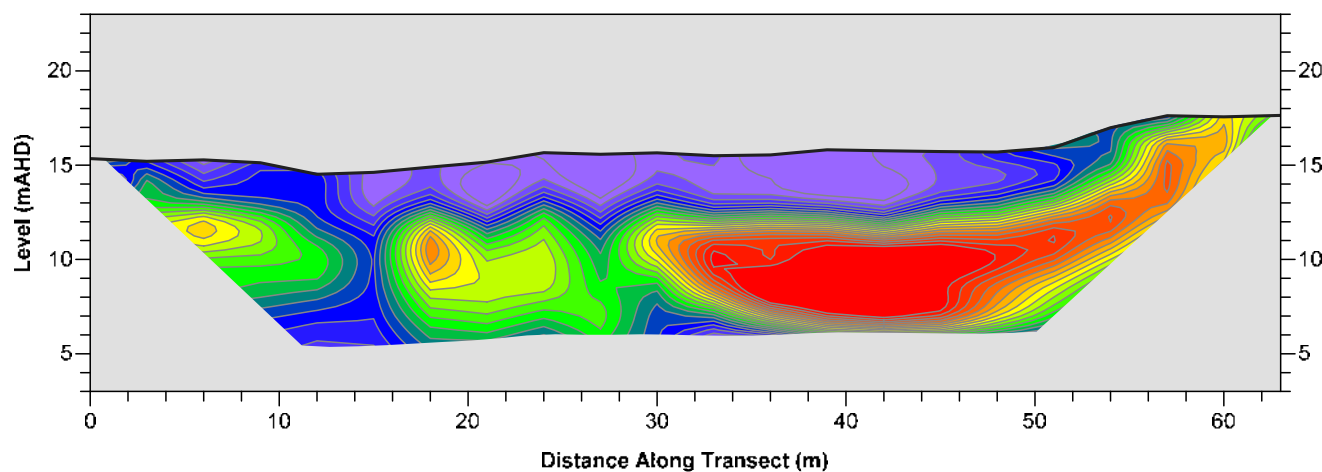
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



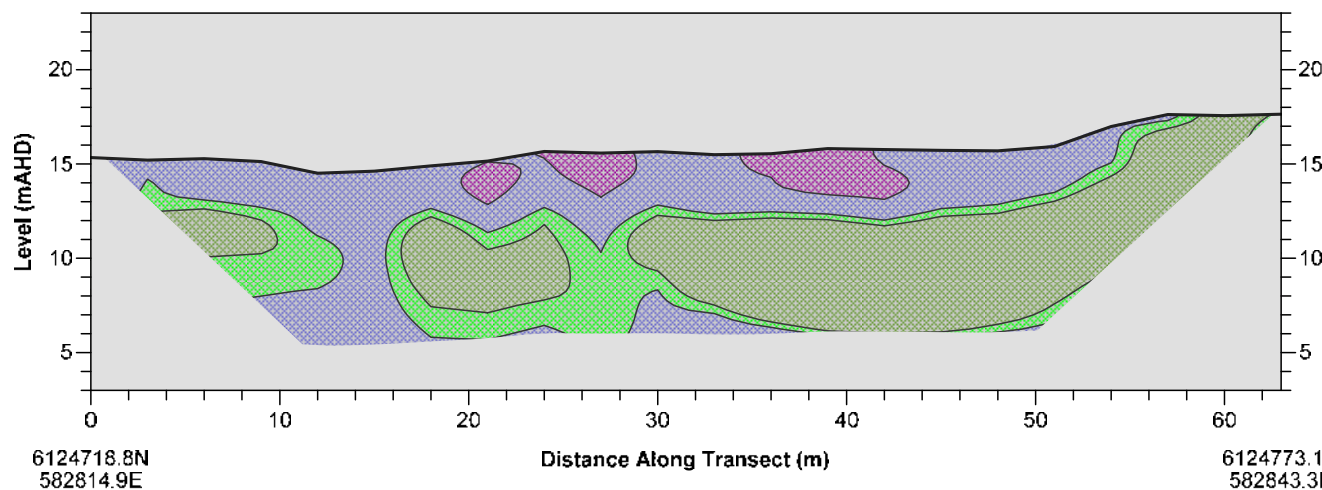
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
Drawing to be used in conjunction with Report 3041.
Map Projection in GDA2020, MGA Zone 50.
Elevation in mAHD.

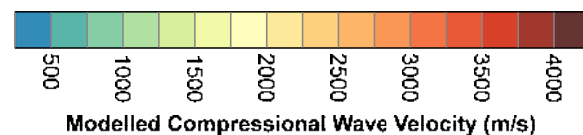
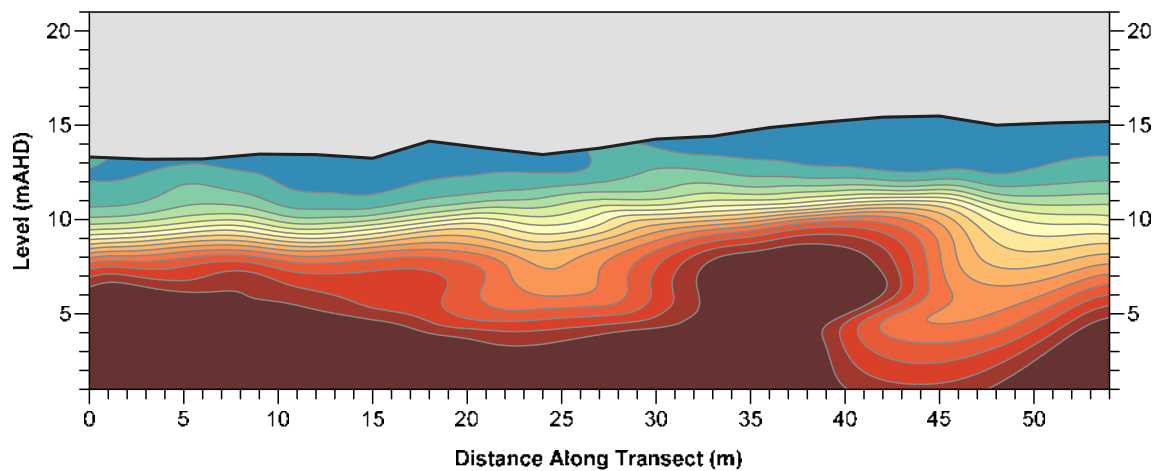
CMW GEOSCIENCES
GEOPHYSICAL SUBSURFACE INVESTIGATION
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA

Date 17 November 2022
Scale 1:400
Drawing 3041-06
Paper Size A3
Drawn AHWS
Revision 0

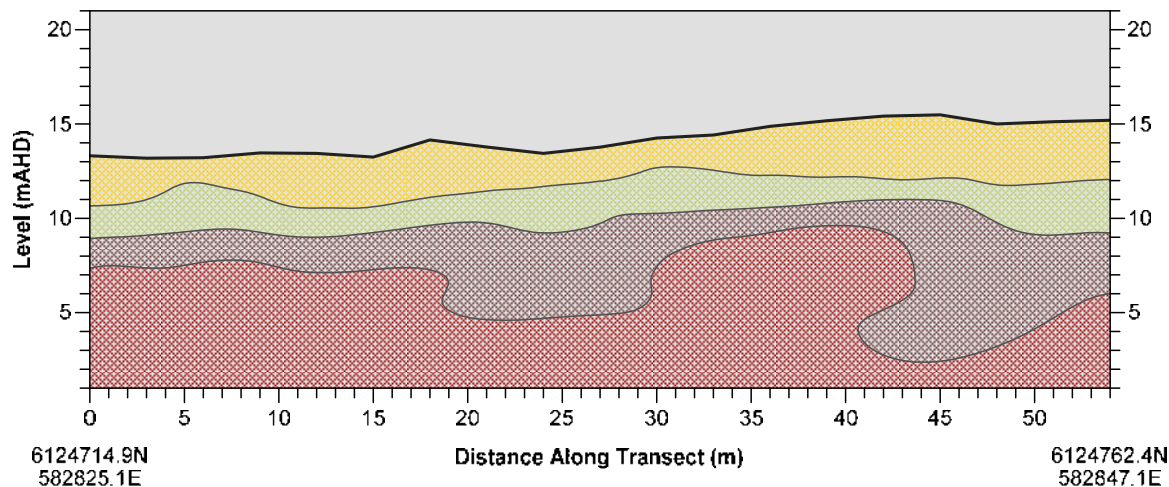
GBG GROUP
GB Geotechnics (Australia) Pty Ltd
ABN: 77 009 550 869
Telephone: 08 9354 6300
Email: info@gbgoz.com.au
Web: gbgoz.com.au

TRANSECT N-6

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



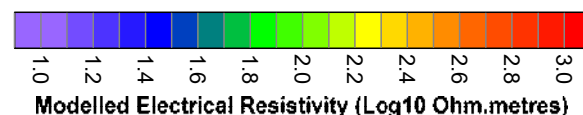
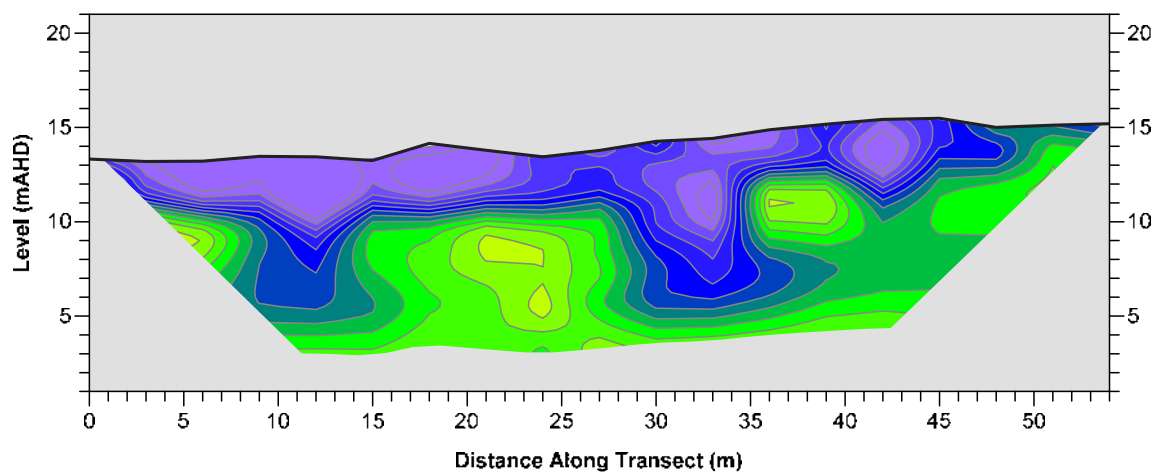
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



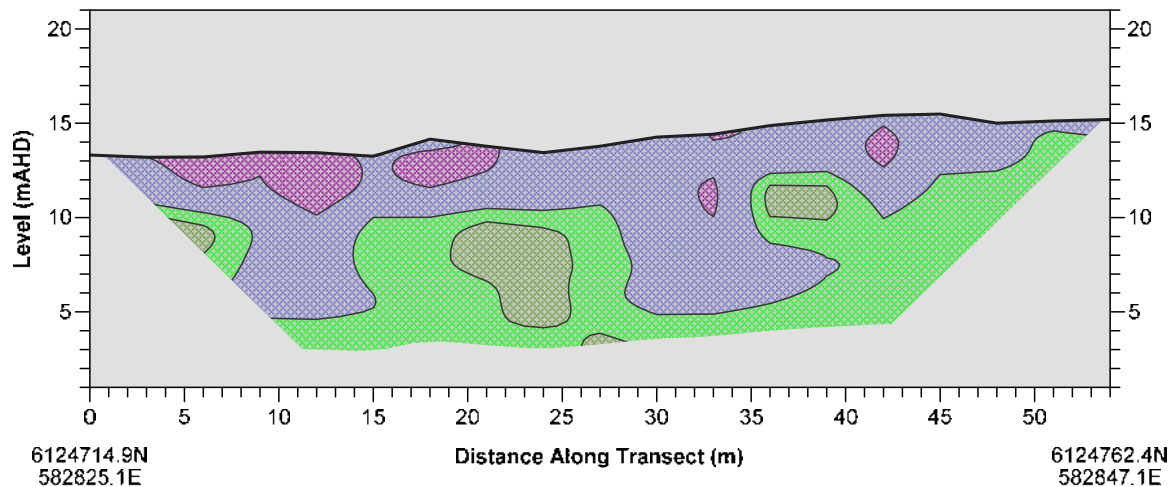
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

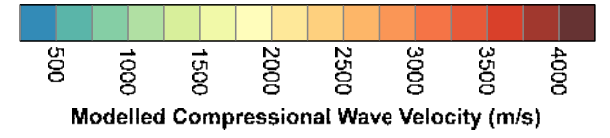
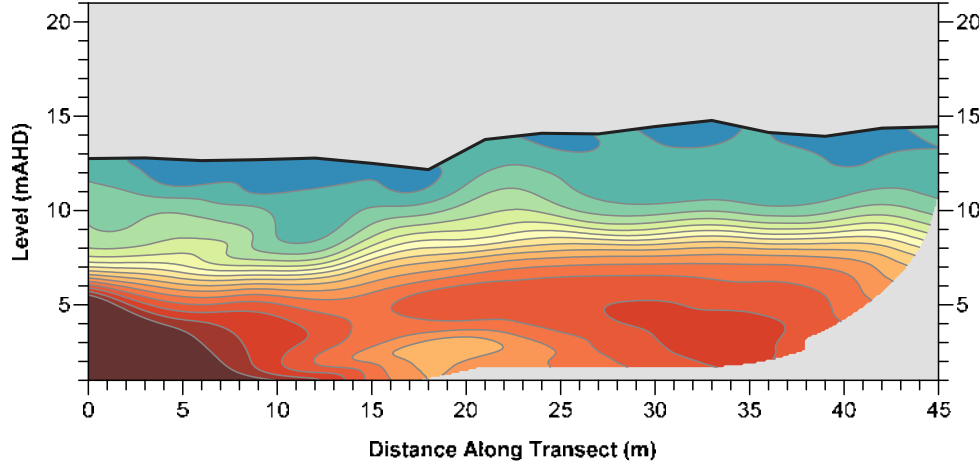
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
 Drawing to be used in conjunction with Report 3041.
 Map Projection in GDA2020, MGA Zone 50.
 Elevation in mAHD.

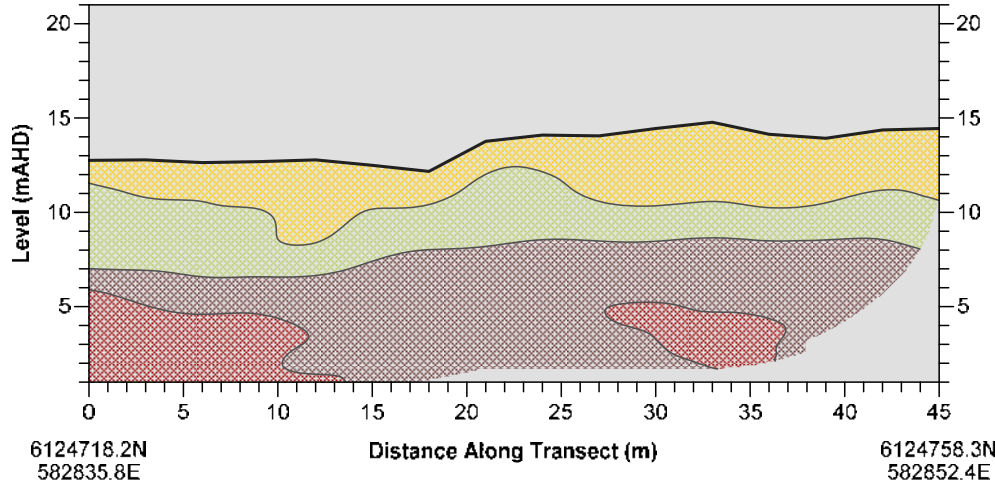
CMW GEOSCIENCES		Date	17 November 2022	Paper Size	A3
GEOPHYSICAL SUBSURFACE INVESTIGATION		Scale	1:400	Drawn	AHWS
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA		Drawing	3041-08	Revision	0

TRANSECT N-7

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



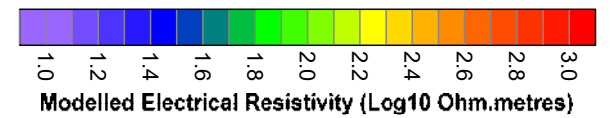
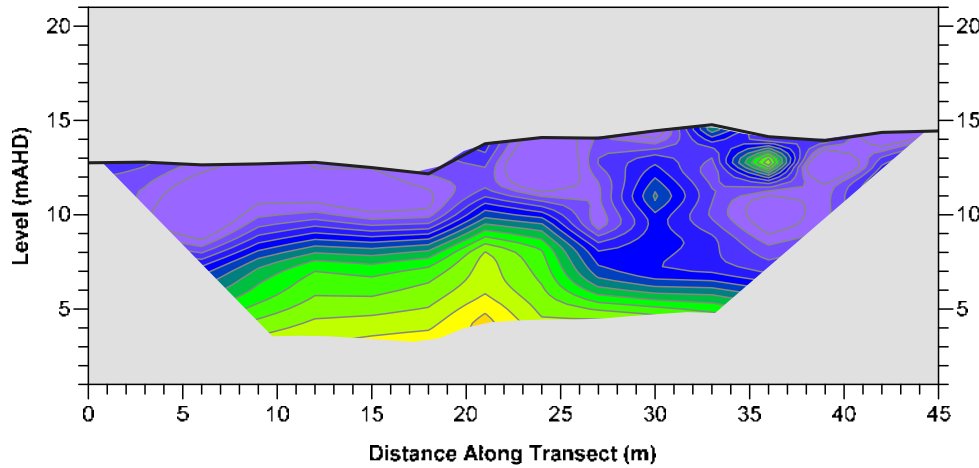
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



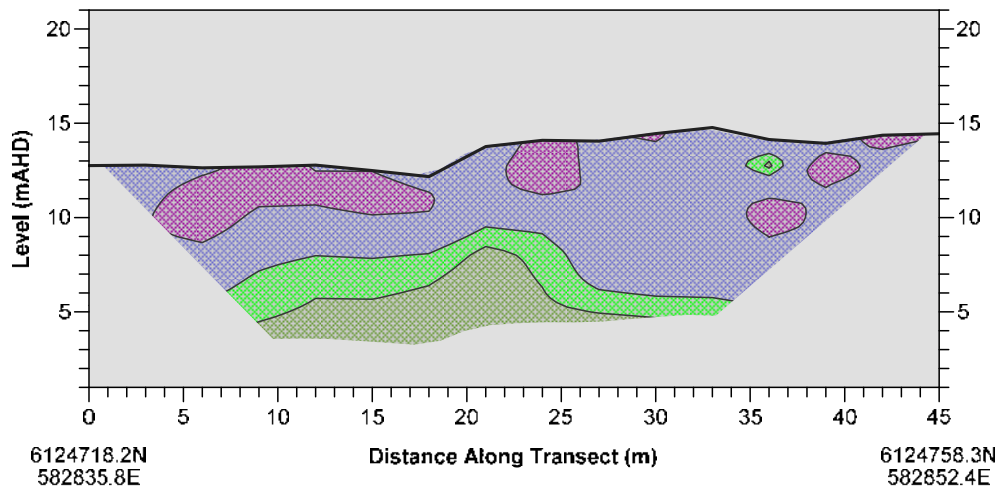
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

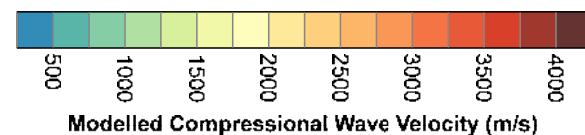
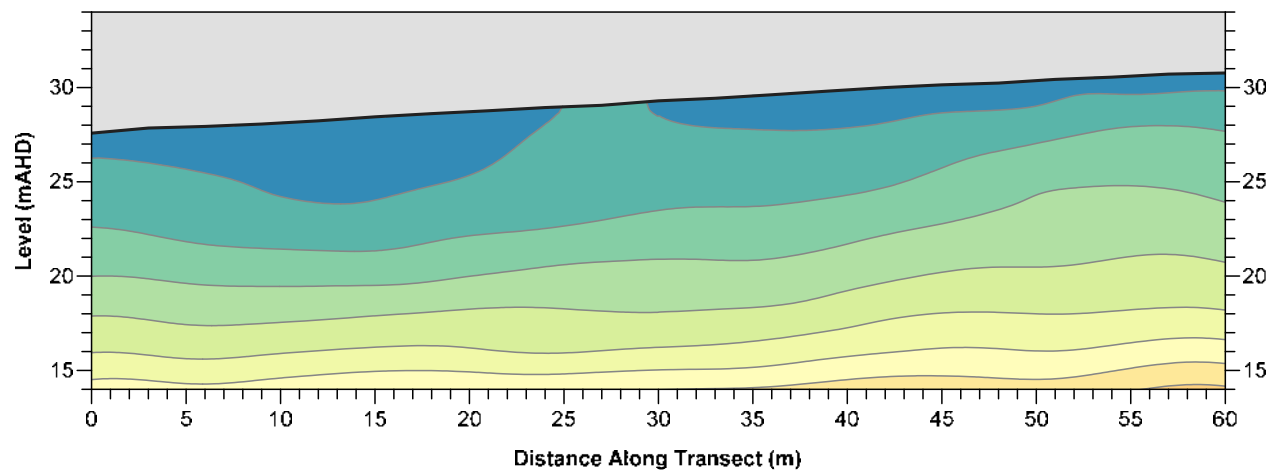
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
 Drawing to be used in conjunction with Report 3041.
 Map Projection in GDA2020, MGA Zone 50.
 Elevation in mAHD.

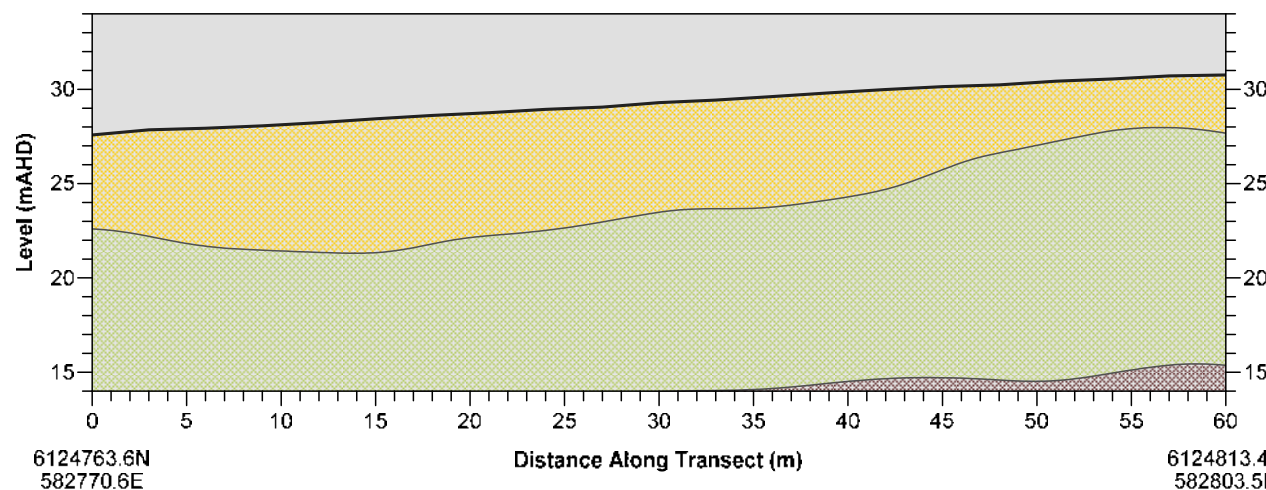
CMW GEOSCIENCES GEOPHYSICAL SUBSURFACE INVESTIGATION 8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA	Date	17 November 2022	Paper Size	A3
	Scale	1:400	Drawn	AHWS
	Drawing	3041-09	Revision	0

TRANSECT N-8

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



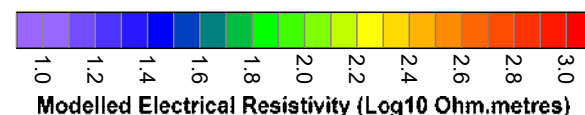
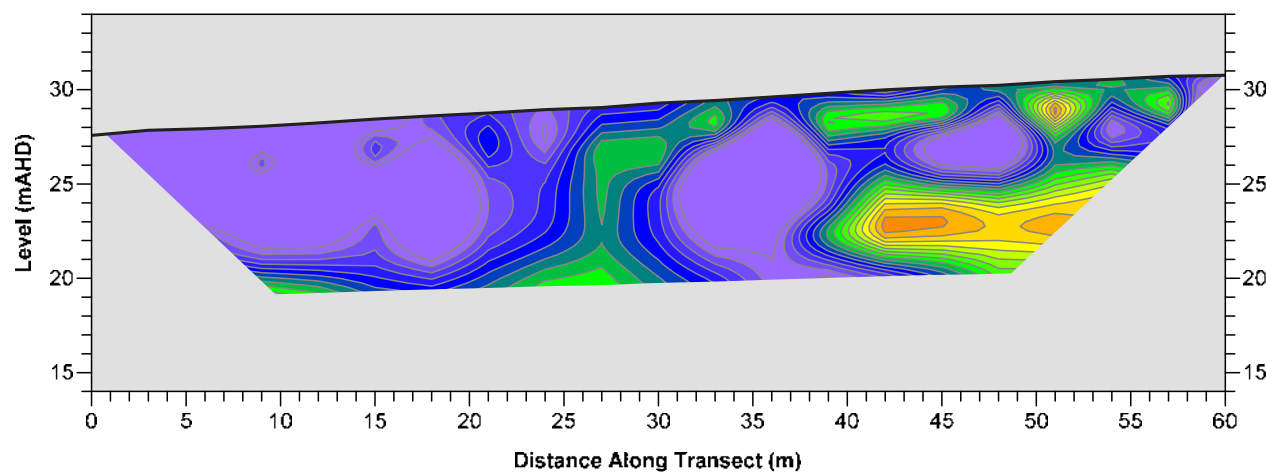
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



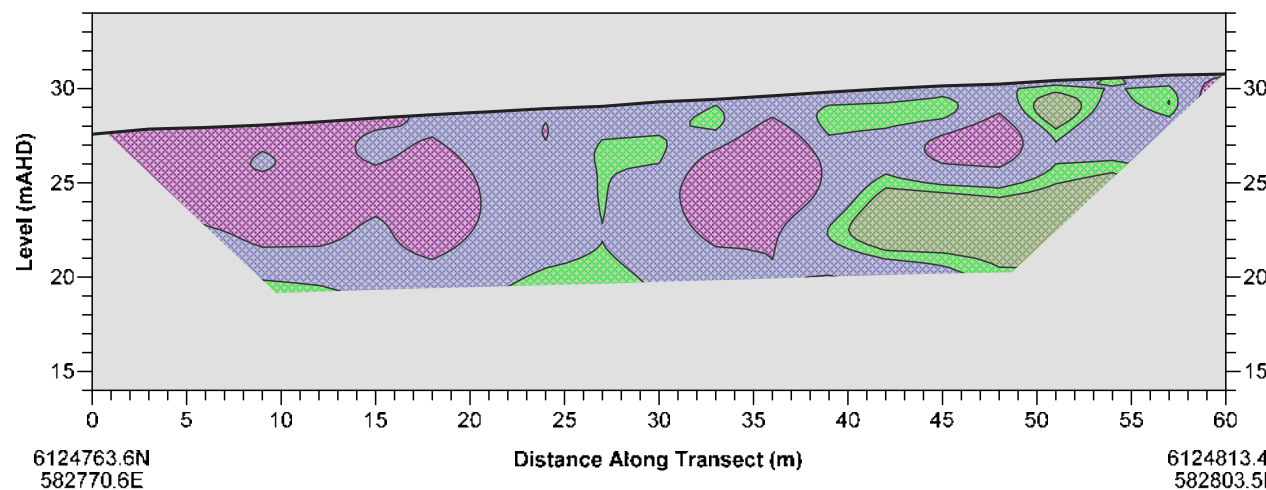
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

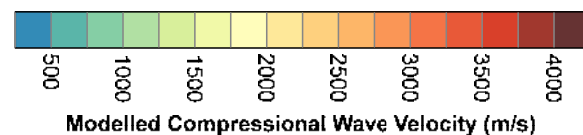
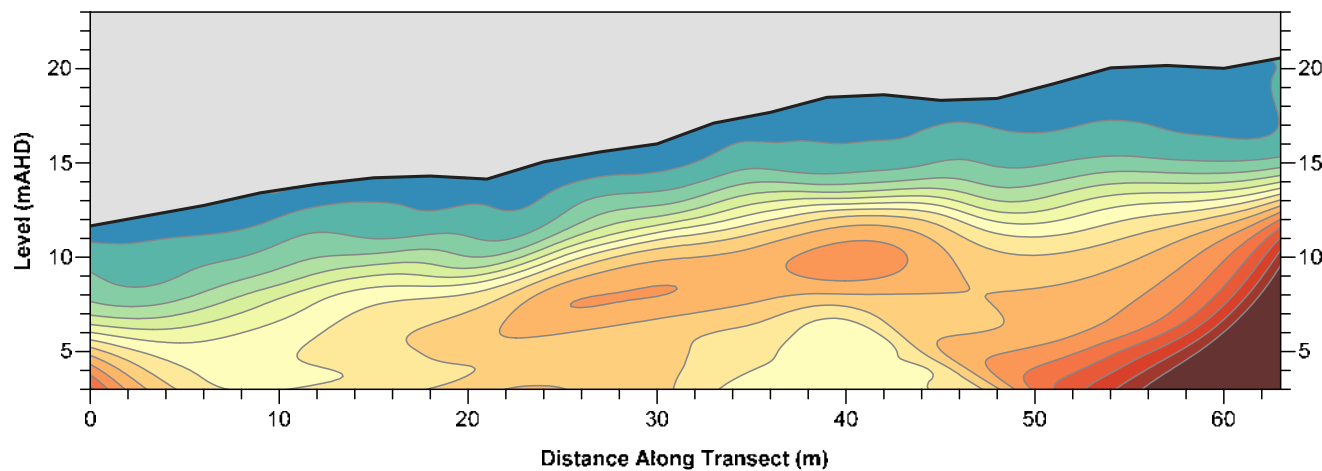
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
Drawing to be used in conjunction with Report 3041.
Map Projection in GDA2020, MGA Zone 50.
Elevation in mAHD.

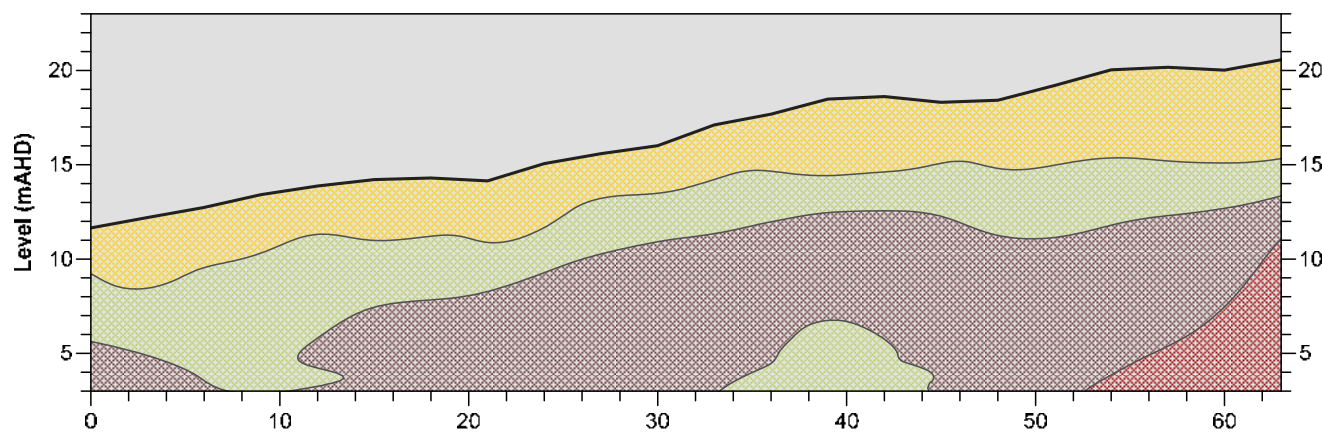
CMW GEOSCIENCES		Date	17 November 2022	Paper Size	A3
GEOPHYSICAL SUBSURFACE INVESTIGATION		Scale	1:400	Drawn	AHWS
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA		Drawing	3041-10	Revision	0

TRANSECT E-1

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



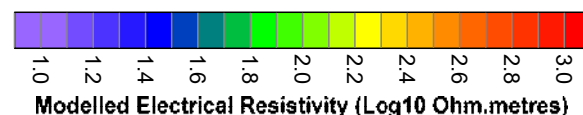
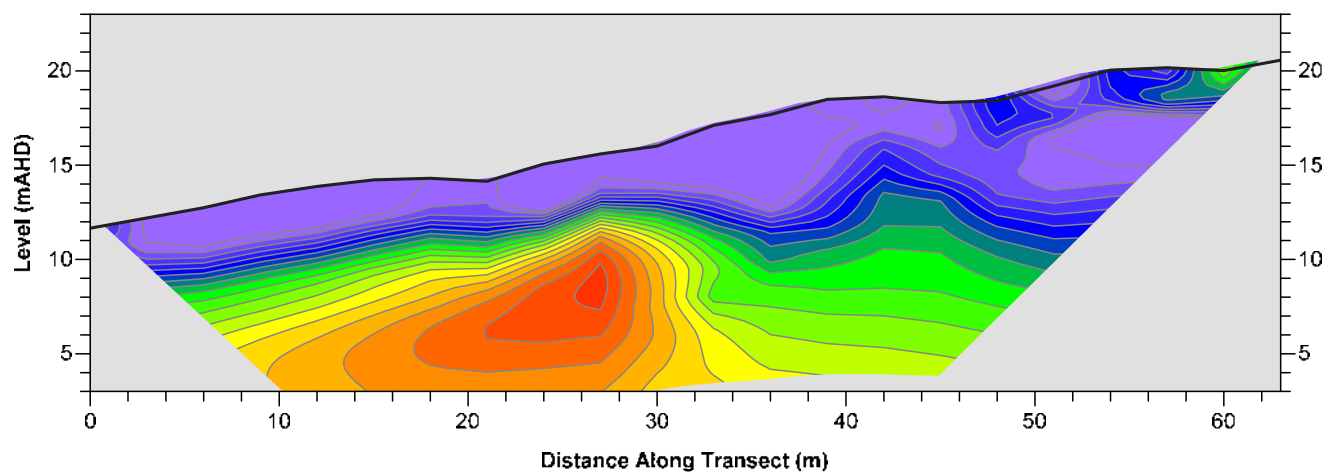
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

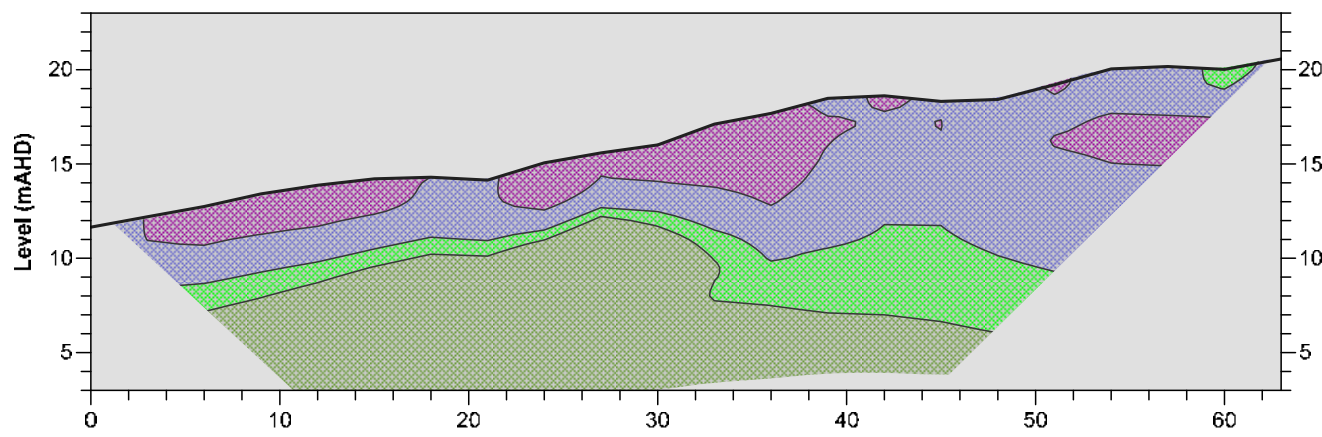
6124726.3N
582846.2E

6124755.8N
582792.4E

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

6124726.3N
582846.2E

6124755.8N
582792.4E

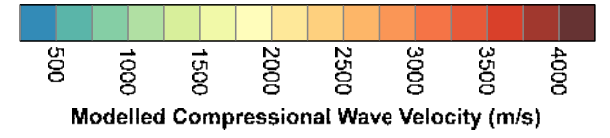
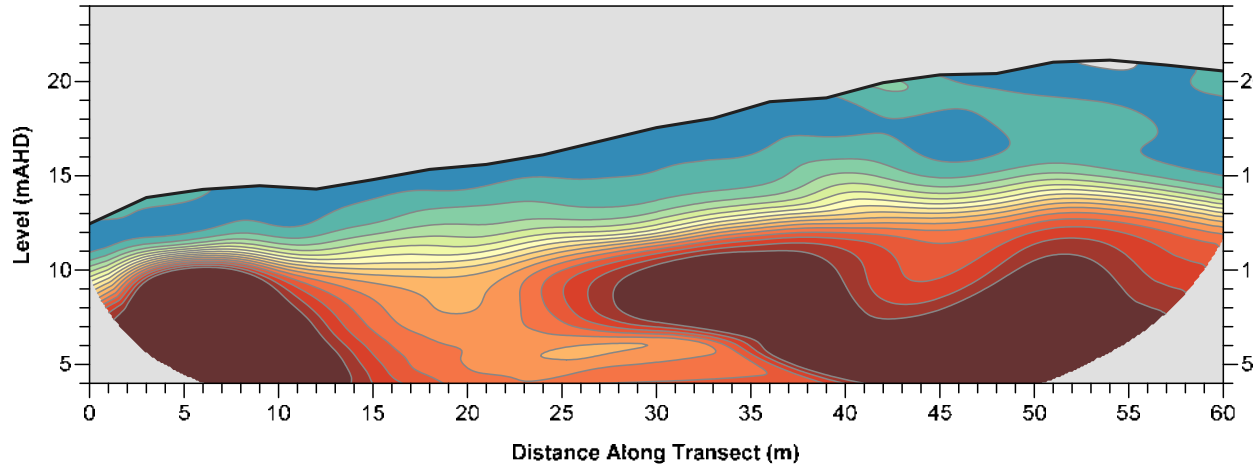
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
Drawing to be used in conjunction with Report 3041.
Map Projection in GDA2020, MGA Zone 50.
Elevation in mAHD.

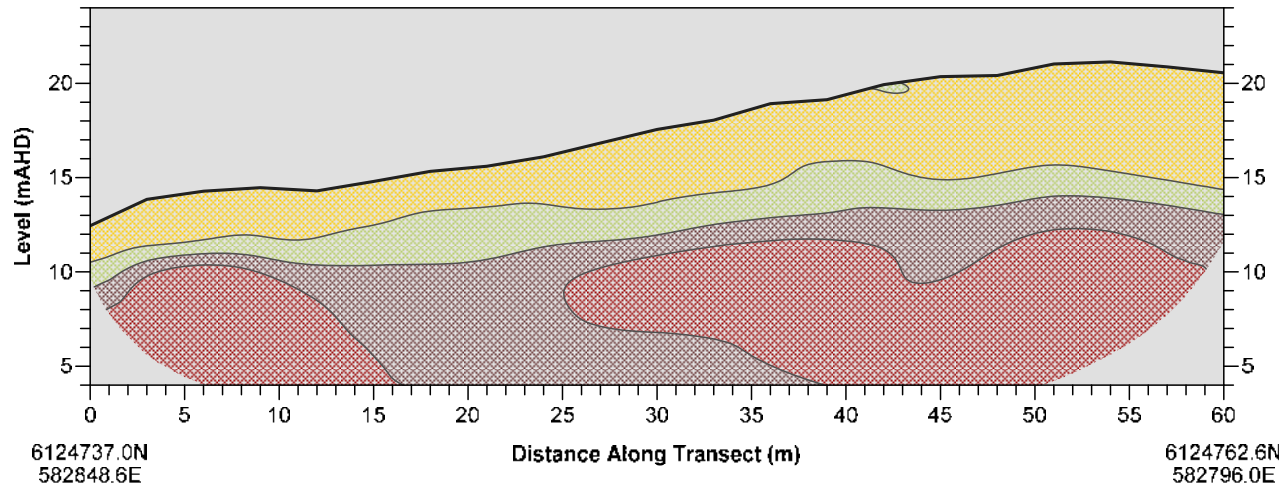
CMW GEOSCIENCES GEOPHYSICAL SUBSURFACE INVESTIGATION 8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA	Date	17 November 2022	Paper Size	A3
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	Drawing	3041-11	Revision	0

TRANSECT E-2

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



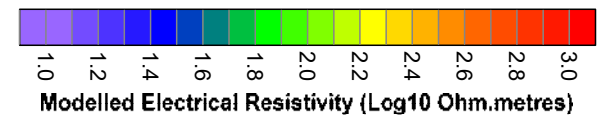
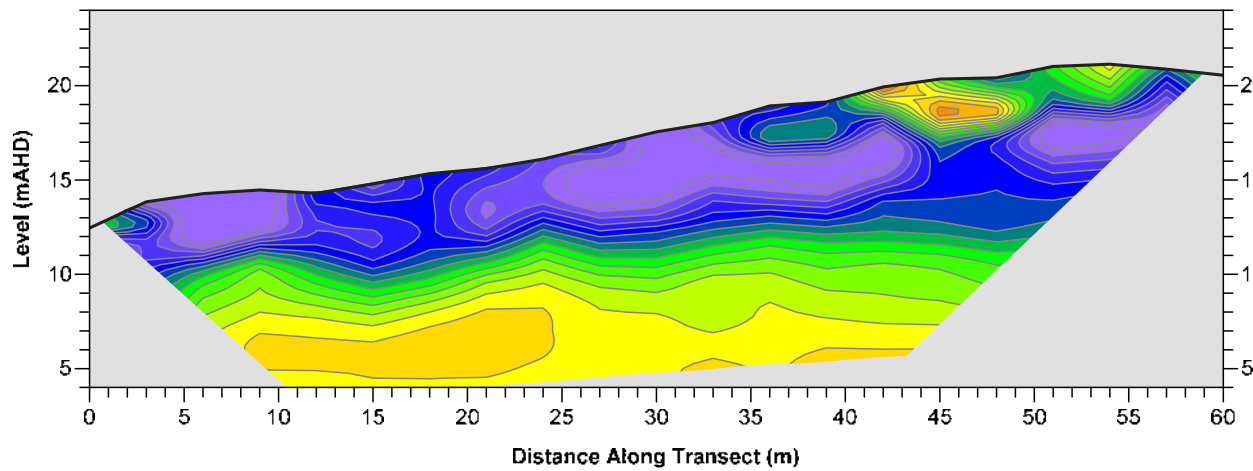
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



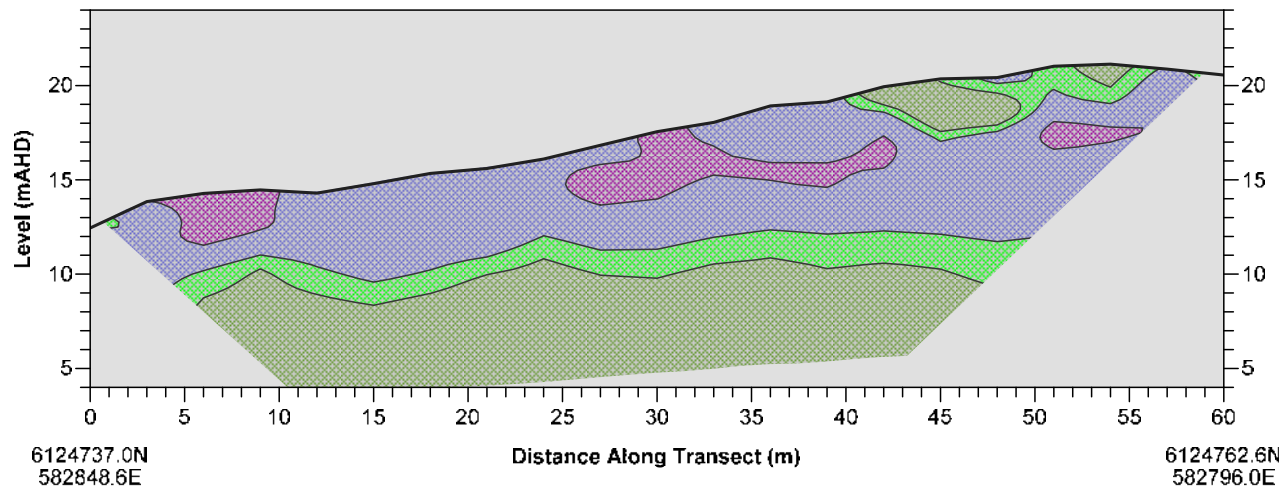
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	3500 ≤ Vp	Slightly weathered to fresh rock
P.2	2000 ≤ Vp < 3500	Moderately weathered rock
P.3	750 ≤ Vp < 2000	Highly weathered rock or residual soil
P.4	Vp < 750	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	100 ≤ R	Very low permeable/porous material (fresh rock)
R.2	50 ≤ R < 100	Low permeable/porous material (weathered rock)
R.3	10 ≤ R < 50	Moderately permeable/porous material (saturated soil)
R.4	R < 10	Highly permeable/porous material (saturated soil)

* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
Drawing to be used in conjunction with Report 3041.
Map Projection in GDA2020, MGA Zone 50.
Elevation in mAHD.

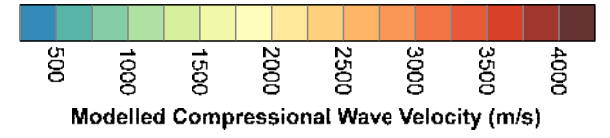
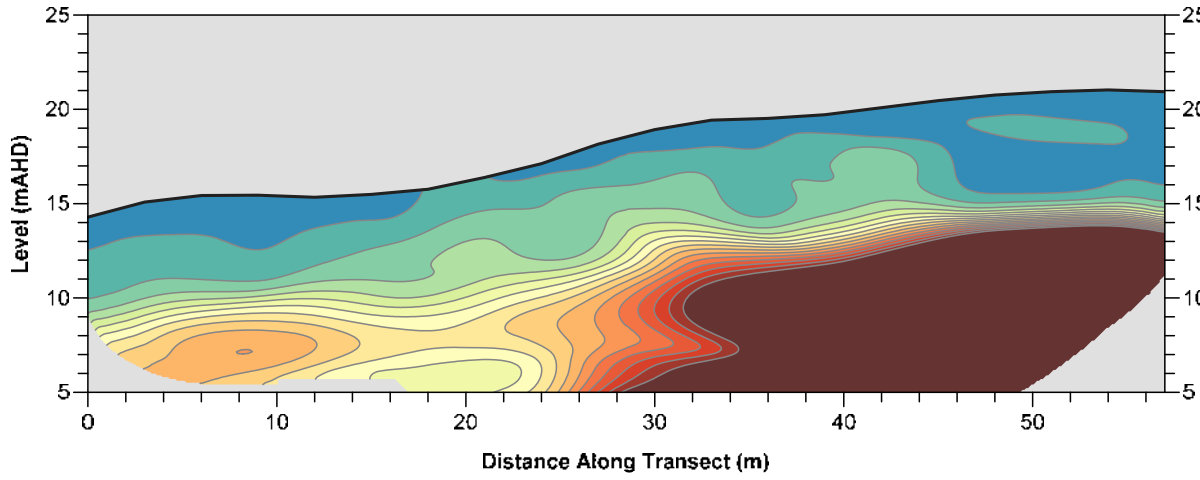
CMW GEOSCIENCES
GEOPHYSICAL SUBSURFACE INVESTIGATION
8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA

Date 17 November 2022
Scale 1:400
Drawing 3041-12

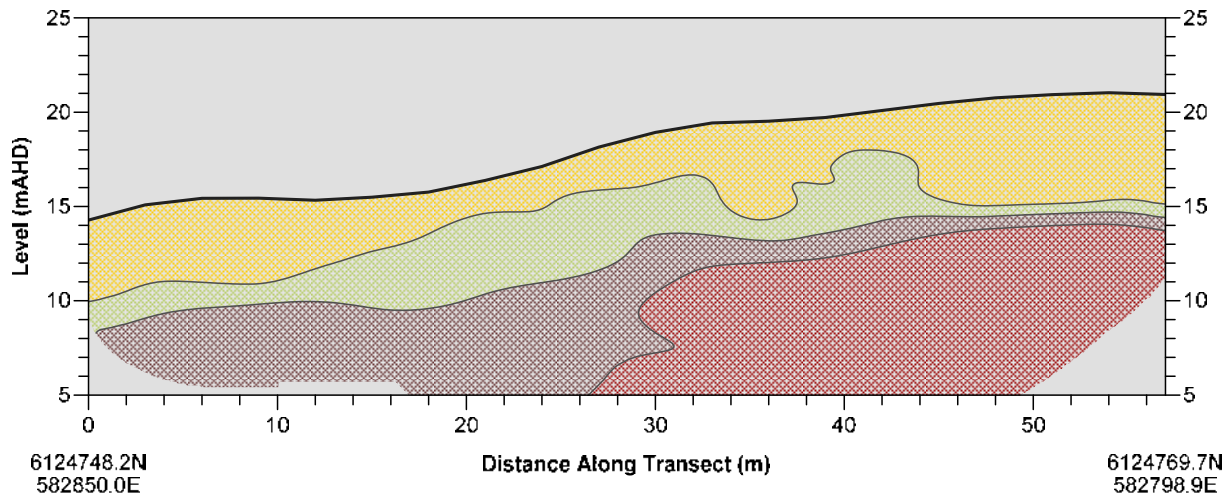
Paper Size A3
Drawn AHWS
Revision 0

TRANSECT E-3

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



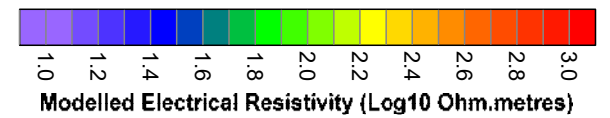
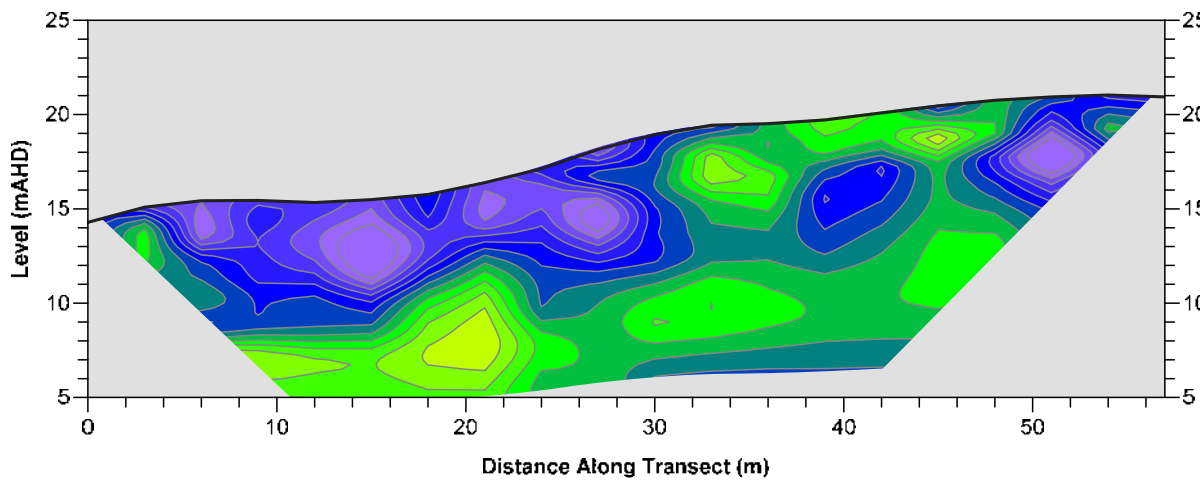
SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



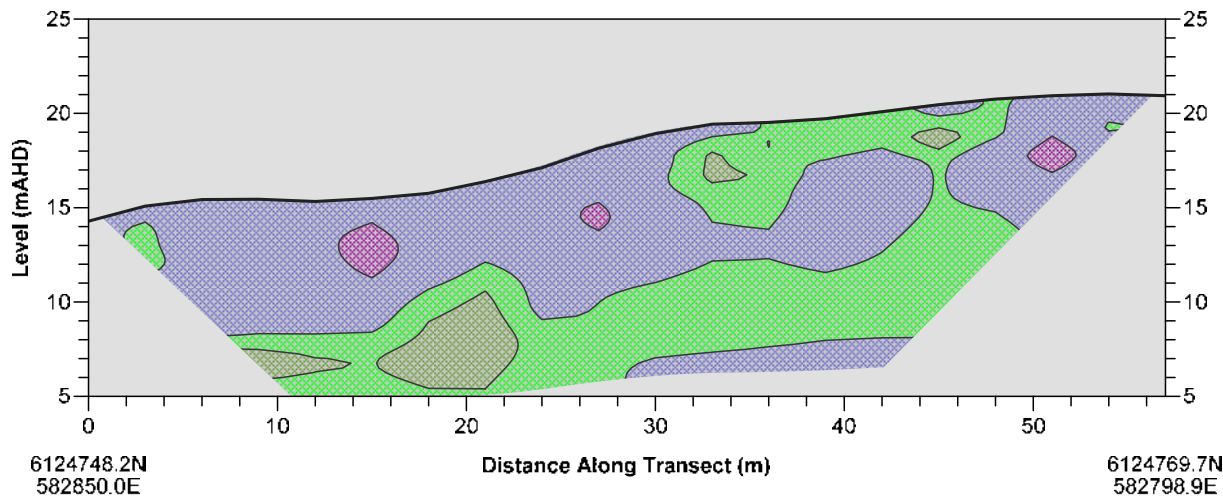
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

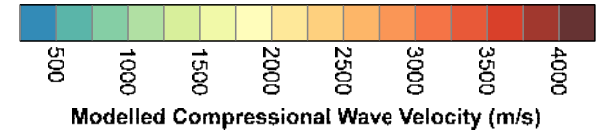
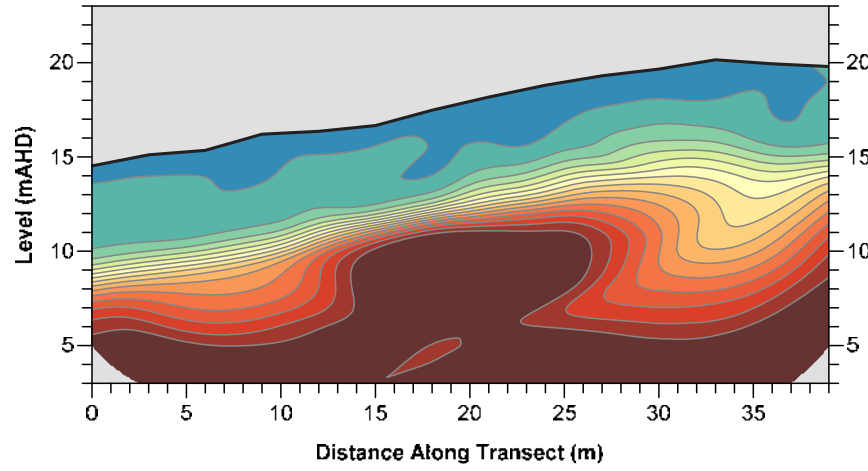
* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
 Drawing to be used in conjunction with Report 3041.
 Map Projection in GDA2020, MGA Zone 50.
 Elevation in mAHD.

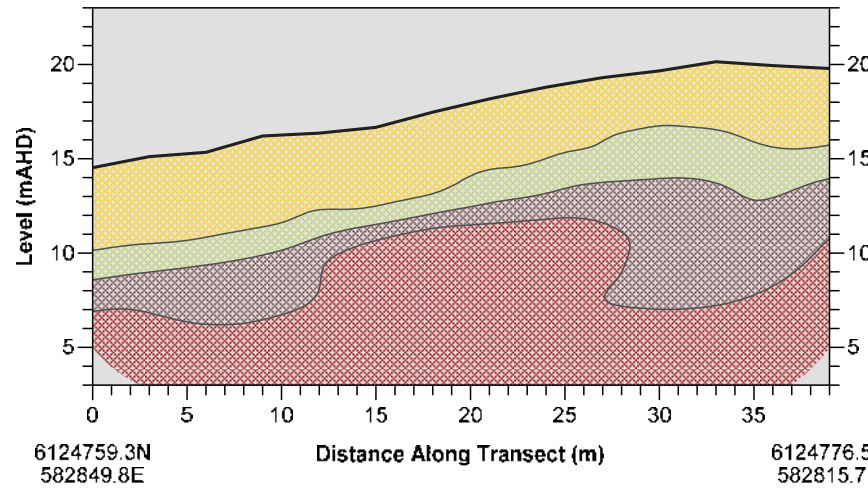
CMW GEOSCIENCES GEOPHYSICAL SUBSURFACE INVESTIGATION 8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA	Date	17 November 2022	Paper Size	A3
	Scale	1:400	Drawn	AHWS
	Drawing	3041-13	Revision	0

TRANSECT E-4

SEISMIC COMPRESSIONAL WAVE VELOCITY MODEL



SEISMIC COMPRESSIONAL WAVE MATERIAL CLASSIFICATION



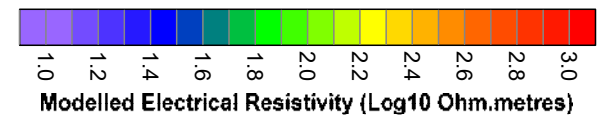
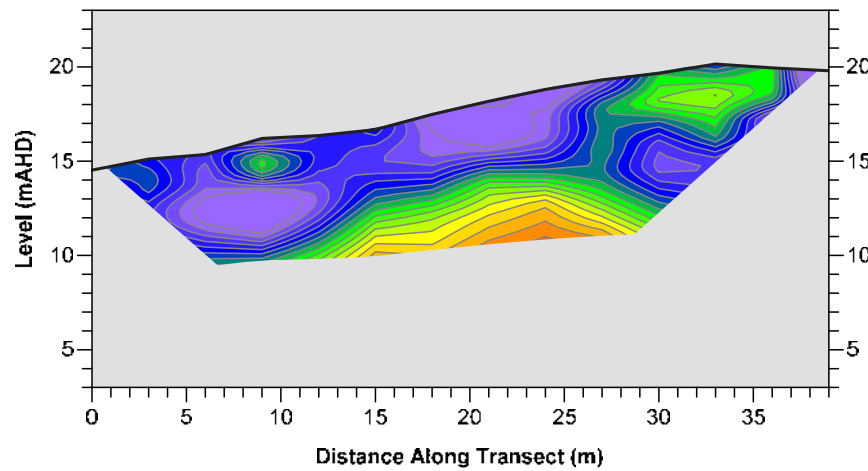
Seismic P-Wave Velocity Material Classification*

Cl.	P-wave velocity (m/s)	Description
P.1	$3500 \leq V_p$	Slightly weathered to fresh rock
P.2	$2000 \leq V_p < 3500$	Moderately weathered rock
P.3	$750 \leq V_p < 2000$	Highly weathered rock or residual soil
P.4	$V_p < 750$	Sediment (soil)

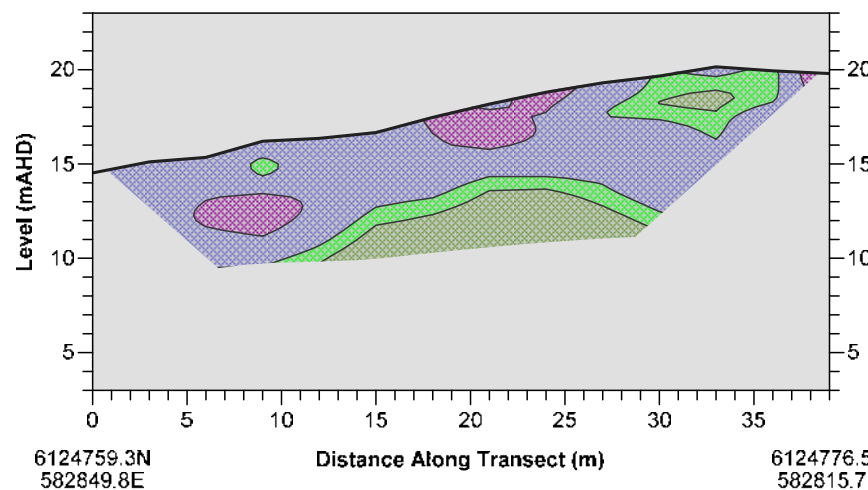
6124759.3N
582849.8E

6124776.5N
582815.7E

ELECTRICAL RESISTIVITY MODEL



ELECTRICAL RESISTIVITY MATERIAL CLASSIFICATION



Electrical Resistivity Material Classification*

Cl.	Resistivity (Ohm.m)	Description
R.1	$100 \leq R$	Very low permeable/porous material (fresh rock)
R.2	$50 \leq R < 100$	Low permeable/porous material (weathered rock)
R.3	$10 \leq R < 50$	Moderately permeable/porous material (saturated soil)
R.4	$R < 10$	Highly permeable/porous material (saturated soil)

6124759.3N
582849.8E

6124776.5N
582815.7E

* Interpreted material classification is based on uncalibrated geophysical dataset. Ground truthing via intrusive geotechnical testing is recommended to verify material types and boundaries.

NOTES
 Drawing to be used in conjunction with Report 3041.
 Map Projection in GDA2020, MGA Zone 50.
 Elevation in mAHD.

CMW GEOSCIENCES GEOPHYSICAL SUBSURFACE INVESTIGATION 8-12 SLEEMAN AVENUE MIRA MAR WESTERN AUSTRALIA	Date	17 November 2022	Paper Size	A3
	Scale	1:400	Drawn	AHWS
	Drawing	3041-14	Revision	0

APPENDIX B – INTERPRETED GEOPHYSICAL SECTIONS

APPLICATIONS

- ✓ Bedrock mapping
- ✓ Mapping weathered zones
- ✓ Stratigraphic mapping
- ✓ Indicative material hardness for piling, tunnelling and excavation works
- ✓ Identification of fault / fractured zones

METHOD

The Seismic Refraction method involves the measurement of travel times of seismic compressional waves (P-waves) that are generated at the surface, propagate through the subsurface and return to the surface after being refracted at the interface between layers of contrasting seismic velocity. Seismic wave velocities are controlled by the fundamental parameters of elastic strength and density of the material it propagates through.

For near surface investigations seismic energy is generated on the surface using a sledge hammer. More powerful sources such as accelerated drop weight, down-hole airguns, or explosives are required for deeper investigations. The generated seismic waves propagate through the subsurface at a certain velocity. On reaching a geological boundary marked by an increase in seismic velocity, at a specific angle the wave is critically refracted and travels along the top of the lower layer at a greater velocity. This generates head waves in the upper layer which return to the surface where it is detected as vibrations by a linear array of geophones spaced at regular intervals.

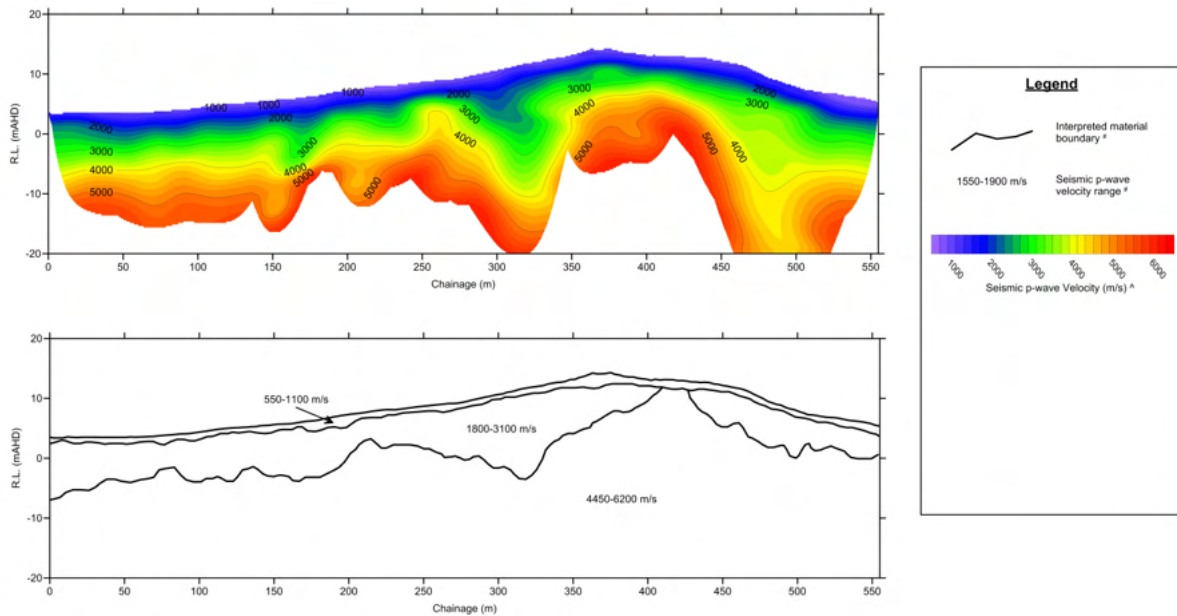
By measuring the travel times of these refracted waves from multiple source points to multiple receivers, the seismic refraction method can resolve lateral changes in the depth to the top of a refracting interface as well as the seismic velocity within it. Furthermore being related to elastic strength and density, the velocities calculated from a seismic refraction survey can be a useful guide to the rippability of a rock for excavation.



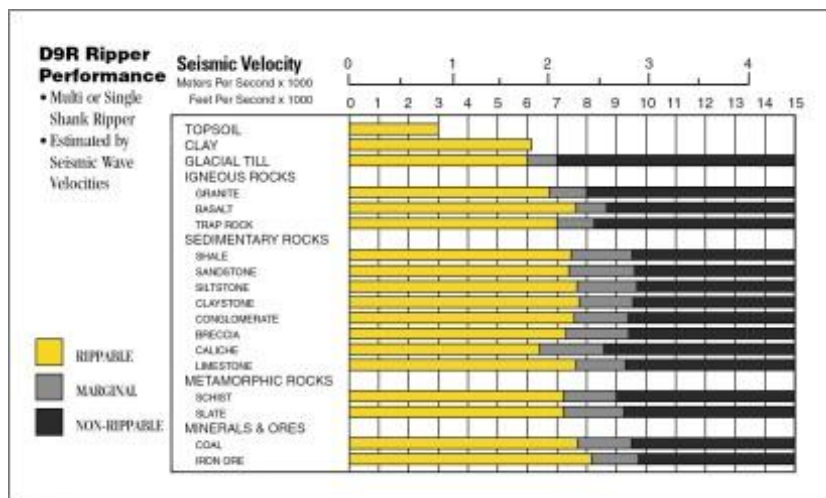
DATA ANALYSIS & PRESENTATION

Processing and analysing seismic refraction data can be carried out using a layered model assuming distinct refractive boundaries or tomographic approach assuming a gradual increase in seismic velocity with depth. Both approaches have benefits and are typically carried out in unison to generate the most detailed geological model possible.

The output is a cross-section showing lateral changes in the depth to the various refracting interfaces and the seismic velocities within them. When correlated with core logs, this information can be related to geological boundaries in the subsurface. This can be particularly useful for planning excavation with the depth to the different layers giving an idea of quantity of rock needed to be removed and the seismic velocities giving an idea of the rock's hardness and hence rippability.



Modelled seismic p-wave velocity section (top) and corresponding layer model section (bottom)



Rippability chart, displays the relationship between rippability and P-wave velocity, taken from Handbook of Ripping, Twelfth Edition, Caterpillar Inc. 2000.

APPLICATIONS

- ✓ Landfill investigations
- ✓ Ground water investigations including depth to water table and aquifers
- ✓ Delineation of freshwater / saltwater interface
- ✓ Mapping and monitoring of soil salinity and inorganic contaminant plumes
- ✓ Location of paleochannels, faults / fractured zones
- ✓ Locating voids and mineshafts / cave systems
- ✓ Stratigraphic mapping including gravel and clay lenses
- ✓ Soil corrosion assessment

METHOD

Electrical Resistivity Tomography (ERT) is sensitive to variations in the electrical resistivity of the subsurface measured in Ohm meters (Ωm). The dominant factors affecting the bulk electric resistivity (and its inverse, conductivity) of soil or rock are:

- Porosity and permeability
- Degree of saturation – the fraction of pore space / fractures filled with fluid
- Fluid type including salt content – the composition of the fluid filling the pore spaces / fractures
- Presence of clays with moderate to high cation exchange capacity (CEC)

Resistivity measurements are made by inducing an electrical current into the earth through two current electrodes and measuring the resulting voltage difference at two potential electrodes. Knowing the current and voltage values, an apparent resistivity value can be calculated, the investigation depth of which is relative to the spacing between electrodes. Greater depths are achieved by increasing the electrode spacing. A number of different electrode configurations exist, each being suitable under various conditions.

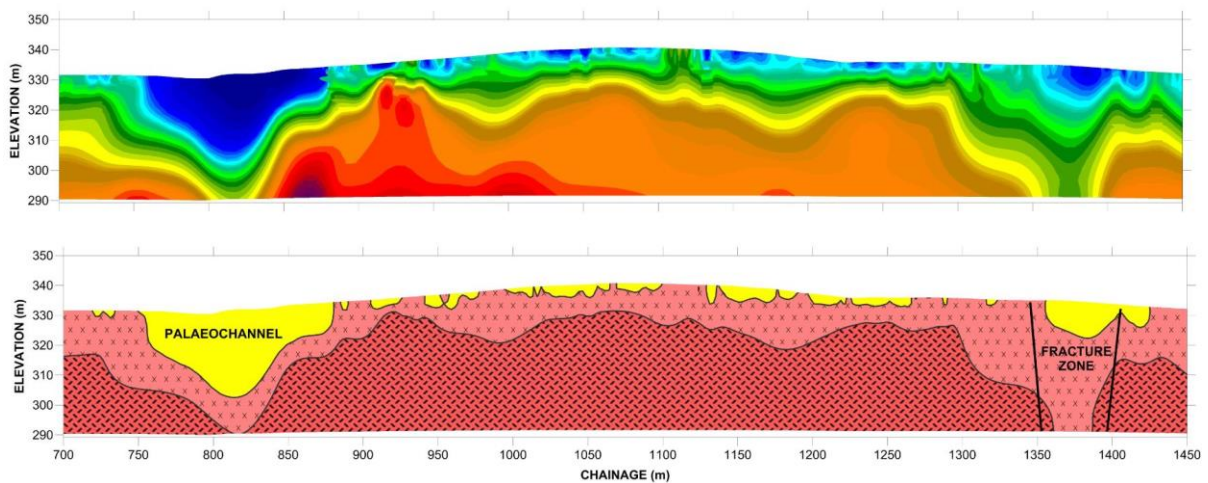
Modern resistivity systems employ multiple electrodes connected to a central control unit via multiple core cables. Once the electrode array is deployed and the sequence program is set in the control unit, readings are automatically taken across a number of electrode positions.



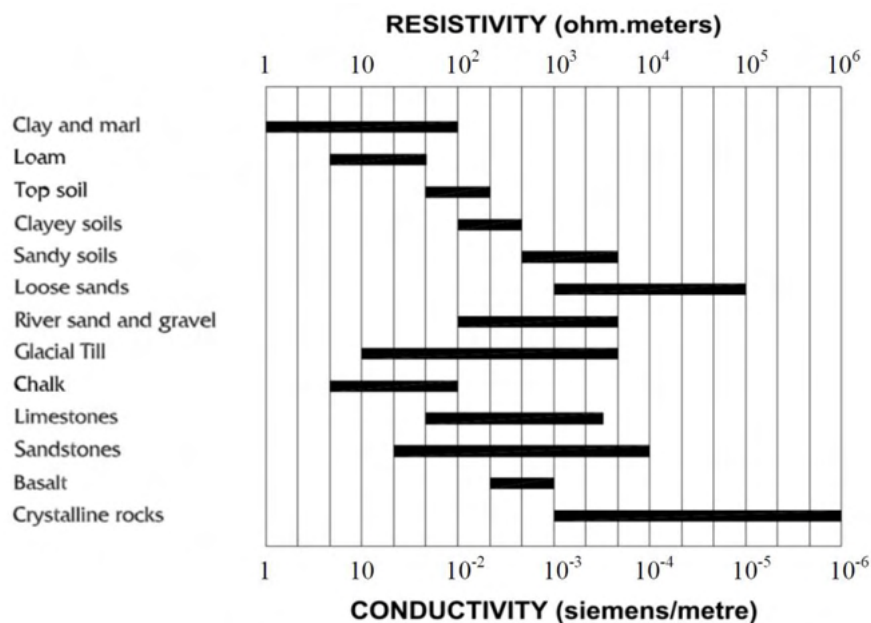
DATA ANALYSIS AND PRESENTATION

After collection of a resistivity sequence a pseudo-section is generated showing the apparent resistivity measurements at the various depths along the profile. Quantitative resistivity readings can be calculated by running the pseudo-section through mathematical inversion algorithms resulting in 2D geo-electrical cross-section showing variations in the modelled electrical resistivity of the subsurface. The resistivity section can be interpreted to provide information on subsurface layering, linear and isolated features.

The imaging depth achievable with the ERI method is dependent on the total length of the electrode array, with larger electrode spacings resulting in greater imaging depth. The overall subsurface resistivity also affects the imaging depth with highly resistive ground tending to decrease the depth after inversion.



Electrical Resistivity 2D cross-section (top) with geological interpretation (bottom)



Typical electrical resistivity / conductivity range of common earth materials

APPENDIX C

Intrusive Ground Investigation Results

BOREHOLE LOG - BH01

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 13/12/2022



Logged by: IA Position: E.582902m N.6124699m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 3.6 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			3.6		ML: TOPSOIL: SANDY SILT: low plasticity, dark brown; sand, fine to medium grained; trace organic rootlets	S	≈PL									
PQ3			100			2.7	1	SM: SILTY SAND: fine to medium grained, pale grey; silt, low plasticity ... at 1.13m, becoming mottled brown and black ... at 1.30m, becoming grey		M									
PQ3			66			2.2	2	CI: CLAY: medium plasticity, brown; trace sand, fine to medium grained ... at 2.00m, becoming mottled blue grey	S	≈PL								1.50-2.00m: core loss	
PQ3						1.1	3	SC: CLAYEY SAND: fine to medium grained, blue grey, quartz; clay, low plasticity		W									
PQ3			100			0.3	4	SP: SAND: fine to medium grained, grey, quartz; trace silt, low plasticity ... at 4.00m, becoming grey/brown		W									
PQ3			100				5	... from 5.61m to 5.90m, becoming dark brown		W to S									
PQ3			100				6												
PQ3			100				7	... at 7.00m, becoming grey		W									
PQ3			100			-4.0	8	SP: SAND: fine to medium grained; grey; with clay, low plasticity; with gravel, fine to coarse grained, sub-angular, quartz ... at 8.20m, moderately cemented (residual granite)										8.54m: joint, 30 degree, irregular, rough, clay	
PQ3			100	100		-5.4	9	GRANITE: fine to coarse grained, grey, massive											
							10												

Termination reason: Target depth reached

Remarks: Standpipe installed at 6.0m

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH01

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 13/12/2022



Logged by: IA Position: E.582902m N.6124699m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 3.6 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification						Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH	EH			
PQ3								GRANITE: fine to coarse grained, grey; massive											10.24m: joint, 15 degree, irregular, rough, clay 10.40m: joint, 15 degree, irregular, rough, clay	
PQ3			100		100		11												11.60m: joint, 10 degree, undulating, rough, clean	
							12	Borehole terminated at 12.00 m												
							13													
							14													
							15													
							16													
							17													
							18													
							19													
							20													

Termination reason: Target depth reached
 Remarks: Standpipe installed at 6.0m

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH03

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 11/12/2022



Logged by: EA Position: E.582862m N.6124753m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 11.9 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification VL L M H V H E H UCS (MPa) Correlated UCS (ts50)	Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD										
PQ3			100		41	11		MICRODIORITE: fine grained; grey; partially recovered as clayey sand, fine to medium grained, mafic clasts; clay, low plasticity				MW		10.70m: joint, 80 degree, planar, rough, clay, 3mm thick 11.10m: joint, 10 degree, planar, rough, clay coating 11.16m: joint, 80 degree, planar, rough, clay, 3mm thick 11.29m: joint, 15 degree, planar, rough, clay coating 11.36m: joint, 15 degree, planar, rough, clay coating 11.44m: joint, 10 degree, planar, rough, clay coating 11.51-12.00m: recovered as crushed rock, clay infilled	
						12		Borehole terminated at 12.00 m							
						13									
						14									
						15									
						16									
						17									
						18									
						19									
						20									

Termination reason: Target depth reached
 Remarks: Vibrating Wire Piezometer at 6.0m, serial number 2206705
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH04

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 02/12/2022



Logged by: IA Position: E.582839m N.6124771m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 17.6 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification						Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH	EH			
PQ3			100			17.6		FILL: SILTY SAND: fine grained, orange brown; silt, low plasticity; with clay, low plasticity												
PQ3			60			17.3		FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone												
PQ3						16.9		SC: CLAYEY SAND: fine to medium grained, quartz, dark brown; clay, low plasticity												
PQ3						16.2		CL: SANDY CLAY: low plasticity; dark brown; sand, fine to medium grained; trace gravel, fine to coarse grained										1.60-2.20m: core loss		
PQ3						15.4		CH: CLAY: high plasticity; brown mottled grey and red brown; trace sand, fine grained										2.50m: pocket penetrometer = 100kPa		
PT						14.2														
PQ3			100		17	13.4		SC: CLAYEY SAND: fine to coarse grained, brown, quartz and mafic clasts; clay, low plasticity. (Extremely weathered MICRODIORITE) ... from 3.47m to 3.60m, MICROGRANITE COBBLE, fine to medium grained, brown to grey; moderately weathered, moderately strong; massive ... from 3.50m to 3.50m, moderately cemented; red brown banded ... from 3.80m to 3.89m, highly weathered, low strength MICRODIORITE band MICRODIORITE : fine to medium grained; grey;									4.17m: joint, 10 degree, undular, rough, iron/clay 4.21m: joint, 10 degree, undular, rough, iron/clay 4.24m: joint, 10 degree, undular, rough, iron/clay 4.94m: joint, 10 degree, irregular, rough, clean			
PQ3			100		100	5														
PQ3			100		98	7												7.21-7.23m: crushed seam rock/clay infill 7.26-7.26m: crushed seam rock/clay infill		
PQ3			100		100	8														
PQ3			100		100	9														

Termination reason: Target depth reached
 Remarks: Standpipe installed at 10.5m
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH04

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 02/12/2022



Logged by: IA Position: E.582839m N.6124771m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 17.6 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)				Samples, test results and additional Data			
			TCR	SCR	RQD							VL	L	M	H	VH		EH	<20	20-40	40-100		100-300	300-1000	>1000
PQ3								MICRODIORITE : fine to medium grained; grey; Borehole terminated at 10.50 m								SW									
						11																			
						12																			
						13																			
						14																			
						15																			
						16																			
						17																			
						18																			
						19																			
						20																			

Termination reason: Target depth reached
 Remarks: Standpipe installed at 10.5m
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH05

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 30/11/2022



1:50 Sheet 1 of 2

Logged by: EA		Position: E.582830m N.6124743m		Hole Diameter: 120mm		Plant: Hanjin DB8													
Checked by: RD		Elevation: 15.3 m		Angle from horizontal: 90°		Contractor: National Geotech													
Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3						15.3			FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone										
						14.9			CL: SILTY CLAY: low to medium plasticity, dark brown; with sand, fine to coarse grained, quartz / felsic clasts; with gravel, fine grained, angular to subangular, granite	S	>PL								
						14.4			... from 0.61m to 0.63m, cobble, granite										
PT						1			CH: SANDY CLAY: high plasticity; pale brown mottled orange and pale grey; sand, fine to coarse grained, quartz and felsic clasts; with gravel, fine to medium grained, angular to subangular, granite	F to St	≈PL				Uc			1.37-2.40m: core loss	
						2			... at 2.40m, gravel, fine to coarse grained										
PQ3						20													
						100													
PT						12.2			SM: SILTY GRAVELLY SAND: fine to medium grained, pale grey, quartz, biotite; silty, low plasticity; gravel, fine to coarse grained, angular to subangular, granite. (Extremely weathered granite)	M					XW			3.60-4.00m: displays granitic fabric	
						11.4													
						11.3			SC: SILTY CLAYEY SAND: fine to medium grained, brown, quartz; clayey, low plasticity	D to M					HW			4.06m: joint, undulating, rough, iron, veneer, 10 degree	
						4			MICRODIORITE : fine to medium grained; greyish brown; joint spacing typically 30-80mm; Fe staining along joints									4.12m: joint, undulating, rough, iron, veneer, 15 degree	
						5			... at 4.28m, grey									4.17m: joint, planar, rough, iron, veneer, 10 degree	
						51												4.25-4.27m: crusted seam, rock infill	
						100												4.34m: joint, undulating, rough, clay coating, 20 degree	
						51												4.37m: infilled seam, undulating, rough, clay, 1mm thick, 80 degree	
						95												4.44m: joint, undulating, rough, iron, veneer, 10 degree	
						98												4.47m: joint, undulating, rough, iron, veneer, 5 degree	
						95												4.64m: joint, undulating, rough, iron, veneer, 85 degree	
						98												4.71m: joint, undulating, rough, iron, veneer, 10 degree	
						95												4.90-5.00m: crushed zone	
						95												5.05m: joint, undulating, rough, iron, veneer, 8 degree	
						95												5.14m: joint, undulating, rough, iron, veneer, 8 degree	
						95												5.34m: joint, undulating, rough, iron, veneer, 0 degree	
						95												5.49m: joint, undulating, rough, iron, veneer, 10 degree	
						95												5.51m: joint, undulating, rough, iron, veneer, 0 degree	
						95												5.56m: joint, undulating, rough, iron, veneer, 5 degree	
						95												5.62m: joint, undulating, rough, iron, veneer, 0 degree	
						95												5.75m: joint, undulating, rough, iron, veneer, 85 degree	
						95												6.51m: joint, undulating, rough, clean, 20 degree	
						95												7.22m: joint, undulating, rough, clean, 60 degree	
						95												7.30m: joint, undulating, rough, clean, 5 degree	
						95												7.81m: joint, undulating, rough, clay coating, 5 degree	
						95												7.84m: joint, undulating, rough, clean, 0 degree	
						95												7.85m: joint, undulating, rough, clean, 5 degree	
						95													

Termination reason: Target depth reached

Remarks: Standpipe installed at 9.0m

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH06

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 29/11/2022



Logged by: EA Position: E.582837m N.6124719m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 12.7 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification						Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data		
			TCR	SCR	RQD							VL	L	M	H	VH	EH					
PQ3						12.7		FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone														
			100				11.6	1	CH: SILTY CLAY: medium to high plasticity, dark grey to brown; trace sand, fine to medium grained; trace gravel, fine to medium grained, subangular to angular ... from 1.40m to 1.42m, granite cobble	S to F									1.33-1.39m: crushed limestone fall in 1.44m: granite cobble likely placed from constructing drill pad			
			100					2	... at 2.00m, becoming fine to coarse grained gravel ... from 2.13m to 2.18m, becoming Silty SAND, medium plasticity, green grey, very soft to soft													
			100				10.2		CH: CLAY: high plasticity, blue grey mottled pale brown; trace sand, fine to medium grained													
			100					3												3.00-3.45m: Push Tube_01, R=0.45		
			100				9.1		ML: SANDY SILT: low plasticity, blue grey mottled pale brown; sand, fine to coarse medium grained; with gravel, clay, and cobbles, fine to coarse grained, granite; cobbles, up to 50mm;													
			100				8.7	4	CH: SANDY CLAY: high plasticity, blue grey mottled pale brown; sand, fine to medium grained											4.15m: potential slip zone		
			100				8.5		MICRODIORITE: fine to medium grained; grey; massive											4.50-4.80m: Push Tube_02, R=0.3 (refused on rock)		
			100				8.3		CH: SANDY CLAY: high plasticity, grey to brown; sand, fine to coarse grained	F												
			PT																			
PQ3																						
PT																						
PQ3						7.8	5	CLAYEY GRAVEL and COBBLES: fine to coarse grained, grey (clasts), grey to brown (matrix), subangular to angular, microdiorite, clay, medium to high plasticity; with sand, fine to coarse grained											4.94m: fines partially washed out from drilling			
			100		37	7.3		MICRODIORITE: fine to medium grained; grey; joint spacing typically 150mm to 350mm	M										5.78m: joint, undulating, rough, 5 degree, clean			
							6													6.15-6.16m: joint, undulating, rough, 25 degree, clay infill, 1mm thick		
			100		31			... at 6.47m, joint spacing irregular ... from 6.66m to 7.65m, recovered as crushed rock												6.47-6.51m: joint set, undulating, rough, 40 degree, clay veneer, typically 1mm apart		
							7														7.11m: joint, undulating, rough, 25 degree, clay coating	
							8															
			100		90																	
							9															9.35m: joint, irregular, rough, 0 degree, clean
			100		100																9.46m: joint, irregular, rough, 5 degree, clean	
							10															

Termination reason: Target depth reached

Remarks: Vibrating Wire Piezometer at 7.5m, serial number 2206552

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH06

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 29/11/2022



Logged by: EA	Position: E.582837m N.6124719m	Hole Diameter: 120mm	Plant: Hanjin DB8
Checked by: RD	Elevation: 12.7 m	Angle from horizontal: 90°	Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data	
			TCR	SCR	RQD							VL	L	M	H	VH				EH
PQ3								MICRODIORITE: fine to medium grained; grey; joint spacing typically 150mm to 350mm												
								Borehole terminated at 10.50 m												
						11														
						12														
						13														
						14														
						15														
						16														
						17														
						18														
						19														
						20														

Termination reason: Target depth reached
 Remarks: Vibrating Wire Piezometer at 7.5m, serial number 2206552

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH07

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 03/12/2022



Logged by: IA Position: E.582824m N.6124762m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 18.6 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			18.6		FILL: SILTY SAND: fine to medium grained, brown; silt, low plasticity; with gravel, fine to coarse grained, sub-angular to sub-rounded, granite; trace organic rootlets	D										
PQ3			100			18.1		... at 0.30m, no organics; becoming black	M									0.50m: pocket penetrometer = 75kPa	
PQ3			100			17.8		SC: CLAYEY SAND: fine to medium grained, brown, quartz and felsic clasts; clay, low plasticity	F	≈PL									
PQ3			100			17.7		CI: SANDY CLAY: medium plasticity; orange brown; sand, fine to medium grained	M										
PQ3			100			17.6	1	SC: CLAYEY SAND: fine to medium grained, grey to brown, quartz and felsic clasts; clay, low plasticity										1.40m: pocket penetrometer = 350kPa	
PQ3			100				2	CH: CLAY: high plasticity; brown mottled pale grey; with sand, fine to medium grained, quartz and mafic clasts	St									2.10-2.55m: core loss	
PQ3			20																
PQ3			100			15.9		CH: SANDY CLAY: high plasticity, brown mottled pale grey; sand, fine to medium grained, quartz and mafic clasts	S										
PT			80				3			≈PL									
PQ3			100					... at 3.48m, becoming pale grey mottled pale brown	F										
PT			100				4	... from 3.61m to 3.68m, SANDY CLAY band; grey										4.00m: pocket penetrometer = 100kPa	
PT			100																
PQ3			100		59	13.7	5	MICRODIORITE : fine to medium grained; brown; joint spacing typically 1-30mm						HW				4.91-4.92m: infilled seam, clay	
								... at 5.00m, becoming brown to grey						MW				5.07-5.09m: infilled seam, clay	
								... at 5.60m, very widely spaced joints										5.18-5.24m: crushed zone, crushed rock and clay infill	
																		5.25-5.26m: joint set, 5 degree, undulating, rough, clay/rock infill, joints ~ 1mm apart	
																		5.39-5.42m: joint set, 5 degree, undulating, rough, clay/rock infill, joints ~ 1mm apart	
			100		99													5.60m: joint, 10 degree, irregular, rough, iron, veneer	
																		6.82-6.83m: infill seam, clay and crushed rock	
																		7.40m: joint, 75 degree, irregular, rough, clean	
			100		100		8												
			100		100		9											9.10m: joint, 15 degree, irregular, rough, clean	
							10												

Termination reason: Target depth reached
 Remarks: Standpipe installed at 10.5m
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH07

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 03/12/2022



Logged by: IA Position: E.582824m N.6124762m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 18.6 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
HQ3								MICRODIORITE : fine to medium grained; brown; joint spacing typically 1-30mm								SW			
								Borehole terminated at 10.75 m											
						11													
						12													
						13													
						14													
						15													
						16													
						17													
						18													
						19													
						20													

Termination reason: Target depth reached
 Remarks: Standpipe installed at 10.5m

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH08

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 01/12/2022



Logged by: IA Position: E.582814m N.6124748m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 18.7 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification						Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH	EH			
PQ3			100			18.7		FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone	D									0.00m: PT01 and PT02 have penetrated the full 0.45m but only recovered 0.3m - clay compressed		
						18.3		FILL: SILTY SAND: fine to medium grained, dark brown; silt, low plasticity												
						18.0		CH: SANDY CLAY: high plasticity; pale grey mottled orange brown; sand, fine, quartz	F to St	≈PL										
						1		... from 1.16m to 1.28m, with gravel, fine to coarse grained, laterite										1.28m: displays granitic fabric		
PT			67						M											
PQ3			52			16.8		CH: CLAY: high plasticity; pale grey mottled orange brown; with sand, fine, quartz, and biolite							Uc					
								... at 2.50m, medium to high plasticity												
								... from 2.64m to 2.72m, SANDY CLAY band; grey												
PT			71			3			F to St	≈PL										
PT			100																	
PQ3			100			4														
PT			100			14.5		SC: CLAYEY SAND: fine to medium grained, brown, quartz and felsic clasts; clay, high plasticity	F to St	≈PL										
						14.4		CH: SANDY CLAY: high plasticity; brown; sand, fine to medium grained												
						14.1		SC: CLAYEY SAND: fine to coarse grained, orange brown, quartz and mafic clasts; clay, high plasticity												
						14.0		... at 4.70m, becoming grey to brown										4.76m: joint, 30 degree, planar, rough, clean		
PQ3			100	76		5		MICRODIORITE: fine to medium grained; grey; joint spacing typically 30-80mm; Fe staining along joints										5.08-5.21m: crushed zone - crushed rock		
								... at 5.70m, joint spacing typically 500mm to 1500mm										5.27m: joint, 80 degree, undular, rough, iron, veneer		
PQ3			100	100		6												5.41-5.50m: joint set, 10 degree, undular, rough, rock infill typically 10mm apart		
																		5.60m: joint, 10 degree, irregular, rough, iron, veneer		
HQ3			100	100		7												5.66-5.70m: joint set, 5 degree, undular, rough, joints 5mm apart		
																		6.77m: joint, 10 degree, rough undular, iron, veneer		
HQ3			100	100		8												7.06m: joint, 15 degree, undular, rough, iron, veneer		
						9		Borehole terminated at 9.00 m										8.81m: joint, 10 degree, undular, rough, clean		

Termination reason: Target depth reached

Remarks: Vibrating Wire Piezometer installed at 4.5m, serial number 2206550

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH09

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 30/11/2022



Logged by: IA Position: E.582810m N.6124734m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 18 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			18.0		FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone											
PQ3			100			17.4		CI: SILTY CLAY: medium to high plasticity, dark brown to black; trace sand, fine to medium grained;	S										
PQ3			100			17.0	1	CH: CLAY: high plasticity, pale brown; trace sand, fine grained ... at 1.05m, becoming brown to black; trace organic rootlets ... at 1.16m, becoming brown mottled red brown and grey	S to F	>PL				Uc					
PQ3			100			16.2		CLAYEY SAND: fine to medium grained, quartz, brown mottled brown to black and pale brown; clay, low plasticity.	S	M									
PQ3			100			16.0	2	CLAY: high plasticity, brown; trace sand, fine grained.		>PL									
PQ3			100			15.9		CL: SANDY CLAY: low plasticity, brown mottled brown to black and pale brown; sand, fine to medium grained, quartz.		M									
PQ3			100			15.3	3	MICRODIORITE: fine to medium grained, greyish brown; joint spacing typically 5mm to 30mm						HW		2.76-2.84m: crushed seam			
PQ3			100		17		4							MW		2.93m: joint, 85 degree, planar, rough finish, iron, veneer			
PQ3			100				5									3.00-3.10m: Recovered as crush rock			
PQ3			100				6									3.17m: joint, 15 degree, undulating, rough finish, iron, veneer			
PQ3			100				7									3.19m: joint, 15 degree, undulating, rough finish, iron, veneer			
PQ3			100				8									3.21m: joint, 15 degree, undulating, rough finish, iron, veneer			
PQ3			100				9									3.24m: joint, 10 degree, undulating, rough finish, iron, veneer			
PQ3			100		93		10									3.33m: joint, 10 degree, undulating, rough finish, iron, veneer			
PQ3			100				11									3.39m: joint, 10 degree, undulating, rough finish, iron, veneer			
PQ3			100				12									3.44m: infill seem, 15 degree, irregular, rough finish, rock/clay leaking			
PQ3			100				13									3.46m: infill seem, 15 degree, irregular, rough finish, clay leaking			
PQ3			100				14									3.56-3.82m: Recovered as crush rock			
PQ3			100				15									3.87m: joint, 10 degree, irregular, rough finish, iron, veneer			
PQ3			100				16									3.98m: joint, 10 degree, irregular, rough finish, iron, veneer			
PQ3			100				17									4.07m: joint, 5 degree, undulating, rough finish, crushed rock, coating			
PQ3			100				18									4.15m: joint, 10 degree, undulating, rough finish, crushed rock, coating			
PQ3			100				19									4.21m: joint, 10 degree, undulating, rough finish, crushed rock, coating			
PQ3			100				20									4.36m: joint, 10 degree, undulating, rough finish, iron, veneer			
PQ3			100				21									4.37-4.40m: infill seem, 15 degree, irregular, rough finish, clay and crushed rock			
PQ3			100				22									4.44m: joint, 10 degree, undulating, rough finish, iron, veneer			
PQ3			100				23									4.72m: joint, 5 degree, undulating, rough finish, iron, veneer			
Borehole terminated at 9.00 m																			

Termination reason: Target depth reached
 Remarks: Standpipe installed at 9.0m

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH10

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 06/12/2022



1:50 Sheet 1 of 1

Logged by: IA		Position: E.582808m N.6124722m		Hole Diameter: 120mm		Plant: Hanjin DB8													
Checked by: RD		Elevation: 16.5 m		Angle from horizontal: 90°		Contractor: National Geotech													
Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			16.5			FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone										
PQ3			100			16.4			FILL: SILTY SAND: fine to medium grained, orange brown; silt, low plasticity										
PQ3			100		83	15.9			FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone	St	≈PL								
PQ3			100		83	15.6			CI: CLAY: medium to high plasticity, dark greyish brown; trace sand, fine grained.										
PQ3			100		0	15.3			SC: CLAYEY SAND: fine to medium grained; dark greyish brown; clay, low plasticity ... at 1.00m, with gravel and cobbles, up to 20mm, sub-angular, MICROGRANITE										
PQ3			100		0	15.0			COBBLES/BOULDERS: grey; sub-angular, up to approximately 60mm MICROGRANITE in a matrix of SANDY CLAY, medium plasticity, grey; sand, fine to medium grained										
PQ3			100		51	12.0			MICRODIORITE: fine to medium grained, grey; joint spacing typically 5-10mm										
HQ3			100		98	5													
HQ3			100		100	6													
						7													
						8			Borehole terminated at 7.50 m										

Termination reason: Target depth reached
 Remarks: No installation in borehole, borehole backfilled

BOREHOLE LOG - BH11

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 05/12/2022



Logged by: IA Position: E.582803m N.6124760m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 20.7 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			20.7		FILL: SILTY SAND: fine to medium grained, brown; silt, low plasticity; trace gravel, fine to coarse grained, angular to sub-angular.											
PQ3			100					... at 0.61m, becoming brown to black											
PQ3			100			19.8	1	CI: CLAY: medium to high plasticity, pale grey mottled orange brown; with sand, fine to medium grained.	S to F	≈PL								1.00m: pocket penetrometer = 50kPa	
PQ3			100			19.6		SM: SILTY SAND: fine to medium grained, brown, quartz; silt, low plasticity.		M to W									
PQ3			100			19.0	2	CH: CLAY: high plasticity, pale grey; with sand, fine grained	F	≈PL								2.00m: pocket penetrometer = 75kPa	
PQ3			100			18.4		SC: CLAYEY SAND: fine grained, brown, quartz; clay, medium to high plasticity		W								2.50m: pocket penetrometer = 75kPa	
PQ3			100			18.1		CL: SANDY CLAY: low to medium plasticity, pale grey; sand, fine grained	F	≈PL									
PQ3			100			17.8	3	SM: SILTY SAND: fine to medium grained, brown, quartz; silt, low plasticity		M to W								3.50-3.60m: saturated from flushing hole	
PQ3			100					... at 3.84m, becoming pale brown		W									
PQ3			100			16.6	4	CI: SANDY CLAY: medium to high plasticity, pale blue grey mottled brown; sand, fine grained		M to W									
PT			56					... at 4.44m, SAND seam; 2mm thick, grey	St										
PQ3			100				5	... from 5.15m to 5.19m, CLAYEY SAND seam: grey, fine to medium grained		≈PL								4.95m: pocket penetrometer = 200kPa	
PQ3			100					... at 5.21m, becoming white		S								5.40m: pocket penetrometer = 25kPa	
PQ3			100					... at 5.31m, sand lense, orange brown										5.70m: pocket penetrometer = 50kPa	
PQ3			100			15.0		... at 5.38m, becoming pale blue to grey											
PQ3			100			14.8	6	CL: SANDY CLAY: low to medium plasticity, orange brown; sand, fine to medium grained	F										
PQ3			100			14.6		CL: CLAY: low plasticity; brown; trace sand, fine to medium grained	S										
PQ3			100	85		14.2	7	... from 6.03m to 6.06m, seam: white, soft, >PL										6.20m: joint, 5 degree, irregular, rough, clay infill	
PQ3								... from 6.09m to 6.10m, seam: white, soft, >PL										6.25m: infilled seam; clay	
PQ3								GRANITE: fine to coarse grained, orange brown to grey; joints typically 10 to 100mm apart, iron stained on healed joints										6.46m: joint, 10 degree, irregular, rough, clean	
PQ3								MICRODIORITE: fine to medium grained; grey to brown; joints typically 20 to 40mm apart; Fe stained on joints										6.51-6.54m: infilled seam; clay	
PQ3								... at 7.00m, becoming grey, no iron staining on joints										6.69m: joint, 5 degree, irregular, rough, clay coating	
HQ3			100				8											6.88m: joint, 10 degree, irregular, rough, clay coating	
HQ3			100															7.18m: joint, 10 degree, undulating, rough, iron, veneer	
HQ3			100															7.50m: joint, 10 degree, undulating, rough, iron, veneer	
HQ3			100															7.65m: joint, 30 degree, undulating, rough, iron, veneer	
HQ3			100															8.00m: joint, 5 degree, irregular, rough, clean	
HQ3			100															8.10m: joint, 5 degree, planar, rough, clean	
HQ3			100															8.41m: joint, 10 degree, irregular, rough, clean	
HQ3			100															8.57m: joint, 5 degree, undulating, rough, clean	
HQ3			100															9.31m: joint, 0 degree, irregular, rough, clean	
HQ3			100															9.60m: joint, 0 degree, planar, rough, clean	

Termination reason: Target depth reached
 Remarks: Vibrating Wire Piezometer installed at 6.0m, serial number 2206549
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH12

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 04/12/2022



Logged by: IA Position: E.582816m N.6124771m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 19.7 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			19.7		FILL: SILTY SAND: fine to medium grained, brown; silt low plasticity; trace gravel, fine to coarse grained, sub-angular, granite											
PQ3			100																
PQ3			100			18.4	1	... at 1.17m, with clay, low plasticity											
PQ3			100					CI: SANDY CLAY: medium to high plasticity, pale grey to brown mottled red brown; sand, fine to medium grained; laterite	VSt									1.40m: pocket penetrometer = 400kPa	
PQ3			100				2	... at 1.75m, becoming pale grey mottled pale brown										1.90m: pocket penetrometer = 100kPa	
PQ3			100					... at 2.00m, trace sand	F to St									2.50m: pocket penetrometer = 125kPa 2.60m: pocket penetrometer = 75kPa	
PQ3			100					... at 2.60m, trace gravel, fine grained, laterite											
PT			87				3	... at 2.92m, with sand, fine to medium grained, quartz	S to F										
PQ3			100					... at 3.60m, increasing sand content, grey mottled brown, quartz and mafic clasts											
PQ3			100		26	15.6	4	... from 3.83m to 3.85m, CLAY BAND; medium plasticity, grey to brown										3.45m: pocket penetrometer = 100kPa	
PQ3			100					MICRODIORITE : fine to medium grained; grey; joint spacing typically 5 - 10mm										4.17-4.21m: joint set, 5 degree, undulating, rough, iron, veneer, joints 1mm apart	
HQ3			100		53		5											4.40m: joint, 0 degree, undulating, rough, iron, veneer	
HQ3			100															4.64m: joint, 30 degree, undulating, rough, iron, veneer	
HQ3			100															4.85-4.88m: crushed seam; crushed rock infill	
HQ3			100															5.11m: joint, 5 degree, undulating, rough, iron, veneer	
HQ3			100															5.14m: joint, 10 degree, undulating, rough, iron, veneer	
HQ3			100															5.33m: joint, 50 degree, undulating, rough, rock infill	
HQ3			100															5.75m: joint, 10 degree, planar, rough, iron, veneer	
HQ3			100															5.76m: joint, 10 degree, planar, rough, iron, veneer	
HQ3			100															5.86m: joint, 10 degree, irregular, rough, clean	
HQ3			100															5.92m: joint, 5 degree, irregular, rough, clean	
HQ3			100																

Termination reason: Target depth reached
 Remarks: Vibrating Wire Piezometer installed at 4.0m, serial number 2206554

BOREHOLE LOG - BH13

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 10/12/2022



1:50 Sheet 1 of 2

Logged by: EA		Position: E.582796m N.6124790m		Hole Diameter: 120mm		Plant: Hanjin DB8															
Checked by: RD		Elevation: 29.1 m		Angle from horizontal: 90°		Contractor: National Geotech															
Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data		
			TCR	SCR	RQD							VL	L	M	H	VH				EH	
PQ3						29.1			ASPHALT: hole dug out to 0.4m												
						28.7			FILL: SILTY SAND: fine to coarse grained, pale brown, crushed limestone; silt, low plasticity												
			100			28.0	1		CI: SANDY CLAY: medium plasticity, orange brown; sand, fine to medium grained		M to W								1.10m: pocket penetrometer = 100kPa		
							2		... at 2.14m, red brown mottled orange brown and white (lateritic) ... at 2.46m, also mottled grey ... at 2.56m, high plasticity, white mottled red brown		F to St									1.50-2.00m: core loss	
			67						... from 2.81m to 2.89m, soft		St									2.00m: pocket penetrometer = 250kPa	
							3			... at 3.30m, also mottled pale orange brown (lateritic)		s									3.00-3.30m: Push Tube_01, pocket penetrometer = 300kPa
			80						... at 3.80m, no red brown mottling		St									3.40m: pocket penetrometer = 150kPa	
							4			... at 5.17m, with indurated pockets up to 400mm (orange brown, lateritic)		≈PL									3.70m: pocket penetrometer = 200kPa
			100									F								4.00m: pocket penetrometer = 100kPa	
							5														4.20m: pocket penetrometer = 250kPa
PQ3						23.4	6		SC: CLAYEY SAND: fine to medium grained, pale grey brown, quartz, mafic clasts; clay, high plasticity, weakly cemented; with gravel, indurated pockets (orange brown, lateritic) up to 40mm										5.00m: pocket penetrometer = 200kPa		
							7												5.50m: pocket penetrometer = 200kPa		
							8														
							9														
			100				20.0	9		MICRODIORITE: fine to medium grained, greyish brown, slightly weathered, low to medium strength; joint typically 20-10mm apart											9.18-9.19m: infilled seam, clay-coating
				10														9.28m: joint, 10 degree, undulating, rough, clay coating			
																		9.30-9.31m: infilled seam. clay-coating			
																		9.47m: joint, 5 degree, undulating, rough, clay coating			

Termination reason: Target Depth Reached

Remarks: Vibrating Wire Piezometer at 10.5m, serial number 2206706

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH13

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 10/12/2022



Logged by: EA Position: E.582796m N.6124790m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 29.1 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100		19	11	MICRODIORITE: fine to medium grained, greyish brown, slightly weathered, low to medium strength; joint typically 20-10mm apart ... at 10.39m, joint typically 10 to 50mm apart										9.64-9.66m: infilled seam, clay, crushed rock 9.70m: joint, 20 degree, irregular, rough, clay coating 9.71m: joint, 5 degree, irregular, rough, clay coating 9.76m: joint, 5 degree, irregular, rough, clay coating 9.78m: joint, 5 degree, irregular, rough, clay coating 9.81m: joint, 10 degree, irregular, rough, clay coating 10.14m: joint, 10 degree, undulating, rough, clay coating 10.19m: joint, 10 degree, undulating, rough, clay coating 10.34m: joint, 50 degree, undulating, rough, clay coating 10.39m: joint, 5 degree, irregular, rough, clay coating 10.44m: joint, 5 degree, undulating, rough, clay coating 10.45m: joint, 5 degree, undulating, rough, clay coating 10.51m: joint, 5 degree, undulating, rough, clay coating 10.55m: joint, 10 degree, undulating, rough, clay coating 10.70m: joint, 20 degree, irregular, rough, clay coating 10.74m: joint, 85 degree, undulating, rough, clay coating 10.78m: joint, 10 degree, undulating, rough, clay coating 10.81m: joint, 10 degree, undulating, rough, clay coating 10.89m: joint, 5 degree, irregular, rough, clay coating 10.95m: joint, 10 degree, undulating, rough, clay coating 10.99m: joint, 10 degree, undulating, rough, clay coating 11.00-11.48m: joint set, 10 degree, undulating, rough, clay coating, joint typically 10 to 20mm apart 11.20m: joint, 70 degree, irregular, rough, clay coating 11.55m: joint, 10 degree, undulating, rough, clay coating 11.68m: joint, 25 degree, undulating, rough, clay coating 11.75m: joint, 75 degree, crushed seam 11.81m: joint, 20 degree, undulating, rough, clay coating 11.92m: joint, 10 degree, undulating, rough, clay coating 12.06m: joint, 5 degree, undulating, rough, iron, veneer 12.15m: joint, 80 degree, undulating, rough, iron, veneer 12.26m: joint, 10 degree, undulating, rough, iron, veneer 12.35m: joint, 70 degree, undulating, rough, iron, veneer 12.43-12.49m: crushed zone		
			100		67	12												... at 12.49m, grey, joint spacing typically less than 1mm	
						13	Borehole terminated at 13.50 m												
						14													
						15													
						16													
						17													
						18													
						19													
						20													

Termination reason: Target Depth Reached
 Remarks: Vibrating Wire Piezometer at 10.5m, serial number 2206706

BOREHOLE LOG - BH14

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 07/12/2022



Logged by: EA Position: E.582772m N.6124749m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 26.3 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100			26.3 26.2 26.0	1	FILL: Crushed Limestone; SILTY SAND, fine to coarse grained, pale yellow brown; silt, low plasticity; with gravel, fine to coarse grained, limestone FILL: CLAYEY SAND: fine to coarse grained, orange brown; clay, low plasticity; with gravel, fine to coarse grained, subrounded to subangular	D to M										
			100			24.8													2
			100			24.5	3	SC: CLAYEY SAND: fine to medium grained, brown mottled orange band brown; clay, low plasticity CI: SANDY CLAY: medium plasticity, dark brown; sand, fine grained MICRODIORITE: fine to medium grained, dark grey/brown, partially recovered as clayey sand, fine to medium grained, dark grey/brown; clay, low plasticity	F	≈PL						3.00m: pocket penetrometer = 100kPa 3.68m: joint, 10 degree, irregular, rough, clay coating			
			100		59	23.4 23.3 23.1											4	... from 4.63m to 4.72m, recovered as clayey sand	
			100			19.9	5	... from 6.30m to 6.38m, pockets of clayey sand, up to 2mm wide MICRODIORITE: fine to medium grained, dark grey/brown, joint spacing typically 20 to 100mm apart; Fe staining on joints											
			100		85												6		
			100				7												
			100														8		
			100				9												
			100														10		

Termination reason: Target depth reached
 Remarks: Standpipe installed at 12.0m

BOREHOLE LOG - BH14

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 07/12/2022



Logged by: EA Position: E.582772m N.6124749m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 26.3 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100		100	11		MICRODIORITE: fine to medium grained, dark grey/brown, joint spacing typically 20 to 100mm apart; Fe staining on joints							SW		7.41m: joint, 2 degree, undulating, rough, clay/rock coating 7.51m: joint, 5 degree, undulating, rough, clay/rock coating 7.52m: joint, 5 degree, undulating, rough, clay/rock coating 7.58m: joint, 5 degree, undulating, rough, clay/rock coating 7.60m: joint, 5 degree, undulating, rough, clay/rock coating 7.64m: joint, 10 degree, undulating, rough, clay/rock coating 7.69m: joint, 10 degree, undulating, rough, clay/rock coating 7.71m: joint, 5 degree, undulating, rough, clay/rock coating 7.74m: joint, 10 degree, undulating, rough, clay/rock coating 7.81m: joint, 10 degree, undulating, rough, clay/rock coating 7.91m: joint, 5 degree, undulating, rough, clay/rock coating 8.11m: joint, 5 degree, undulating, rough, clay/rock coating 8.14m: joint, 5 degree, undulating, rough, clay/rock coating 8.21m: joint, 10 degree, undulating, rough, clay/rock coating 8.33m: joint, 5 degree, undulating, rough, clay/rock coating 8.42-8.46m: recovered as crushed rock 8.62m: joint, 15 degree, irregular, rough, clean 8.66m: joint, 15 degree, planar, rough, clean 8.77m: joint, 5 degree, undulating, rough, clean 8.83m: joint, 15 degree, undulating, rough, clean 8.91m: joint, 20 degree, irregular, rough, clean 9.32m: joint, 5 degree, irregular, rough, clean 9.59m: joint, 10 degree, irregular, rough, clean 9.82m: joint, 5 degree, irregular, rough, clean 10.10m: joint, 80 degree, undulating, rough, clean 10.30m: joint, 5 degree, undulating, rough, clean 10.89m: joint, 10 degree, irregular, rough, clean 11.25m: joint, 5 degree, irregular, rough, clean 11.42m: joint, 5 degree, irregular, rough, clean 11.67m: joint, 5 degree, irregular, rough, clean 11.93m: joint, 5 degree, irregular, rough, clean		
						12		Borehole terminated at 12.00 m											
						13													
						14													
						15													
						16													
						17													
						18													
						19													
						20													

Termination reason: Target depth reached
 Remarks: Standpipe installed at 12.0m
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH15

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 08/12/2022



Logged by: EA Position: E.582775m N.6124756m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 26.8 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data	
			TCR	SCR	RQD							VL	L	M	H	VH				EH
PQ3						26.8		ASPHALT/BASECOURSE:										0.00-0.85m: core loss		
						26.0	1	FILL: CLAYEY SANDY GRAVEL: fine to coarse grained, subangular to subrounded, brown; sand, fine to medium grained; clay, low plasticity		M										
						25.4		SC: CLAYEY SAND: fine to medium grained, brown; clay, low to medium plasticity												
						25.3		CH: CLAY: high plasticity, dark grey; with sand, fine grained		S	≈PL									
						24.8	2	CL: SANDY CLAY: low plasticity, orange brown mottled pale brown; sand, fine to medium grained, quartz, mafic clasts; ... at 2.00m, trace gravel, fine to coarse grained, subangular to subrounded			M									
						24.3		CI: CLAY: medium to high plasticity, dark grey; trace sand, fine grained												
							3	... at 2.90m, with sand, fine to medium grained, brown		S	≈PL									
						23.4		CL: SANDY CLAY: low plasticity, orange brown mottled pale brown; sand, fine to medium grained, quartz, mafic clasts;			M									
							4	MICRODIORITE: fine to medium grained, dark greyish brown, joint spacing typically 5 to 100mm												
								... at 9.70m, grey												
PT																				
PQ3																				

Termination reason: Target depth reached
 Remarks: Vibrating Wire Piezometer at 7.5m, serial number 2206553
 This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH15

Client: Great Southern Development Commission
 Project: Land slip - Mira Mar, Albany, WA
 Location: Sleeman Avenue
 Project ID: PER2021-0347
 Date: 08/12/2022



Logged by: EA Position: E.582775m N.6124756m Hole Diameter: 120mm Plant: Hanjin DB8
 Checked by: RD Elevation: 26.8 m Angle from horizontal: 90° Contractor: National Geotech

Drilling Method	Well	Groundwater	Coring			RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Density/Consistency	Moisture Condition	Rock Strength Classification					Cementation/Weathering	Defect Spacing (mm)	Samples, test results and additional Data
			TCR	SCR	RQD							VL	L	M	H	VH			
PQ3			100		100	11		MICRODIORITE: fine to medium grained, dark greyish brown, joint spacing typically 5 to 100mm							SW		undulating, rough, clay coating 6.69-6.74m: crushed seam, clayey sand 6.83-6.93m: crushed seam, clayey sand 6.96m: joint, 10 degree, undulating, rough, clay coating 6.98m: joint, 5 degree, undulating, rough, clay coating 7.01m: joint, 5 degree, undulating, rough, clay coating 7.17m: joint, 5 degree, undulating, rough, clay coating 7.30m: joint, 5 degree, undulating, rough, clay coating 7.38-7.61m: joint set, 5 degree, undulating, rough, clay coating typically seam apart 7.50-7.56m: recovered as crushed rock (drilling induced start of run) 7.68m: joint, 10 degree, undulating, rough, clay coating 7.73m: joint, 10 degree, undulating, rough, clay coating 7.78m: joint, 5 degree, undulating, rough, clay coating 7.81m: joint, 5 degree, undulating, rough, clay coating 7.85m: joint, 5 degree, undulating, rough, clay coating 7.92m: joint, 5 degree, undulating, rough, clay coating 8.02m: joint, 5 degree, undulating, rough, clay coating 8.18-8.41m: joint set, 5 degree, undulating, rough, typically 5mm 8.62m: infilled seam, clay 8.69m: infilled seam, clay 8.72m: joint, 5 degree, undulating, rough, clay coating 8.82m: joint, 10 degree, undulating, rough, clay coating 8.96m: joint, 10 degree, undulating, rough, clay coating 9.03m: joint, 5 degree, undulating, rough, clay coating 9.06m: joint, 5 degree, undulating, rough, clay coating 9.09m: joint, 5 degree, undulating, rough, clay coating 9.13m: joint, 5 degree, undulating, rough, clay coating 9.19-9.23m: crushed zone 9.31m: joint, 10 degree, undulating, rough, clay coating 9.37m: joint, 5 degree, undulating, rough, clay coating 9.39m: joint, 5 degree, undulating, rough, clay coating 9.43m: joint, 10 degree, undulating, rough, clay coating 9.53m: joint, 5 degree, undulating, rough, clay coating 9.57m: joint, 5 degree, undulating, rough, clay coating 9.61m: joint, 10 degree, undulating, rough, clay coating 9.67m: joint, 10 degree, undulating, rough, clay coating 9.73m: joint, 10 degree, irregular, rough, rock infilled 10.04m: joint, 5 degree, irregular, rough, clean 10.44m: joint, 5 degree, irregular, rough 10.64m: joint, 5 degree, irregular, rough 11.46m: joint, 65 degree, irregular, rough		
						12		Borehole terminated at 12.00 m											
						13													
						14													
						15													
						16													
						17													
						18													
						19													
						20													

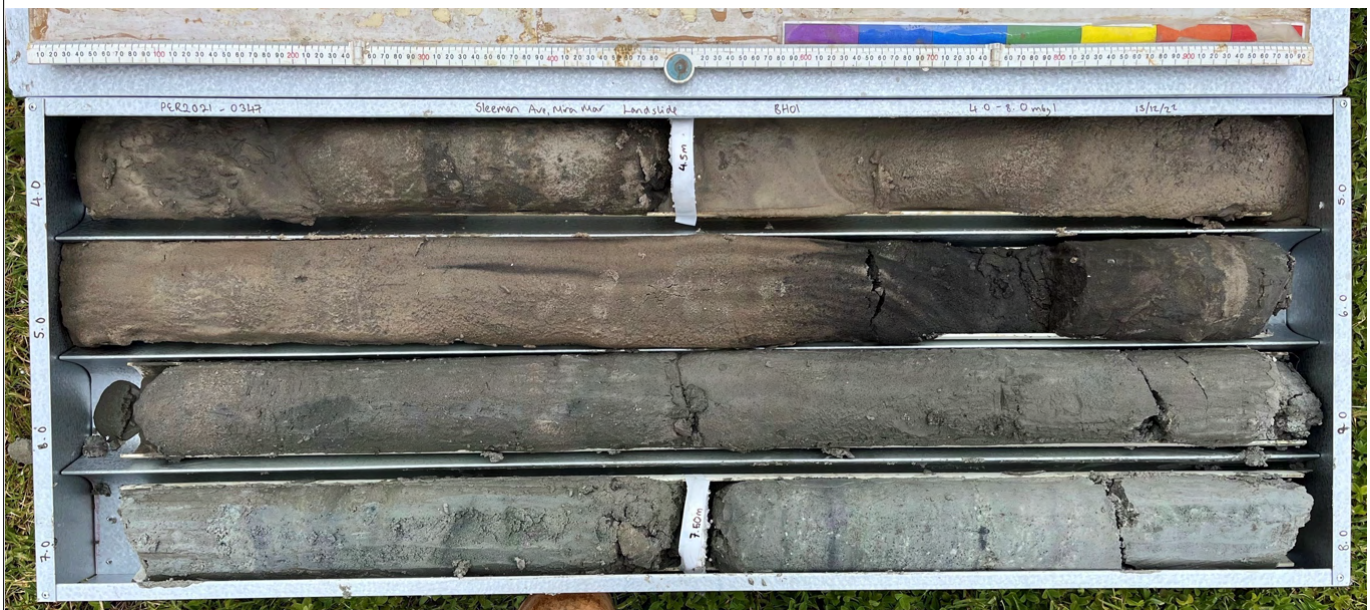
Termination reason: Target depth reached
 Remarks: Vibrating Wire Piezometer at 7.5m, serial number 2206553

CORE PHOTOGRAPH SHEET - BH01

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 13/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH01

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 13/12/2022



Core Tray 3: 08.00m to 12.00m

CORE PHOTOGRAPH SHEET - BH03

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 11/12/2022



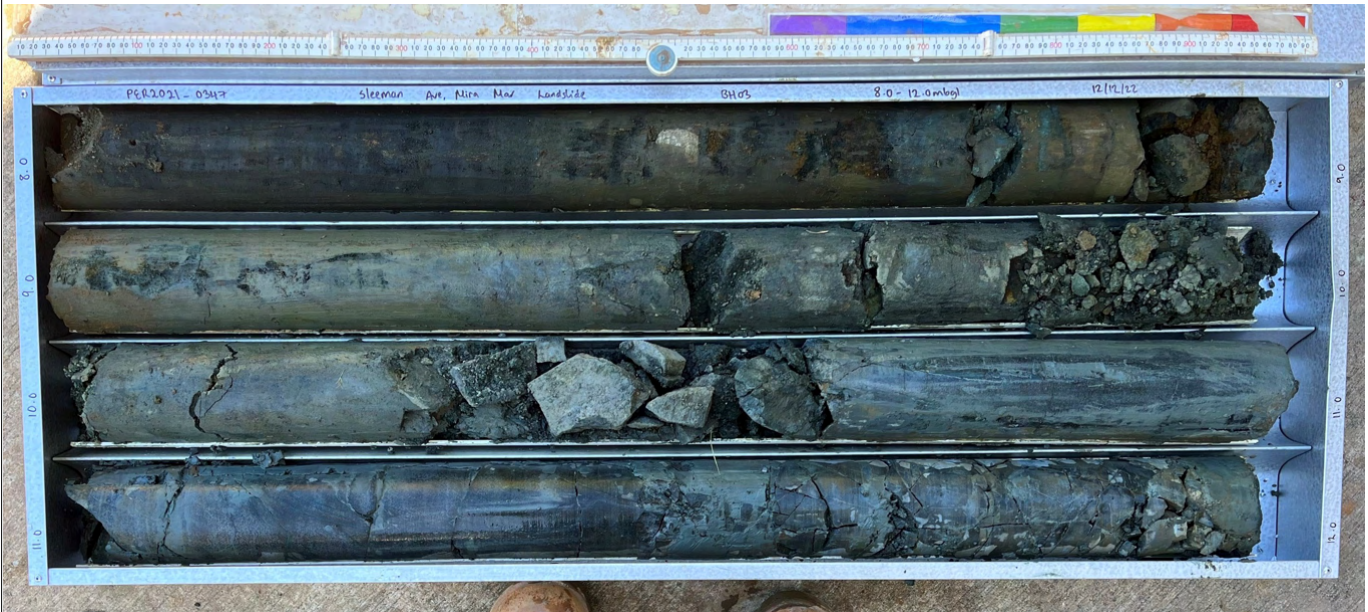
Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH03

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 11/12/2022



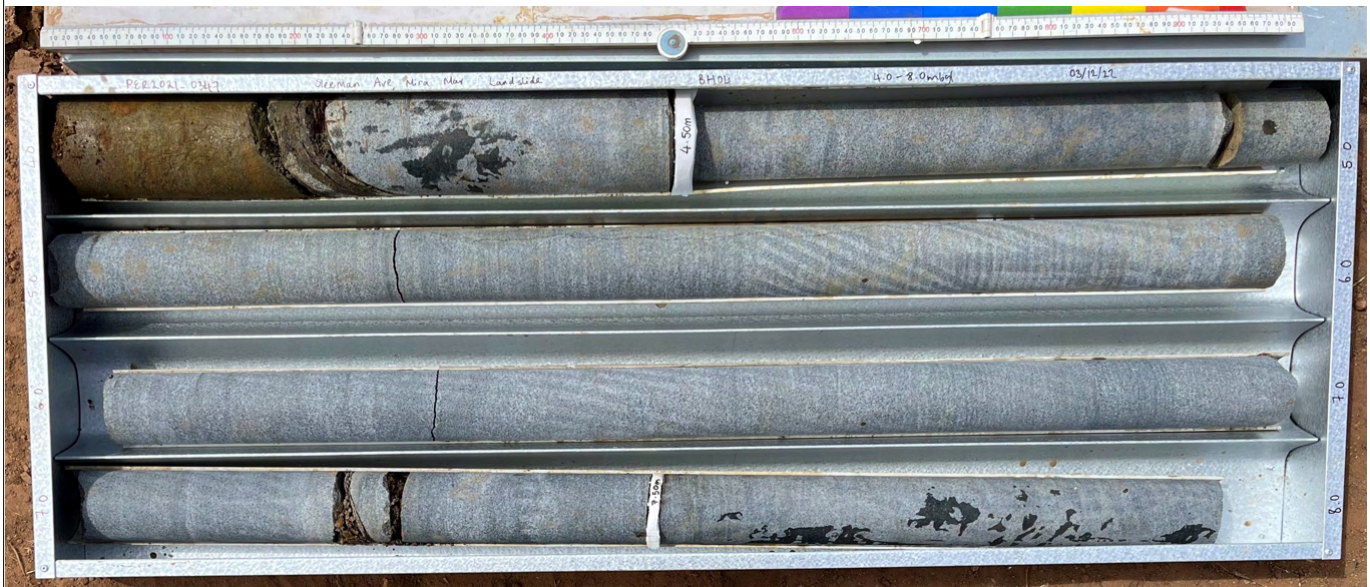
Core Tray 3: 08.00m to 12.00m

CORE PHOTOGRAPH SHEET - BH04

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 02/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH04

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 02/12/2022



Core Tray 3: 08.00m to 10.50m

CORE PHOTOGRAPH SHEET - BH05

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 30/11/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH05

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 30/11/2022



Core Tray 3: 08.00m to 09.00m

CORE PHOTOGRAPH SHEET - BH06

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 29/11/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH06

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 29/11/2022



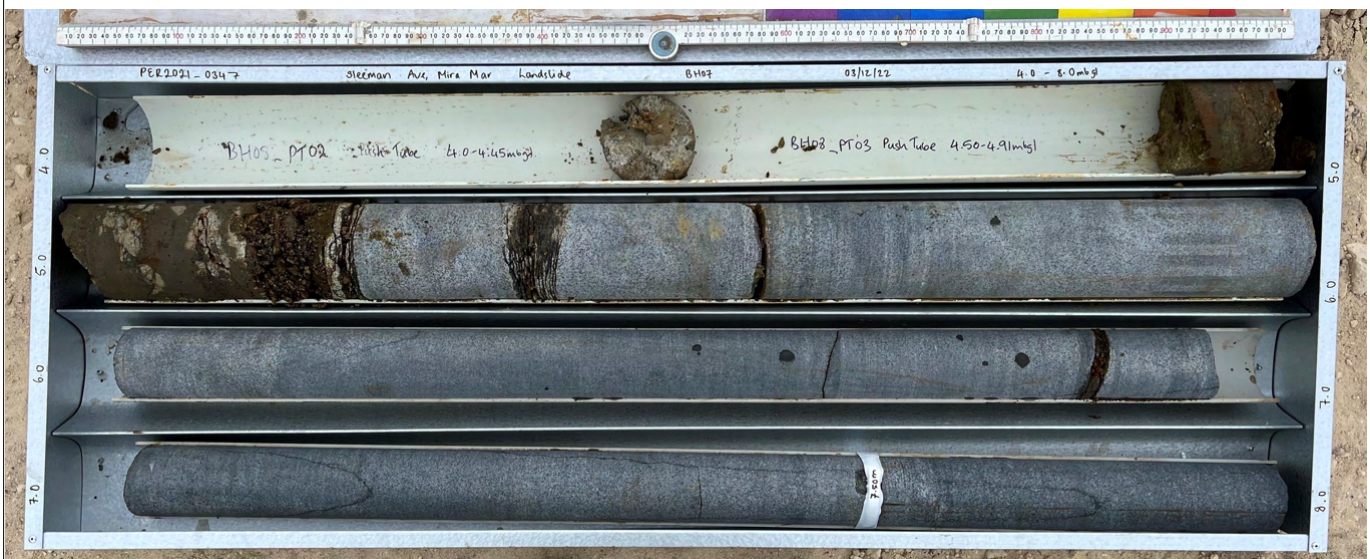
Core Tray 3: 08.00 to 10.50m

CORE PHOTOGRAPH SHEET - BH07

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 03/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH07

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 03/12/2022



Core Tray 3: 08.00m to 10.75m

CORE PHOTOGRAPH SHEET - BH08

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 01/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH08

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 01/12/2022



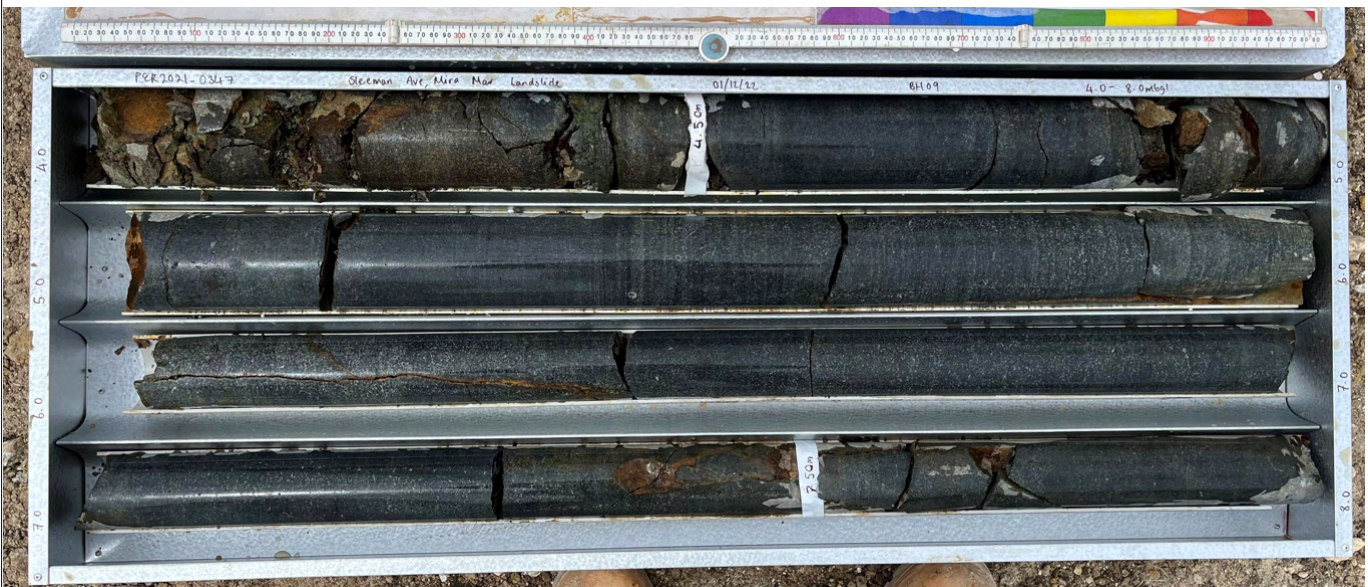
Core Tray 3: 08.00m to 09.00m

CORE PHOTOGRAPH SHEET - BH09

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 30/11/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH09

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 30/11/2022



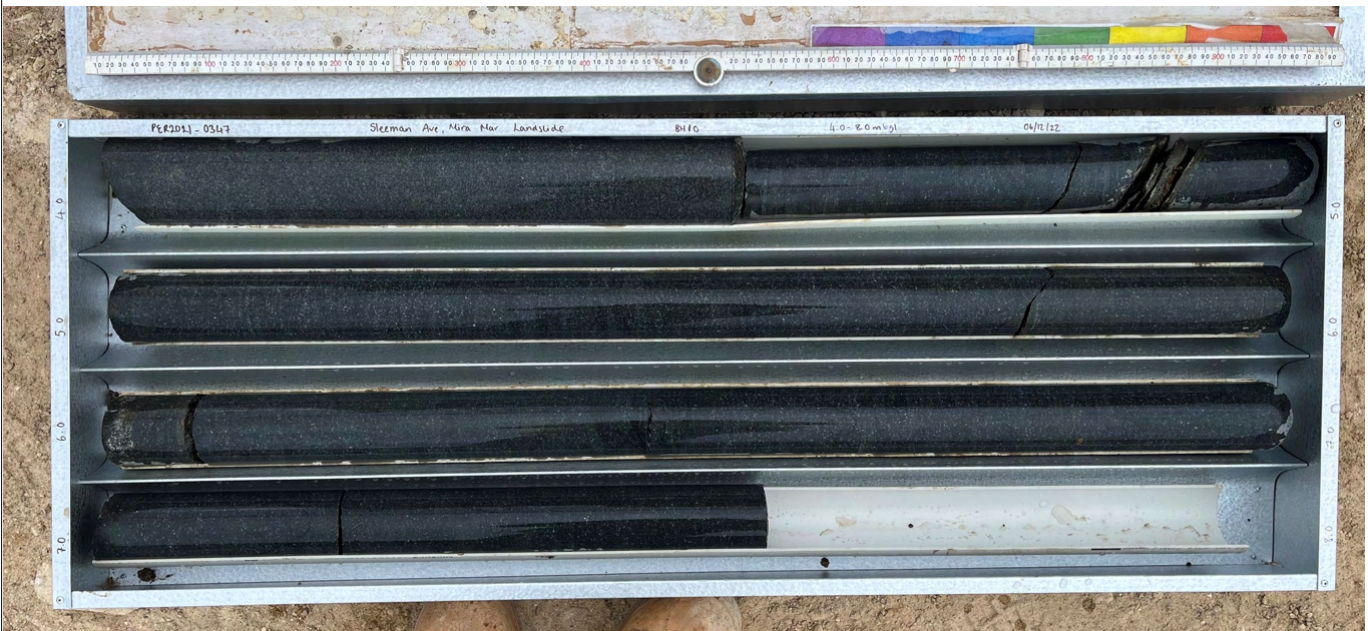
Core Tray 3: 08.00m to 09.00m

CORE PHOTOGRAPH SHEET - BH10

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 06/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 07.50m

CORE PHOTOGRAPH SHEET - BH11

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 05/12/2022



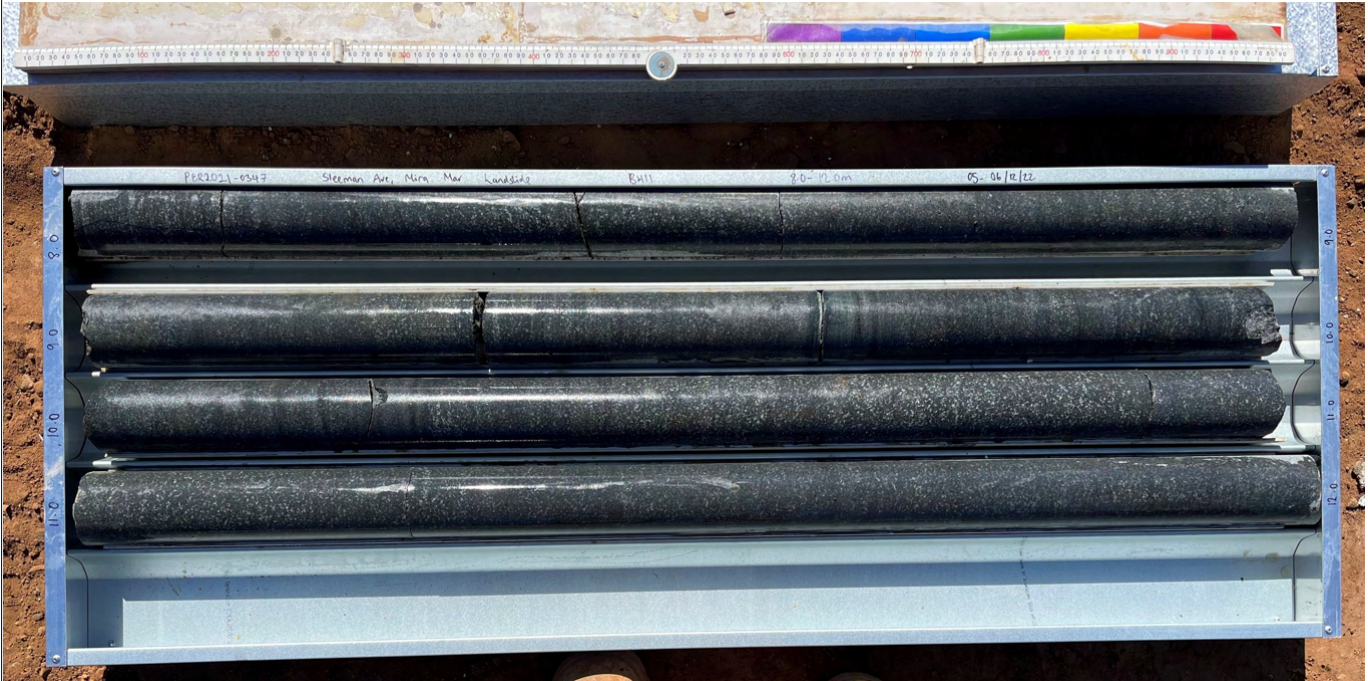
Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH11

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 05/12/2022



Core Tray 3: 08.00m to 12.00m

CORE PHOTOGRAPH SHEET - BH12

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 04/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH12

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 04/12/2022



Core Tray 3: 08.00m to 10.50m

CORE PHOTOGRAPH SHEET - BH13

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 10/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH13

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 10/12/2022



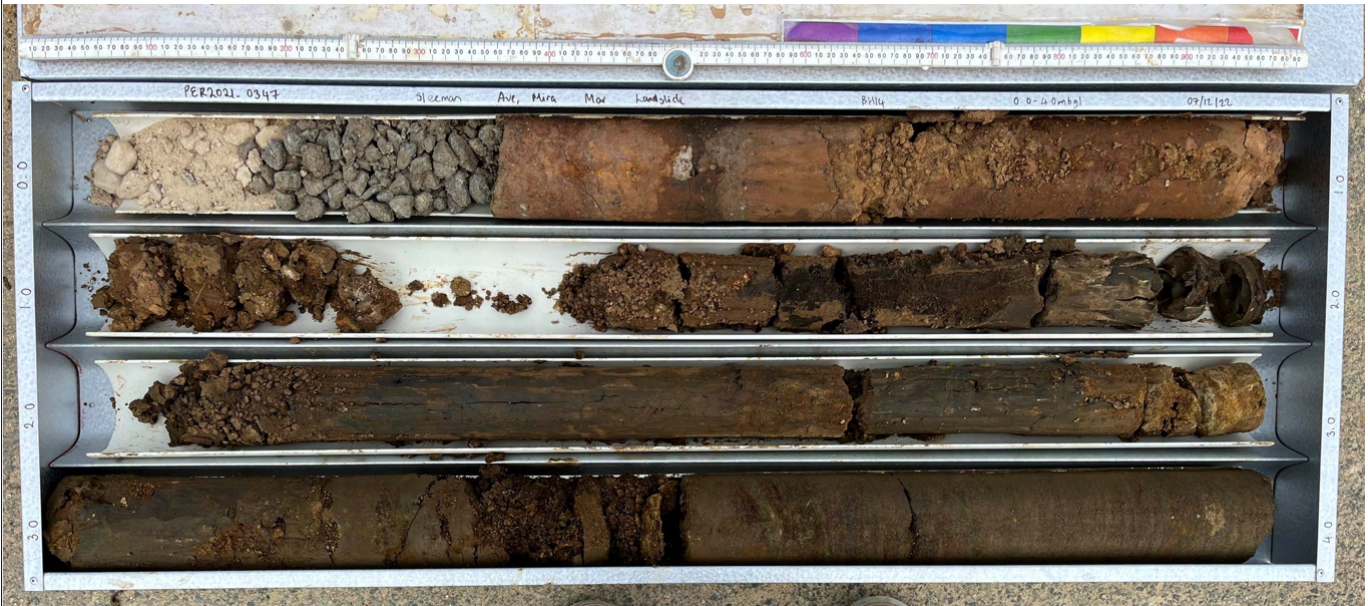
Core Tray 3: 08.00m to 12.00m



Core Tray 4: 08.00m to 13.50m

CORE PHOTOGRAPH SHEET - BH14

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 07/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH14

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 07/12/2022



Core Tray 3: 08.00m to 12.00m

CORE PHOTOGRAPH SHEET - BH15

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 08/12/2022



Core Tray 1: 00.00m to 04.00m



Core Tray 2: 04.00m to 08.00m

CORE PHOTOGRAPH SHEET - BH15

Client: Great Southern Development Commission
Project: Land slip - Mira Mar, Albany, WA
Location: Sleeman Avenue
Project ID: PER2021-0347
Date: 08/12/2022



Core Tray 3: 08.00m to 12.00m

APPENDIX D

Laboratory Test Results

Report No: MAT:MC23-00215-S01


Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



Accredited for compliance with ISO/IEC
 The results in this report relate only to the
 items/samples that were tested.



Signatory: Alex Briggs
 (Laboratory Supervisor)

NATA Accredited
 Laboratory
 Number: 1763

Date of Issue: 21/02/2023

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

Sample ID MC23-00215-S01
Date Sampled 13/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH01 - 2.0m to 2.35m
Sample Location Sleeman Ave
 BH01 - 2.0m to 2.35m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	43	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	27	
Date Tested		8/02/2023	

Comments

N/A

Report No: MAT:MC23-00215-S02

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



Accredited for compliance with ISO/IEC
 The results in this report relate only to the
 items/samples that were tested.



Signatory: Alex Briggs
 (Laboratory Supervisor)
 Date of Issue: 21/02/2023

NATA Accredited
 Laboratory
 Number: 1763

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

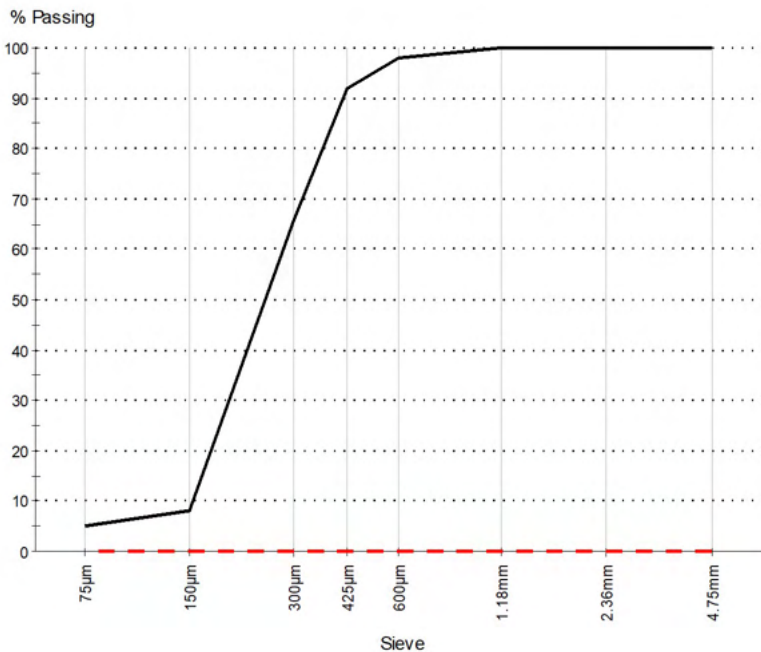
Sample Details

Sample ID MC23-00215-S02
Date Sampled 13/12/2023
Sampling Method Tested as received
Soil Description Sand
Specification AS 1289.3.6.1
Client ID BH01 - 4.0m to 4.3m
Sample Location Sleeman Ave
 BH01 - 4.0m to 4.3m

Other Test Results

Description	Method	Result	Limits
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Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	-
2.36mm	100	-
1.18mm	100	-
600µm	98	-
425µm	92	-
300µm	66	-
150µm	8	-
75µm	5	-

Comments

N/A

Report No: MAT:MC23-00215-S03

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



Accredited for compliance with ISO/IEC
 The results in this report relate only to the
 items/samples that were tested.



Signatory: Alex Briggs
 (Laboratory Supervisor)
 Date of Issue: 21/02/2023

NATA Accredited
 Laboratory
 Number: 1763

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

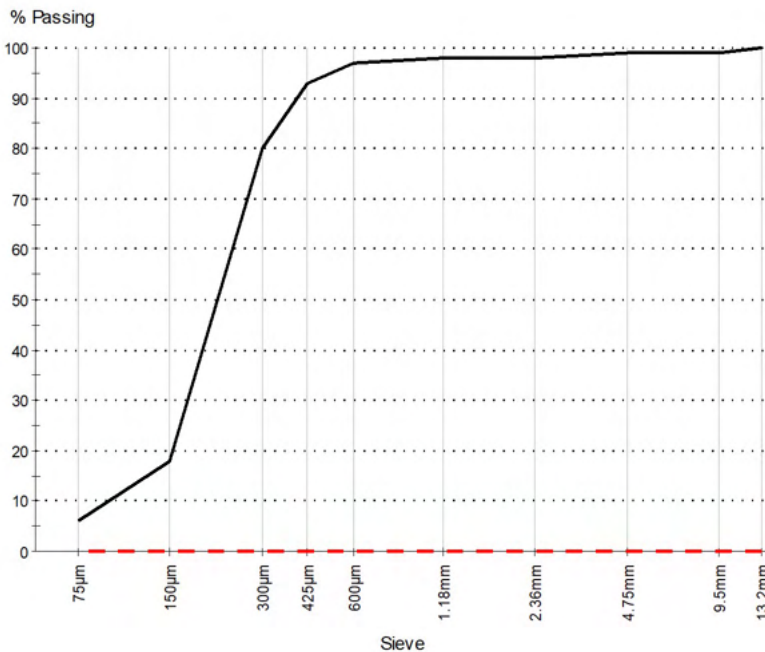
Sample Details

Sample ID MC23-00215-S03
Date Sampled 11/12/2023
Sampling Method Tested as received
Soil Description Sand
Specification AS 1289.3.6.1
Client ID BH03 - 1.0m to 1.45m
Sample Location Sleeman Ave
 BH03 - 1.0m to 1.45m

Other Test Results

Description	Method	Result	Limits
-------------	--------	--------	--------

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	-
9.5mm	99	-
4.75mm	99	-
2.36mm	98	-
1.18mm	98	-
600µm	97	-
425µm	93	-
300µm	80	-
150µm	18	-
75µm	6	-

Comments

N/A

Report No: MAT:MC23-00215-S04


Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



Accredited for compliance with ISO/IEC
 The results in this report relate only to the
 items/samples that were tested.



Signatory: Alex Briggs
 (Laboratory Supervisor)

NATA Accredited
 Laboratory
 Number: 1763

Date of Issue: 21/02/2023

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

Sample ID MC23-00215-S04
Date Sampled 11/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH03 - 2.8m to 3.0m
Sample Location Sleeman Ave
 BH03 - 2.8m to 3.0m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	11.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	64	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	48	
Date Tested		8/02/2023	

Comments

N/A

Report No: MAT:MC23-00215-S05

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
 (Laboratory Supervisor)
 Date of Issue: 21/02/2023

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 Laboratory
 Number: 1763

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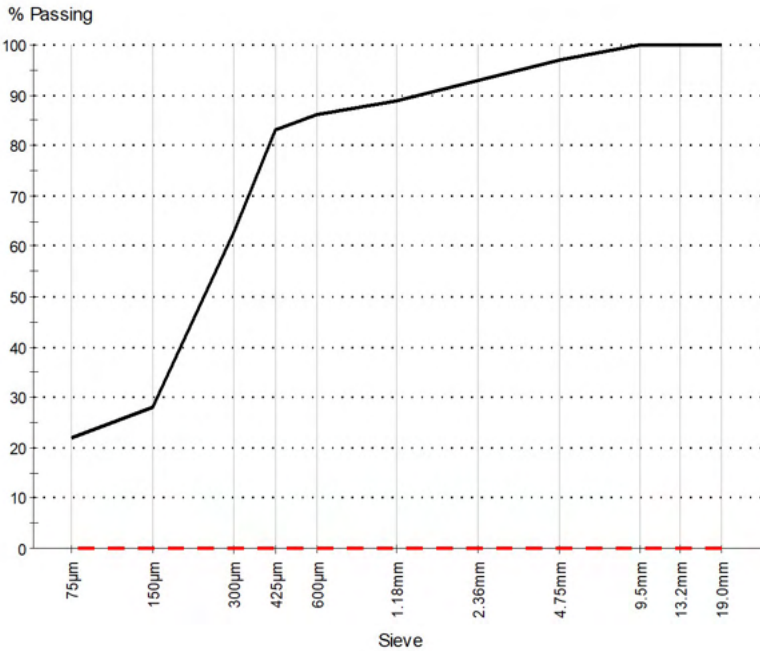
Sample Details

Sample ID MC23-00215-S05
Date Sampled 12/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH03 - 6.0m to 6.4m
Sample Location Sleeman Ave
 BH03 - 6.0m to 6.4m

Other Test Results

Description	Method	Result	Limits
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Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
13.2mm	100	-
9.5mm	100	-
4.75mm	97	-
2.36mm	93	-
1.18mm	89	-
600µm	86	-
425µm	83	-
300µm	63	-
150µm	28	-
75µm	22	-

Comments

N/A

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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Sample Details

Sample ID MC23-00215-S06
Date Sampled 2/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH04 - 2.3m to 2.8m
Sample Location Sleeman Ave
 BH04 - 2.3m to 2.8m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	11.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	73	
Plastic Limit (%)	AS 1289.3.2.1	25	
Plasticity Index (%)	AS 1289.3.3.1	48	
Date Tested		8/02/2023	

Comments

N/A

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Date of Issue: 21/02/2023

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Sample Details

Sample ID MC23-00215-S07
Date Sampled 2/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH04 - 2.8m to 3.0m
Sample Location Sleeman Ave
 BH04 - 2.8m to 3.0m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	20.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	111	
Plastic Limit (%)	AS 1289.3.2.1	25	
Plasticity Index (%)	AS 1289.3.3.1	86	
Date Tested		10/02/2023	

Comments

N/A

Report No: MAT:MC23-00215-S08

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
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 Date of Issue: 21/02/2023

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 Number: 1763

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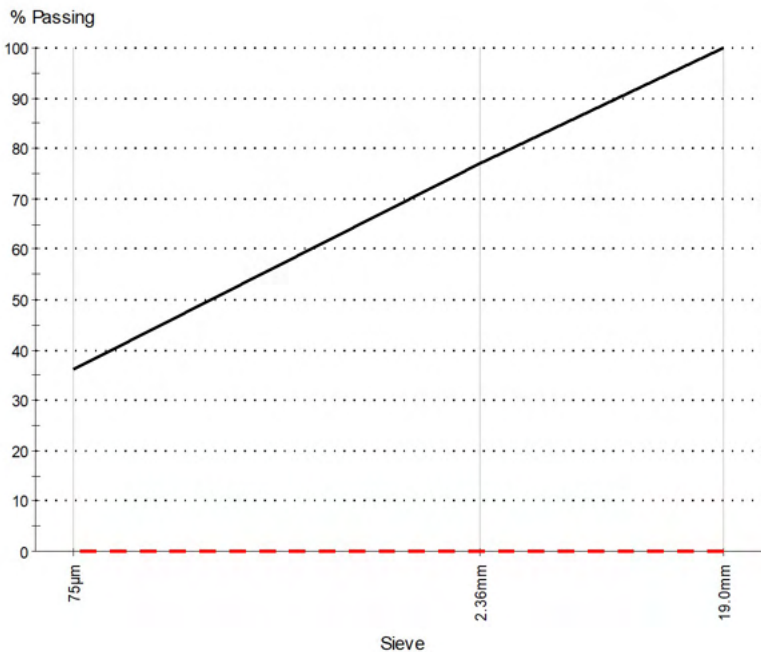
Sample Details

Sample ID MC23-00215-S08
Date Sampled 30/11/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH05 - 2.5m to 2.8m
Sample Location Sleeman Ave
 BH05 - 2.5m to 2.8m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	9.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	56	
Plastic Limit (%)	AS 1289.3.2.1	23	
Plasticity Index (%)	AS 1289.3.3.1	33	
Date Tested		17/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	77	-
75µm	36	-

Comments

N/A

Report No: MAT:MC23-00215-S09

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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 Date of Issue: 21/02/2023

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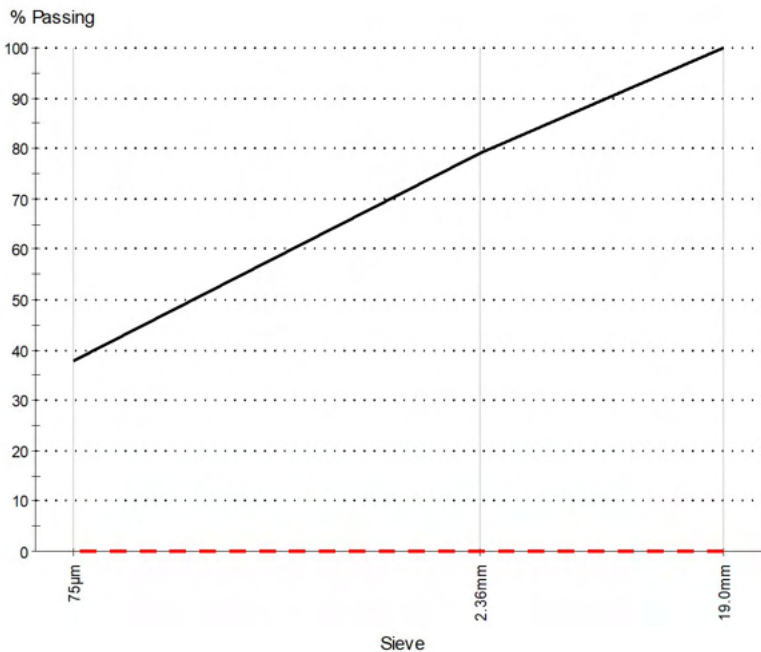
Sample Details

Sample ID MC23-00215-S09
Date Sampled 30/11/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH05 - 2.9m to 3.05m
Sample Location Sleeman Ave
 BH05 - 2.9m to 3.05m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	53	
Plastic Limit (%)	AS 1289.3.2.1	22	
Plasticity Index (%)	AS 1289.3.3.1	31	
Date Tested		17/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	79	-
75µm	38	-

Comments

N/A

Report No: MAT:MC23-00215-S10

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
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 Number: 1763

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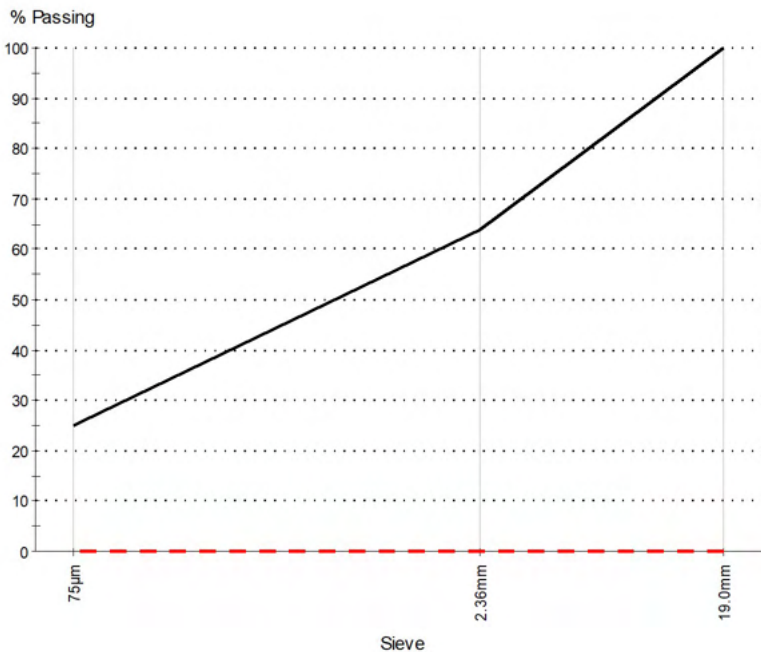
Sample Details

Sample ID MC23-00215-S10
Date Sampled 30/11/2023
Sampling Method Tested as received
Soil Description Sand
Specification AS 1289.3.6.1 % Fines
Client ID BH05 - 3.3m to 3.6m
Sample Location Sleeman Ave
 BH05 - 3.3m to 3.6m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	3.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	43	
Plastic Limit (%)	AS 1289.3.2.1	28	
Plasticity Index (%)	AS 1289.3.3.1	15	
Date Tested		10/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	64	-
75µm	25	-

Comments

N/A

Report No: MAT:MC23-00215-S11

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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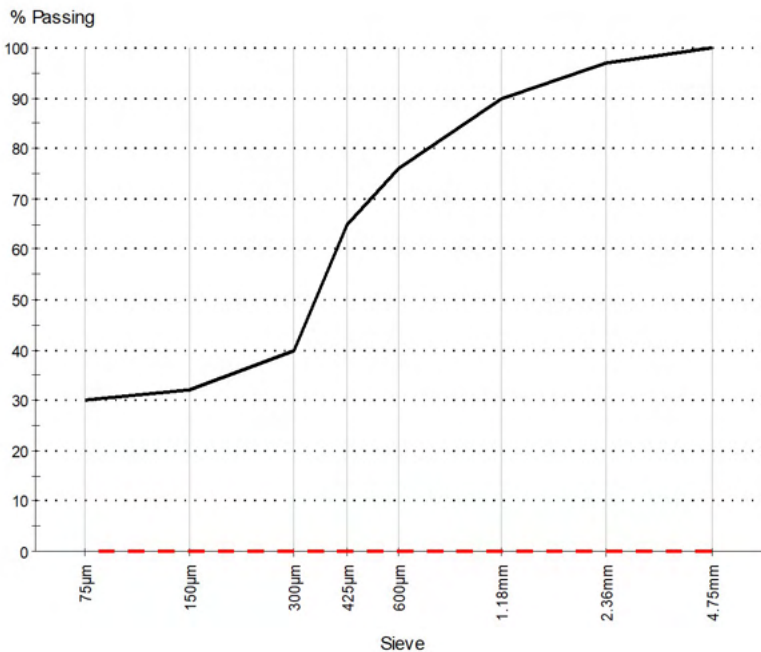
Sample Details

Sample ID MC23-00215-S11
Date Sampled 29/11/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH06 - 3.9m to 4.0m
Sample Location Sleeman Ave
 BH06 - 3.9m to 4.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	3.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	37	
Plastic Limit (%)	AS 1289.3.2.1	26	
Plasticity Index (%)	AS 1289.3.3.1	11	
Date Tested		17/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	-
2.36mm	97	-
1.18mm	90	-
600µm	76	-
425µm	65	-
300µm	40	-
150µm	32	-
75µm	30	-

Comments

N/A

Report No: MAT:MC23-00216-S01

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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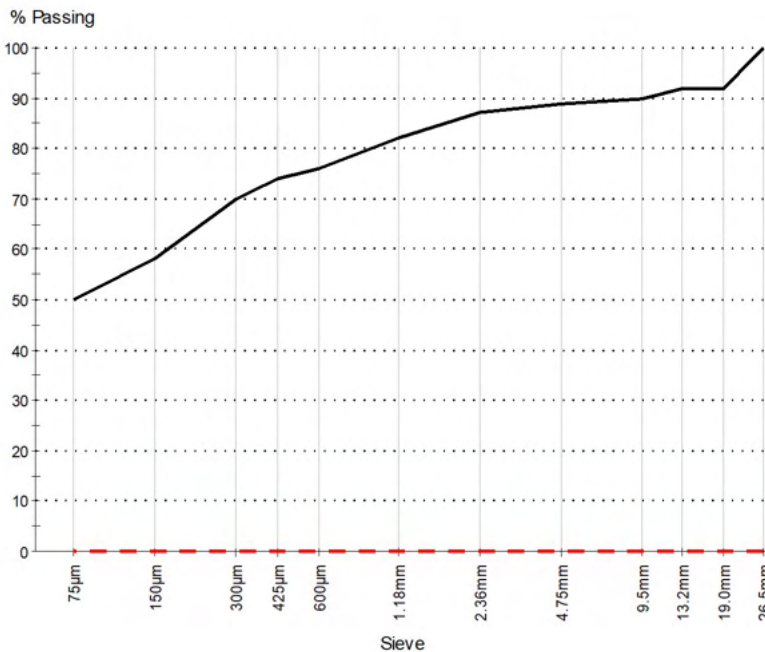
Sample Details

Sample ID MC23-00216-S01
Date Sampled 29/11/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH06 - 4.0m to 4.2m
Sample Location Sleeman Ave
 BH06 - 4.0m to 4.2m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	58	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	42	
Date Tested		22/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
26.5mm	100	-
19.0mm	92	-
13.2mm	92	-
9.5mm	90	-
4.75mm	89	-
2.36mm	87	-
1.18mm	82	-
600µm	76	-
425µm	74	-
300µm	70	-
150µm	58	-
75µm	50	-

Comments

N/A

Report No: MAT:MC23-00216-S02

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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 (Laboratory Supervisor)
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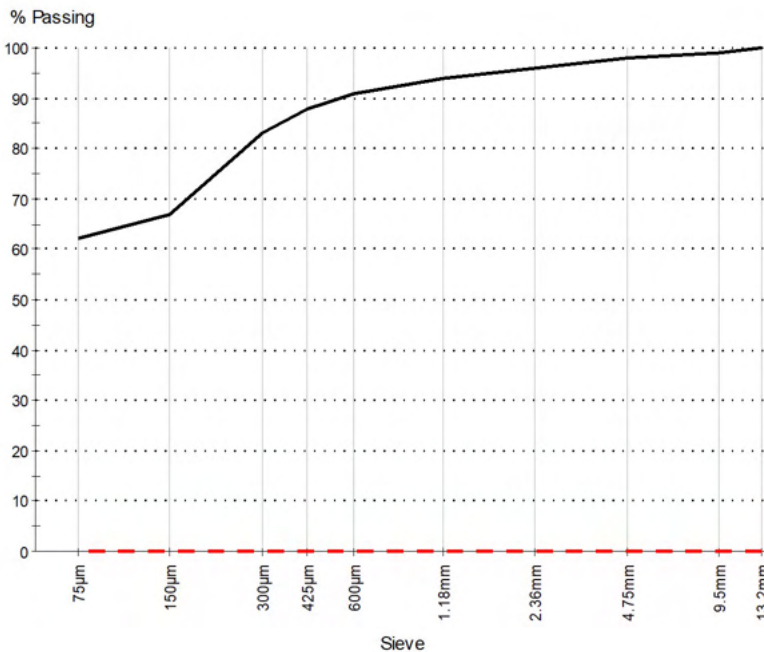
Sample Details

Sample ID MC23-00216-S02
Date Sampled 29/11/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH06 - 4.8m to 5.0m
Sample Location Sleeman Ave
 BH06 - 4.8m to 5.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	15.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	80	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	61	
Date Tested		16/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
13.2mm	100	-
9.5mm	99	-
4.75mm	98	-
2.36mm	96	-
1.18mm	94	-
600µm	91	-
425µm	88	-
300µm	83	-
150µm	67	-
75µm	62	-

Comments

N/A

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Sample Details

Sample ID MC23-00216-S03
Date Sampled 29/11/2023
Sampling Method Tested as received
Soil Description Clay
Client ID BH06 - 5.2m to 5.5m
Sample Location Sleeman Ave
 BH06 - 5.2m to 5.5m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	50	
Plastic Limit (%)	AS 1289.3.2.1	18	
Plasticity Index (%)	AS 1289.3.3.1	32	
Date Tested		18/02/2023	

Comments

N/A

Report No: MAT:MC23-00216-S04

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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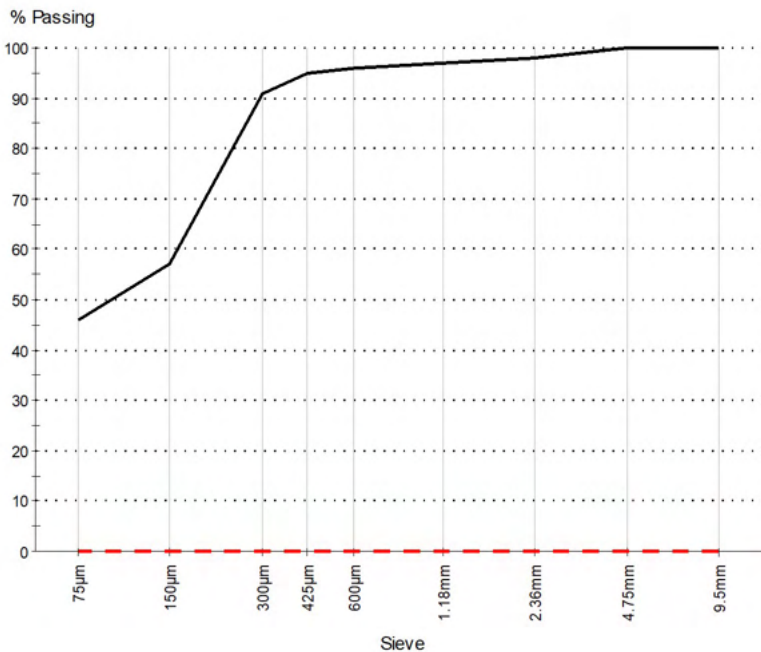
Sample Details

Sample ID MC23-00216-S04
Date Sampled 3/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH07 - 2.7m to 3.0m
Sample Location Sleeman Ave
 BH07 - 2.7m to 3.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	59	
Plastic Limit (%)	AS 1289.3.2.1	22	
Plasticity Index (%)	AS 1289.3.3.1	37	
Date Tested		18/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 8/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
9.5mm	100	-
4.75mm	100	-
2.36mm	98	-
1.18mm	97	-
600µm	96	-
425µm	95	-
300µm	91	-
150µm	57	-
75µm	46	-

Comments

N/A

Report No: MAT:MC23-00216-S05

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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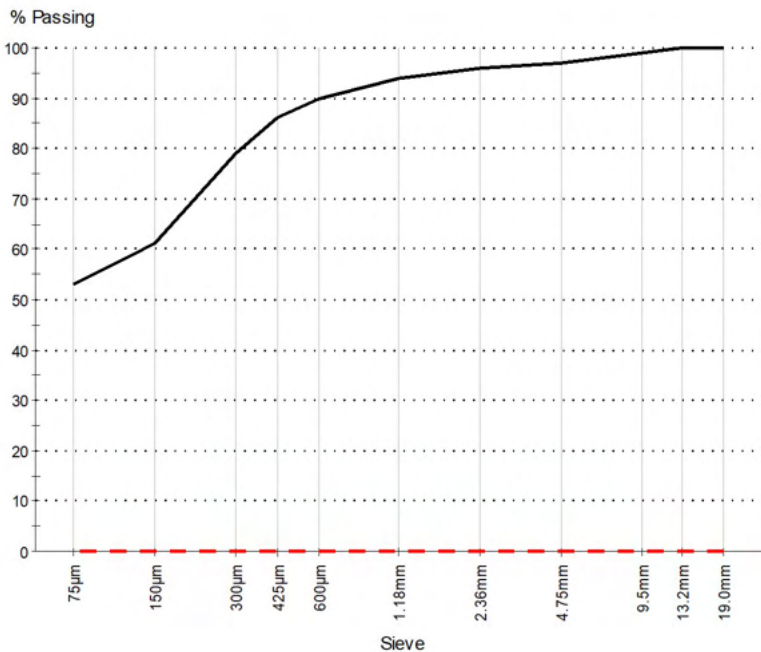
Sample Details

Sample ID MC23-00216-S05
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH08 - 0.7m to 1.0m
Sample Location Sleeman Ave
 BH08 - 0.7m to 1.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	53	
Plastic Limit (%)	AS 1289.3.2.1	20	
Plasticity Index (%)	AS 1289.3.3.1	33	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
13.2mm	100	-
9.5mm	99	-
4.75mm	97	-
2.36mm	96	-
1.18mm	94	-
600µm	90	-
425µm	86	-
300µm	79	-
150µm	61	-
75µm	53	-

Comments

N/A

Report No: MAT:MC23-00216-S06

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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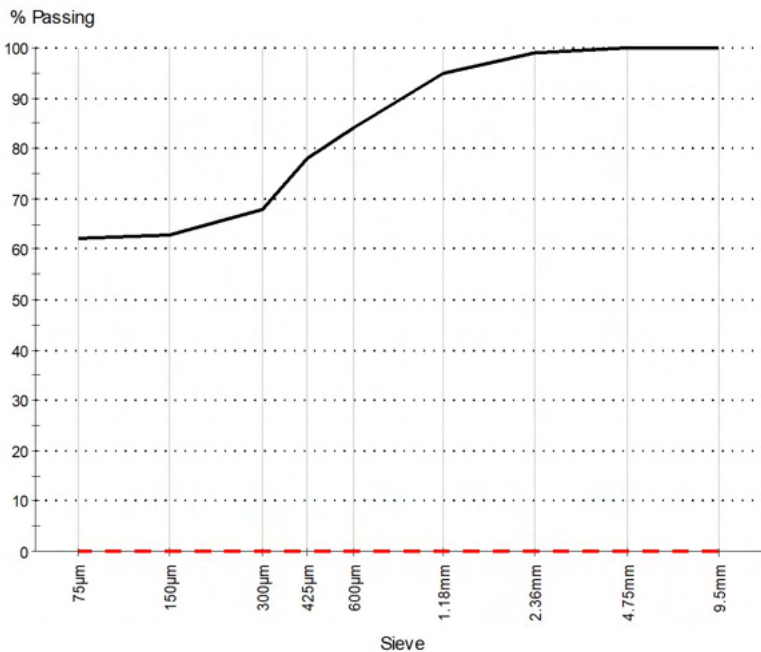
Sample Details

Sample ID MC23-00216-S06
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH08 - 1.3m to 1.5m
Sample Location Sleeman Ave
 BH08 - 1.3m to 1.5m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	62	
Plastic Limit (%)	AS 1289.3.2.1	29	
Plasticity Index (%)	AS 1289.3.3.1	33	
Date Tested		17/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
9.5mm	100	-
4.75mm	100	-
2.36mm	99	-
1.18mm	95	-
600µm	84	-
425µm	78	-
300µm	68	-
150µm	63	-
75µm	62	-

Comments

N/A

Report No: MAT:MC23-00216-S07

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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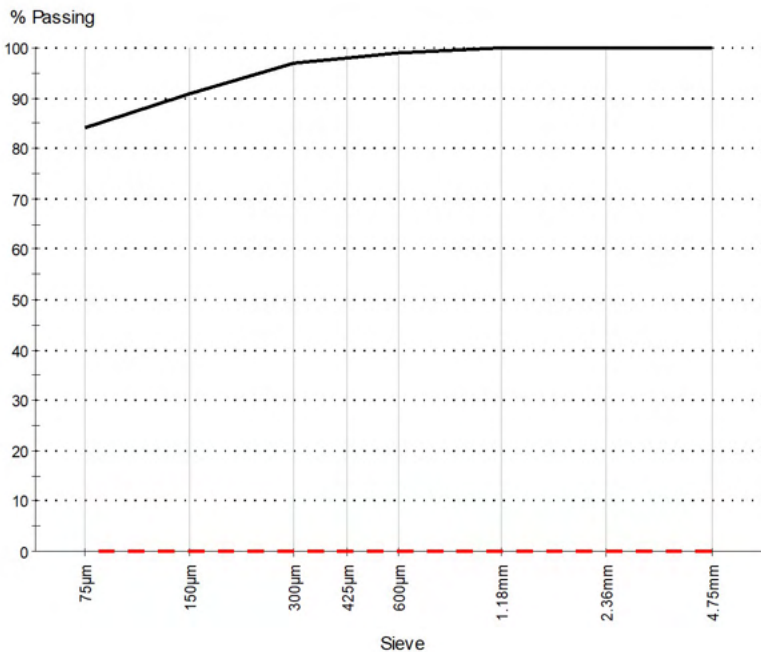
Sample Details

Sample ID MC23-00216-S07
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH08 - 2.5m to 2.65m
Sample Location Sleeman Ave
 BH08 - 2.5m to 2.65m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	7.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	57	
Plastic Limit (%)	AS 1289.3.2.1	29	
Plasticity Index (%)	AS 1289.3.3.1	28	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 15/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	-
2.36mm	100	-
1.18mm	100	-
600µm	99	-
425µm	98	-
300µm	97	-
150µm	91	-
75µm	84	-

Comments


N/A

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Date of Issue: 24/02/2023

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Sample Details

Sample ID MC23-00216-S08
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Client ID BH08 - 4.5m to 4.75m
Sample Location Sleeman Ave
 BH08 - 4.5m to 4.75m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		254	
Crumbling		No	
Curling		Yes	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	64	
Plastic Limit (%)	AS 1289.3.2.1	24	
Plasticity Index (%)	AS 1289.3.3.1	40	
Date Tested		21/02/2023	

Comments

N/A

Report No: MAT:MC23-00216-S09

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Sample Details

Sample ID MC23-00216-S09
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Client ID BH08 - 2.8m to 3.0m
Sample Location Sleeman Ave
 BH08 - 2.8m to 3.0m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	74	
Plastic Limit (%)	AS 1289.3.2.1	31	
Plasticity Index (%)	AS 1289.3.3.1	43	
Date Tested		22/02/2023	

Comments

N/A

Report No: MAT:MC23-00216-S10

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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Sample Details

Sample ID MC23-00216-S10
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Client ID BH08 - 4.1m to 4.3m
Sample Location Sleeman Ave
 BH08 - 4.1m to 4.3m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	16.0	
Mould Length (mm)		254	
Crumbling		No	
Curling		Yes	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	89	
Plastic Limit (%)	AS 1289.3.2.1	28	
Plasticity Index (%)	AS 1289.3.3.1	61	
Date Tested		18/02/2023	

Comments


N/A

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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Sample Details

Sample ID MC23-00216-S11
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Client ID BH08 - 4.3m to 4.5m
Sample Location Sleeman Ave
 BH08 - 4.3m to 4.5m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	16.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	86	
Plastic Limit (%)	AS 1289.3.2.1	26	
Plasticity Index (%)	AS 1289.3.3.1	60	
Date Tested		18/02/2023	

Comments

N/A

Report No: MAT:MC23-00220-S01


Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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Sample Details

Sample ID MC23-00220-S01
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Client ID BH09 - 1.2m to 1.5m
Sample Location Sleeman Ave
 BH09 - 1.2m to 1.5m

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	19.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	110	
Plastic Limit (%)	AS 1289.3.2.1	24	
Plasticity Index (%)	AS 1289.3.3.1	86	
Date Tested		23/02/2023	

Comments

N/A

Report No: MAT:MC23-00220-S02

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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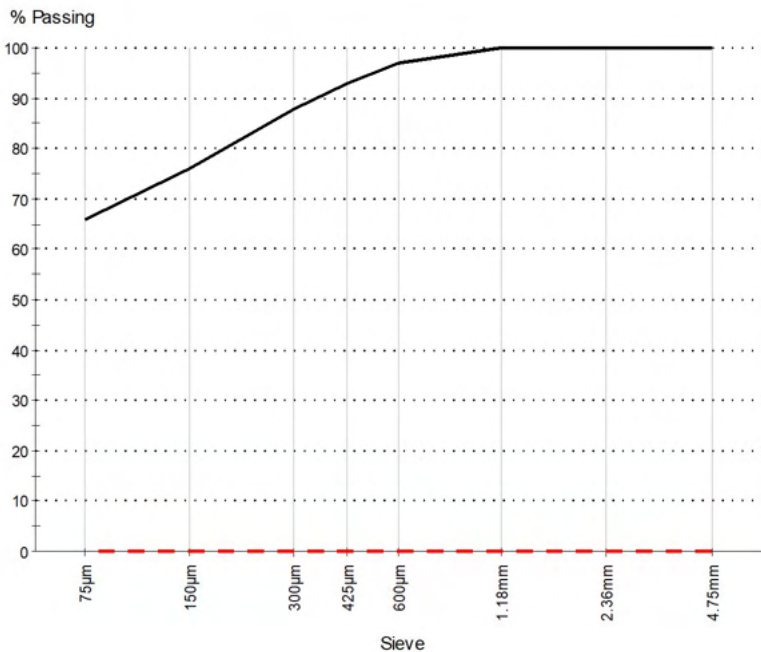
Sample Details

Sample ID MC23-00220-S02
Date Sampled 1/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH09 - 2.4m to 2.65m
Sample Location Sleeman Ave
 BH09 - 2.4m to 2.65m

Other Test Results

Description	Method	Result	Limits
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Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 15/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	-
2.36mm	100	-
1.18mm	100	-
600µm	97	-
425µm	93	-
300µm	88	-
150µm	76	-
75µm	66	-

Comments

N/A

Report No: MAT:MC23-00220-S03

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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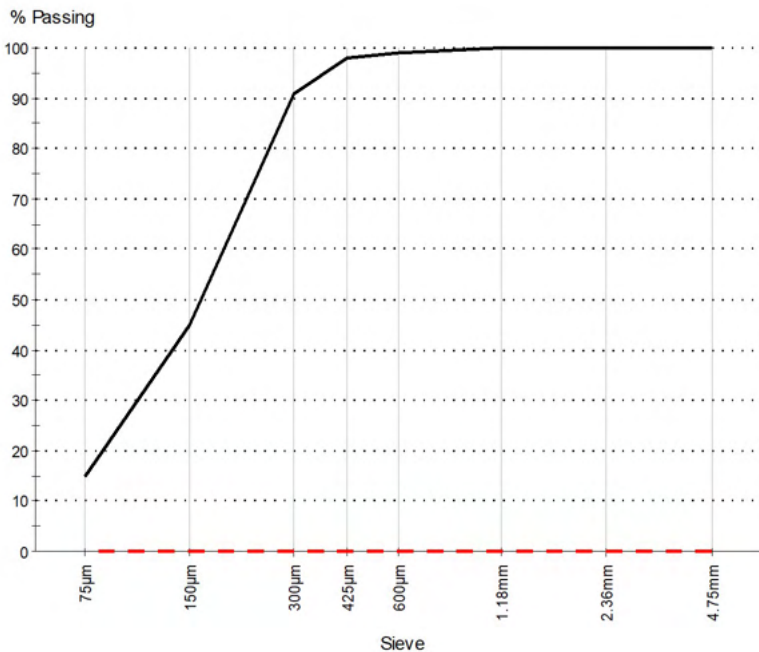
Sample Details

Sample ID MC23-00220-S03
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Sand
Specification AS 1289.3.6.1
Client ID BH11 - 0.5m to 0.8m
Sample Location Sleeman Ave
 BH11 - 0.5m to 0.8m

Other Test Results

Description	Method	Result	Limits
Organic Matter (%)	AS 1289.4.1.1	0.6	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	-
2.36mm	100	-
1.18mm	100	-
600µm	99	-
425µm	98	-
300µm	91	-
150µm	45	-
75µm	15	-

Comments

N/A

Report No: MAT:MC23-00220-S04


Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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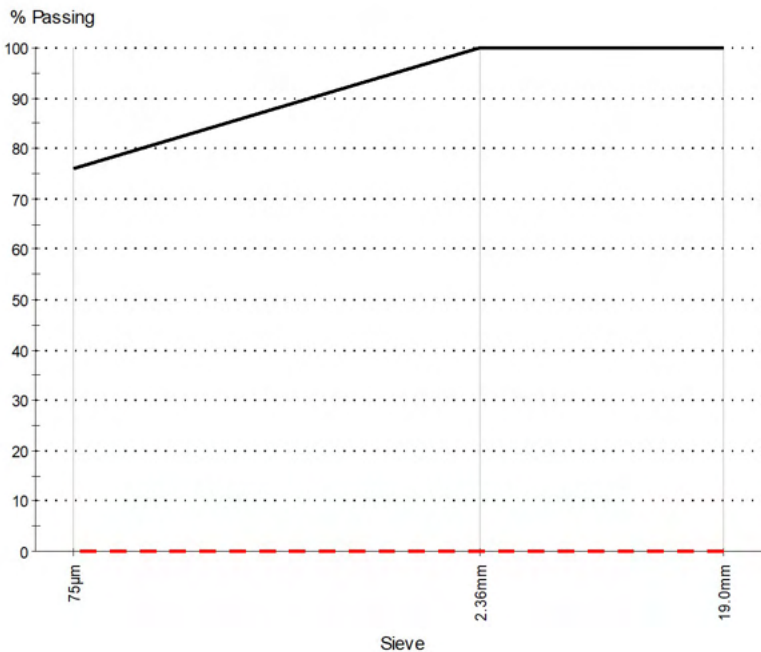
Sample Details

Sample ID MC23-00220-S04
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 1.7m to 1.9m
Sample Location Sleeman Ave
 BH11 - 1.7m to 1.9m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	12.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	68	
Plastic Limit (%)	AS 1289.3.2.1	28	
Plasticity Index (%)	AS 1289.3.3.1	40	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	76	-

Comments

N/A

Report No: MAT:MC23-00220-S05

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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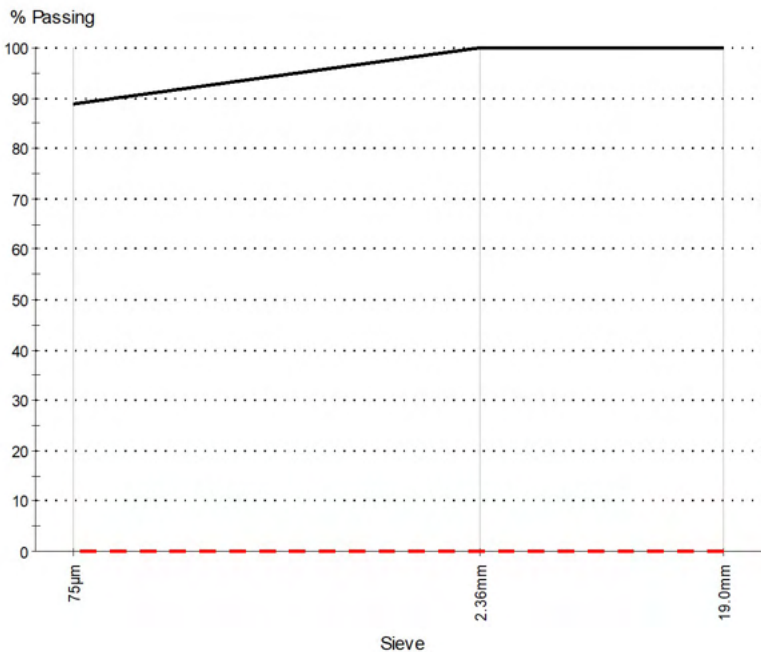
Sample Details

Sample ID MC23-00220-S05
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 1.9m to 2.2m
Sample Location Sleeman Ave
 BH11 - 1.9m to 2.2m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	85	
Plastic Limit (%)	AS 1289.3.2.1	36	
Plasticity Index (%)	AS 1289.3.3.1	49	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	89	-

Comments

N/A

Report No: MAT:MC23-00220-S06

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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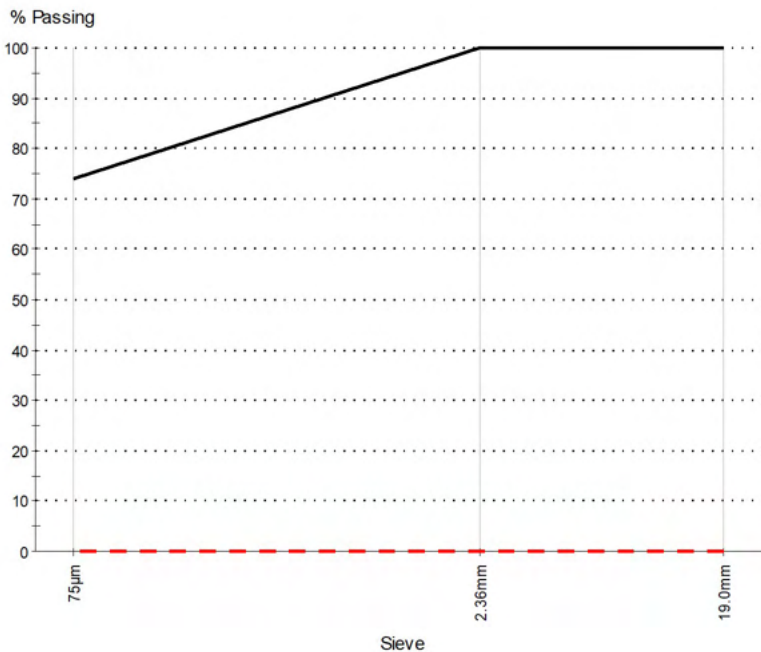
Sample Details

Sample ID MC23-00220-S06
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 2.2m to 2.4m
Sample Location Sleeman Ave
 BH11 - 2.2m to 2.4m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	9.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	51	
Plastic Limit (%)	AS 1289.3.2.1	21	
Plasticity Index (%)	AS 1289.3.3.1	30	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	74	-

Comments

N/A

Report No: MAT:MC23-00220-S07

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
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Project: PER2021-0347: Mira Mar, Albany Landslide



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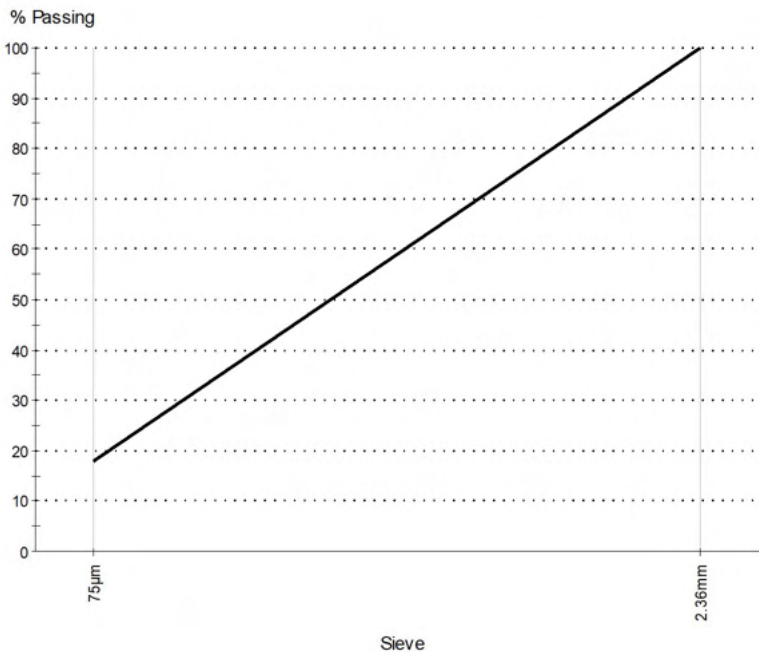
Sample Details

Sample ID MC23-00220-S07
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Silt
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 2.4m to 2.6m
Sample Location Sleeman Ave
 BH11 - 2.4m to 2.6m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	N/A	
Plastic Limit (%)	AS 1289.3.2.1	NP	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Date Tested		22/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
2.36mm	100	
75µm	18	-

Comments

NP = Non Plastic

Report No: MAT:MC23-00220-S08

Issue No: 1

Material Test Report

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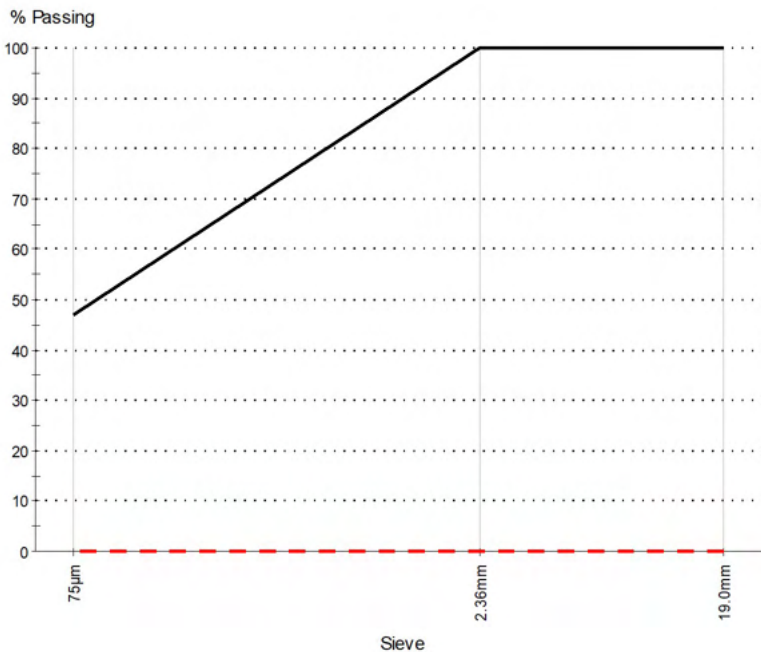
Sample Details

Sample ID MC23-00220-S08
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 2.6m to 2.8m
Sample Location Sleeman Ave
 BH11 - 2.6m to 2.8m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	7.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	35	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	18	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	47	-

Comments

N/A

Report No: MAT:MC23-00220-S09

Issue No: 1

Material Test Report

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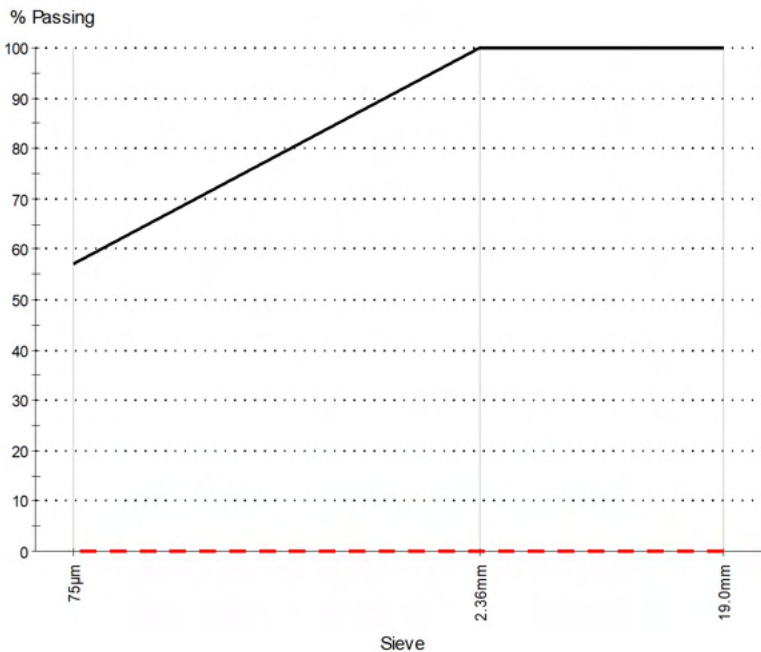
Sample Details

Sample ID MC23-00220-S09
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 5.1m to 5.25m
Sample Location Sleeman Ave
 BH11 - 5.1m to 5.25m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	8.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	46	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	27	
Date Tested		22/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	57	-

Comments

N/A

Report No: MAT:MC23-00220-S10


Issue No: 1

Material Test Report

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Project: PER2021-0347: Mira Mar, Albany Landslide



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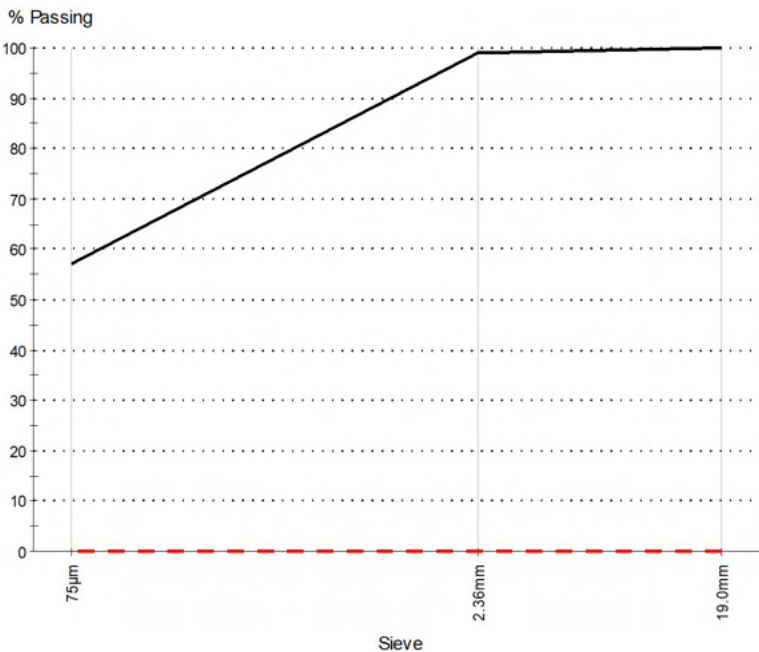
Sample Details

Sample ID MC23-00220-S10
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 5.25m to 5.4m
Sample Location Sleeman Ave
 BH11 - 5.25m to 5.4m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	57	
Plastic Limit (%)	AS 1289.3.2.1	25	
Plasticity Index (%)	AS 1289.3.3.1	32	
Date Tested		22/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	99	-
75µm	57	-

Comments

N/A

Report No: MAT:MC23-00220-S11


Issue No: 1

Material Test Report

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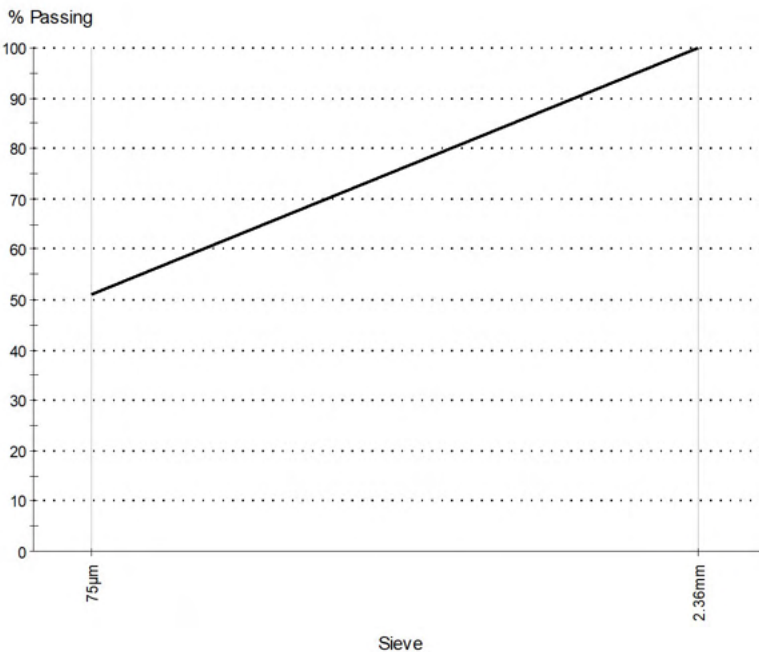
Sample Details

Sample ID MC23-00220-S11
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 5.5m to 5.7m
Sample Location Sleeman Ave
 BH11 - 5.5m to 5.7m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	7.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	48	
Plastic Limit (%)	AS 1289.3.2.1	20	
Plasticity Index (%)	AS 1289.3.3.1	28	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Natural
Date Tested: 16/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
2.36mm	100	
75µm	51	-

Comments

N/A

Report No: MAT:MC23-00221-S01

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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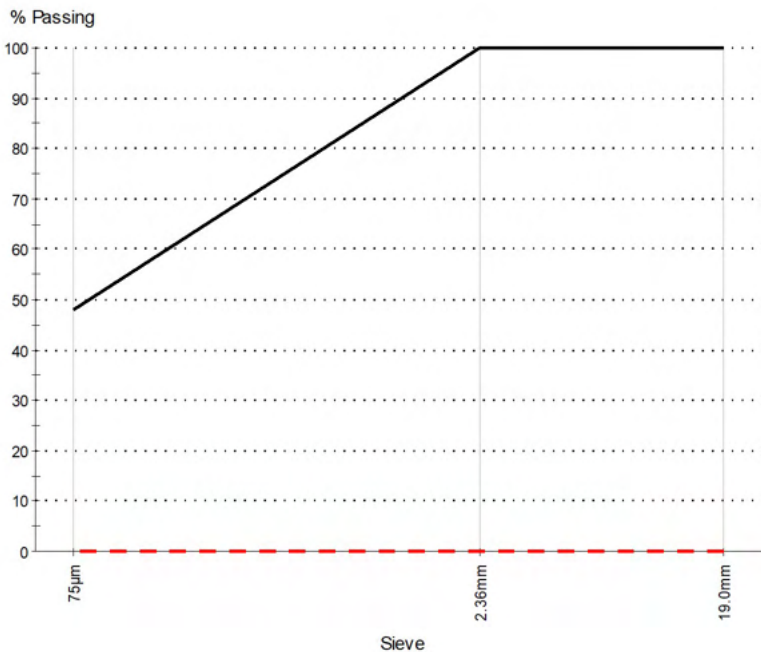
Sample Details

Sample ID MC23-00221-S01
Date Sampled 6/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH11 - 6 6m to .15m
Sample Location Sleeman Ave
 BH11 - 6 6m to .15m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	11.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	43	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	24	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	48	-

Comments

N/A

Report No: MAT:MC23-00221-S02

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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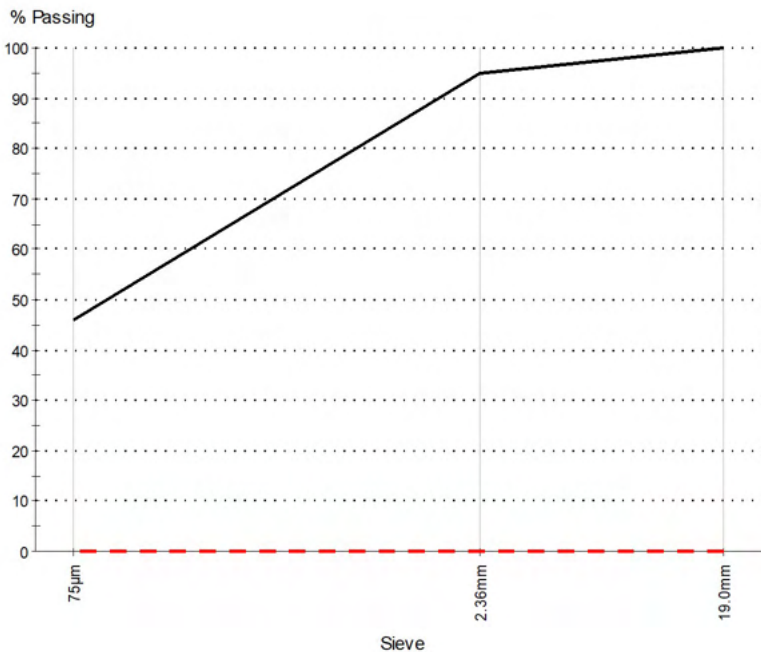
Sample Details

Sample ID MC23-00221-S02
Date Sampled 4/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH12 - 1.5m to 1.7m
Sample Location Sleeman Ave
 BH12 - 1.5m to 1.7m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	8.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	45	
Plastic Limit (%)	AS 1289.3.2.1	21	
Plasticity Index (%)	AS 1289.3.3.1	24	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	95	-
75µm	46	-

Comments

N/A

Report No: MAT:MC23-00221-S03

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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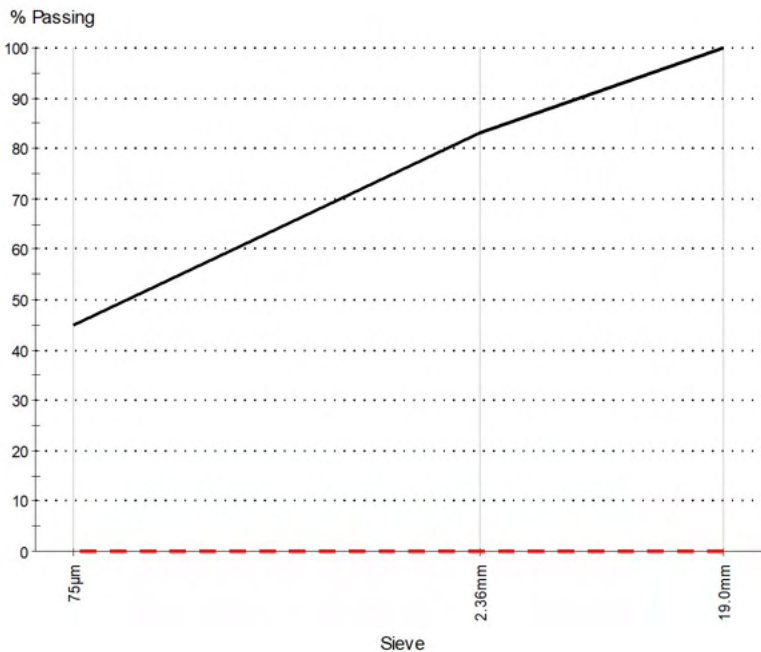
Sample Details

Sample ID MC23-00221-S03
Date Sampled 4/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH12 - 2.6 to 3.0m
Sample Location Sleeman Ave
 BH12 - 2.6 to 3.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	9.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	53	
Plastic Limit (%)	AS 1289.3.2.1	23	
Plasticity Index (%)	AS 1289.3.3.1	30	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	83	-
75µm	45	-

Comments

N/A

Report No: MAT:MC23-00221-S04


Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
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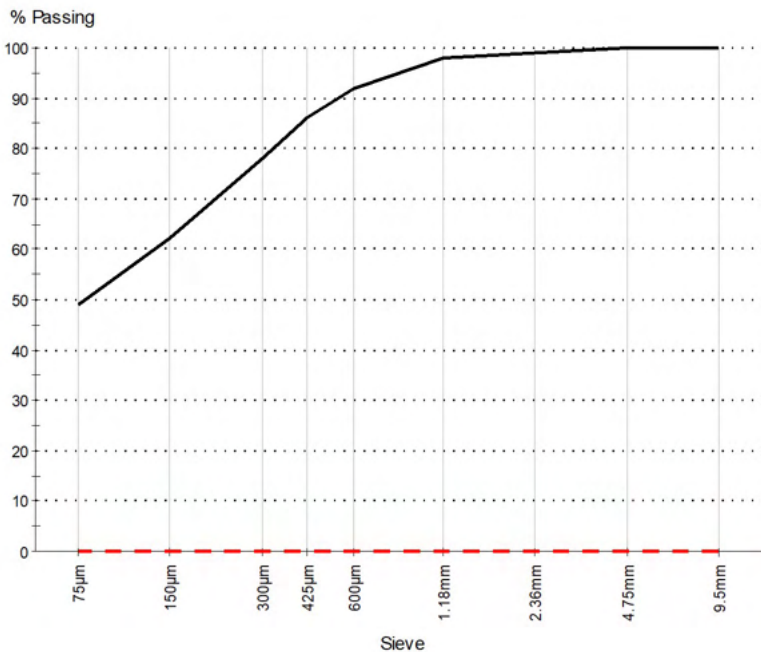
Sample Details

Sample ID MC23-00221-S04
Date Sampled 4/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH12 - 3.7m to 4.0m
Sample Location Sleeman Ave
 BH12 - 3.7m to 4.0m

Other Test Results

Description	Method	Result	Limits
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Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
9.5mm	100	-
4.75mm	100	-
2.36mm	99	-
1.18mm	98	-
600µm	92	-
425µm	86	-
300µm	78	-
150µm	62	-
75µm	49	-

Comments

N/A

Report No: MAT:MC23-00221-S05

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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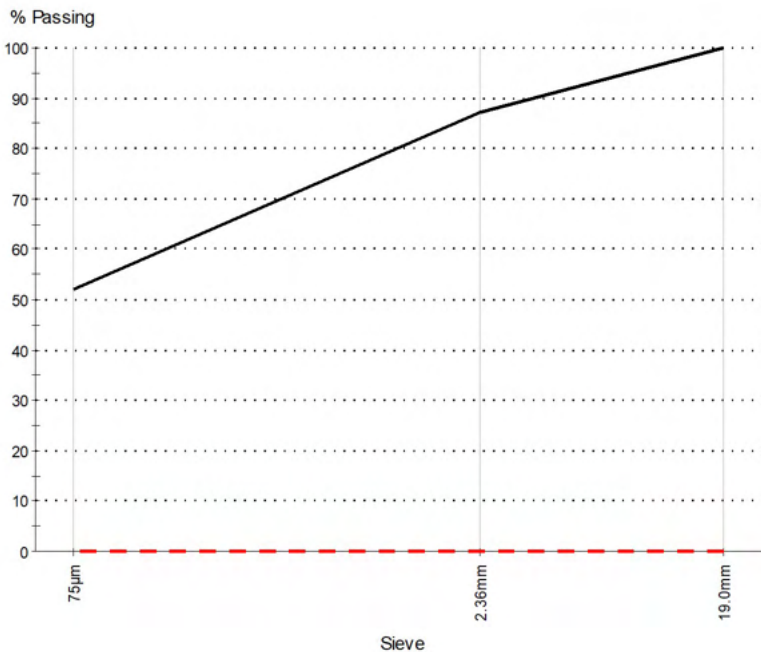
Sample Details

Sample ID MC23-00221-S05
Date Sampled 10/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH13 - 3.75m to 4.0m
Sample Location Sleeman Ave
 BH13 - 3.75m to 4.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.0	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	62	
Plastic Limit (%)	AS 1289.3.2.1	29	
Plasticity Index (%)	AS 1289.3.3.1	33	
Date Tested		20/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 15/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	87	-
75µm	52	-

Comments

N/A

Report No: MAT:MC23-00221-S06

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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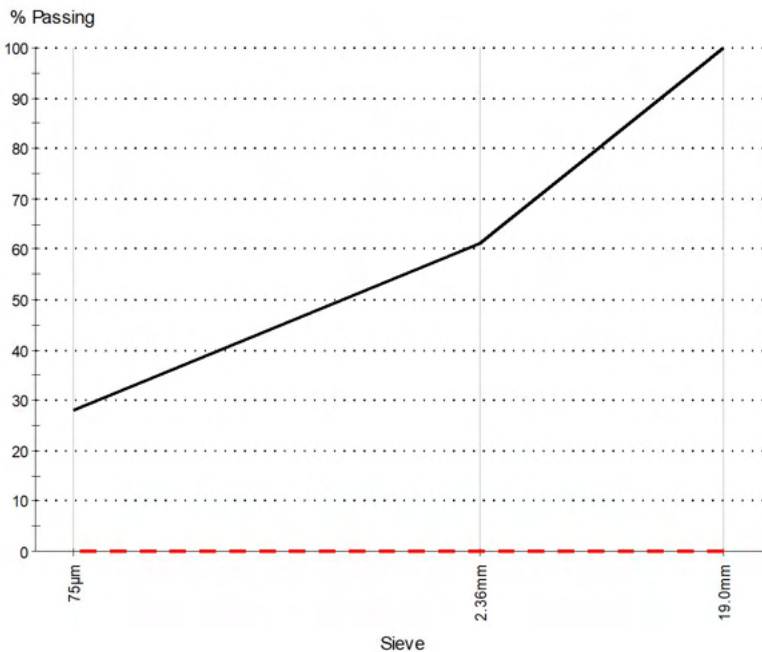
Sample Details

Sample ID MC23-00221-S06
Date Sampled 10/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH13 - 4.4m to 4.6m
Sample Location Sleeman Ave
 BH13 - 4.4m to 4.6m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	5.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	49	
Plastic Limit (%)	AS 1289.3.2.1	36	
Plasticity Index (%)	AS 1289.3.3.1	13	
Date Tested		22/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 15/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	61	-
75µm	28	-

Comments

N/A

Report No: MAT:MC23-00221-S07

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
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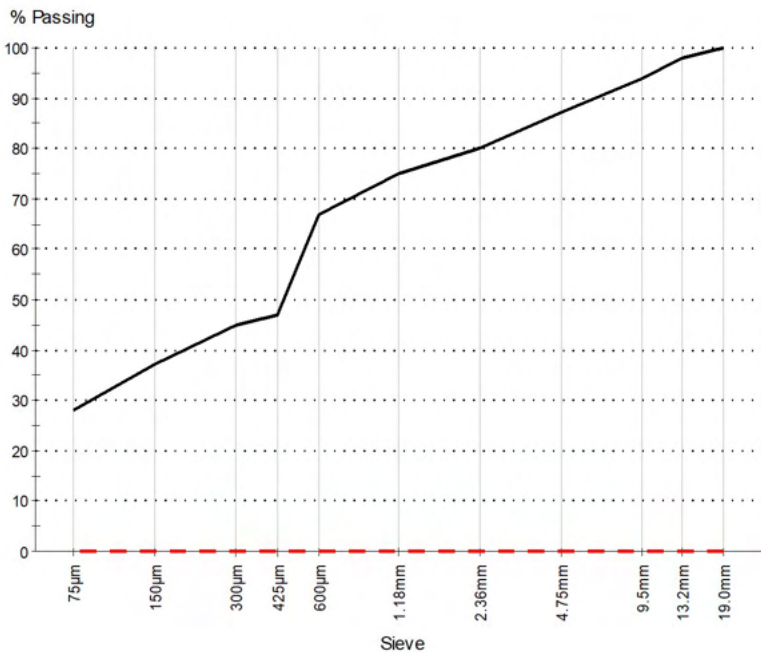
Sample Details

Sample ID MC23-00221-S07
Date Sampled 10/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH13 - 7.0m to 7.3m
Sample Location Sleeman Ave
 BH13 - 7.0m to 7.3m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	65	
Plastic Limit (%)	AS 1289.3.2.1	26	
Plasticity Index (%)	AS 1289.3.3.1	39	
Date Tested		20/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 15/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
13.2mm	98	-
9.5mm	94	-
4.75mm	87	-
2.36mm	80	-
1.18mm	75	-
600µm	67	-
425µm	47	-
300µm	45	-
150µm	37	-
75µm	28	-

Comments

N/A

Report No: MAT:MC23-00221-S08

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
 (Laboratory Supervisor)
 Date of Issue: 24/02/2023

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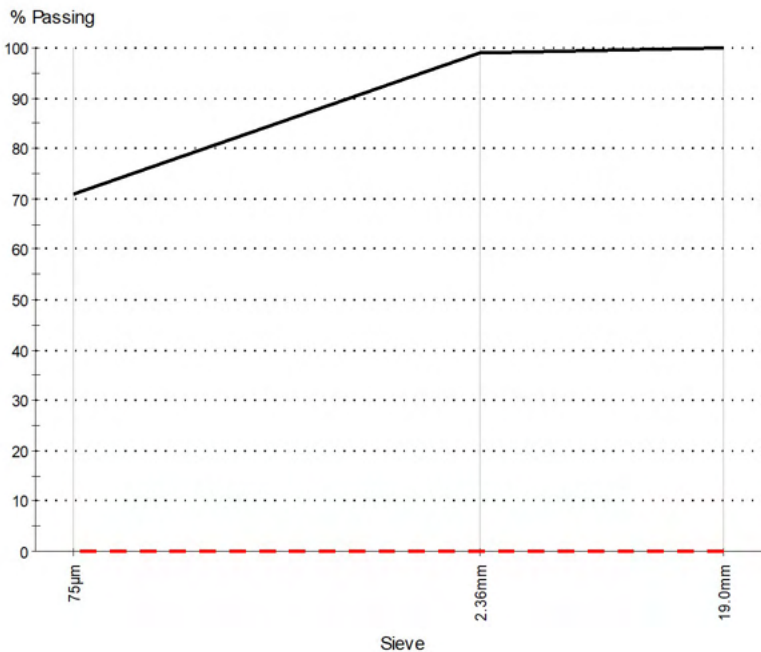
Sample Details

Sample ID MC23-00221-S08
Date Sampled 7/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH14 - 2.2m to 2.5m
Sample Location Sleeman Ave
 BH14 - 2.2m to 2.5m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	15.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	86	
Plastic Limit (%)	AS 1289.3.2.1	24	
Plasticity Index (%)	AS 1289.3.3.1	62	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	99	-
75µm	71	-

Comments

N/A

Report No: MAT:MC23-00221-S09

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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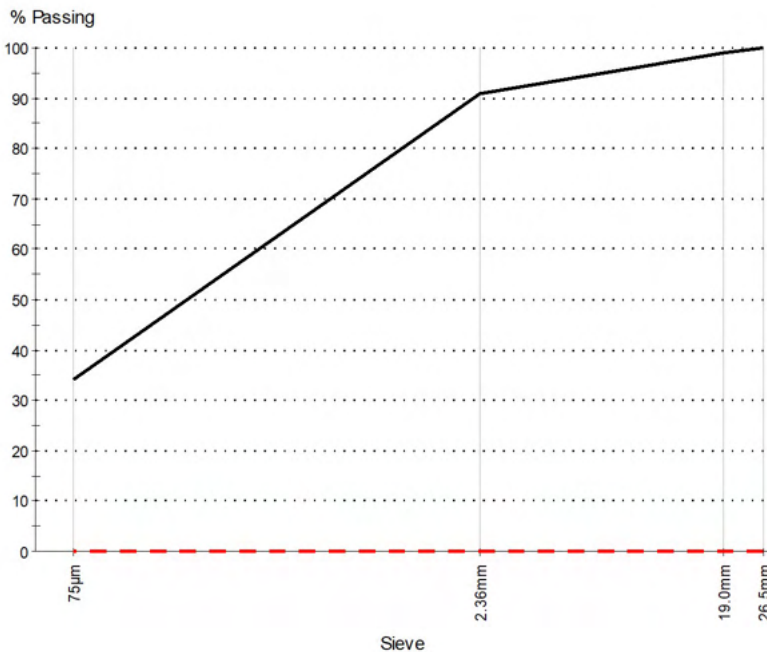
Sample Details

Sample ID MC23-00221-S09
Date Sampled 7/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH14 - 3.0m to 3.3m
Sample Location Sleeman Ave
 BH14 - 3.0m to 3.3m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	6.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	43	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	24	
Date Tested		21/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 15/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
26.5mm	100	-
19.0mm	99	-
2.36mm	91	-
75µm	34	-

Comments

N/A

Report No: MAT:MC23-00221-S10

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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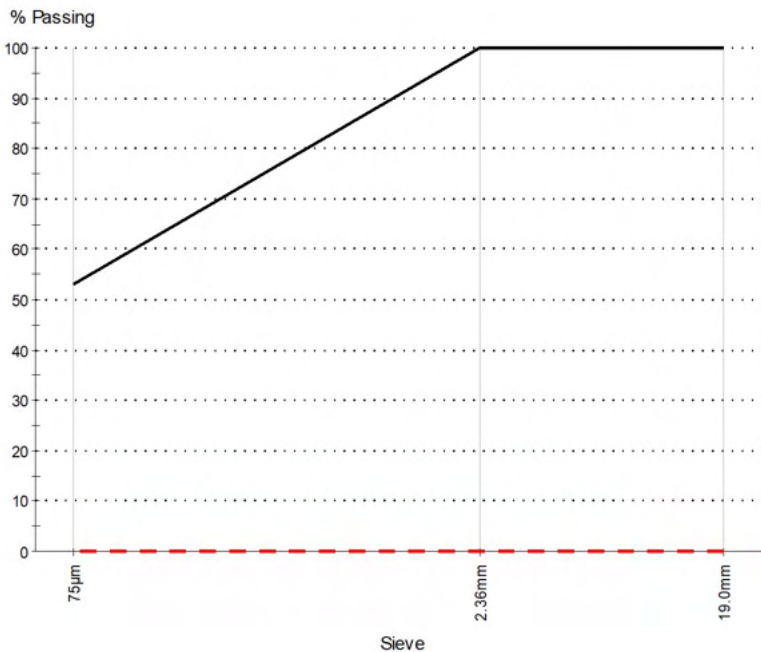
Sample Details

Sample ID MC23-00221-S10
Date Sampled 8/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1 % Fines
Client ID BH15 - 1.8m to 2.0m
Sample Location Sleeman Ave
 BH15 - 1.8m to 2.0m

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-Dried	
Preparation	AS 1289.1.1	Dry-Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	63	
Plastic Limit (%)	AS 1289.3.2.1	21	
Plasticity Index (%)	AS 1289.3.3.1	42	
Date Tested		23/02/2023	

Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	-
2.36mm	100	-
75µm	53	-

Comments

N/A

Report No: MAT:MC23-00221-S11

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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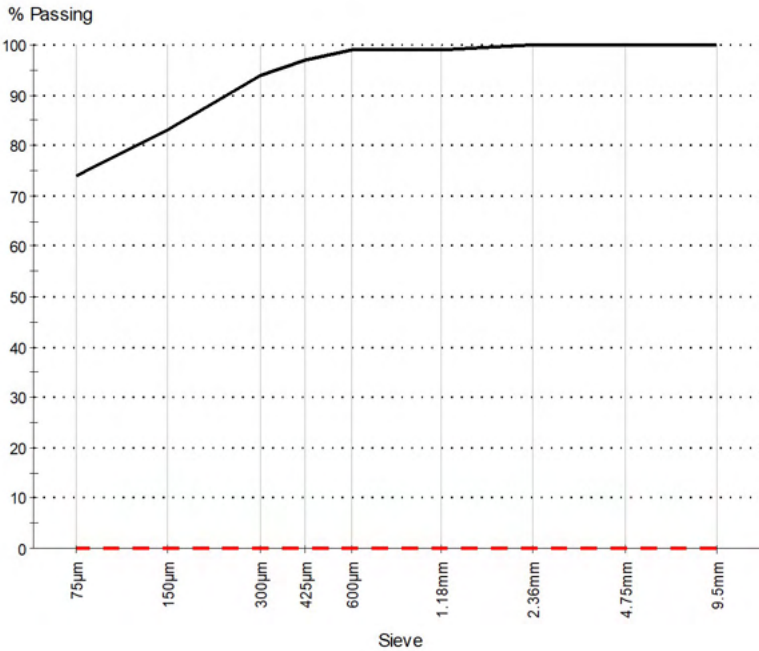
Sample Details

Sample ID MC23-00221-S11
Date Sampled 8/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH15 - 2.5m to 2.8m
Sample Location Sleeman Ave
 BH15 - 2.5m to 2.8m

Other Test Results

Description	Method	Result	Limits
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Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
9.5mm	100	-
4.75mm	100	-
2.36mm	100	-
1.18mm	99	-
600µm	99	-
425µm	97	-
300µm	94	-
150µm	83	-
75µm	74	-

Comments

N/A

Report No: MAT:MC23-00221-S12

Issue No: 1

Material Test Report

Client: CMW Geosciences Pty Ltd
 Suite 1, Level 3, 29 Flynn St Wembley WA 6014
Project: PER2021-0347: Mira Mar, Albany Landslide



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Signatory: Alex Briggs
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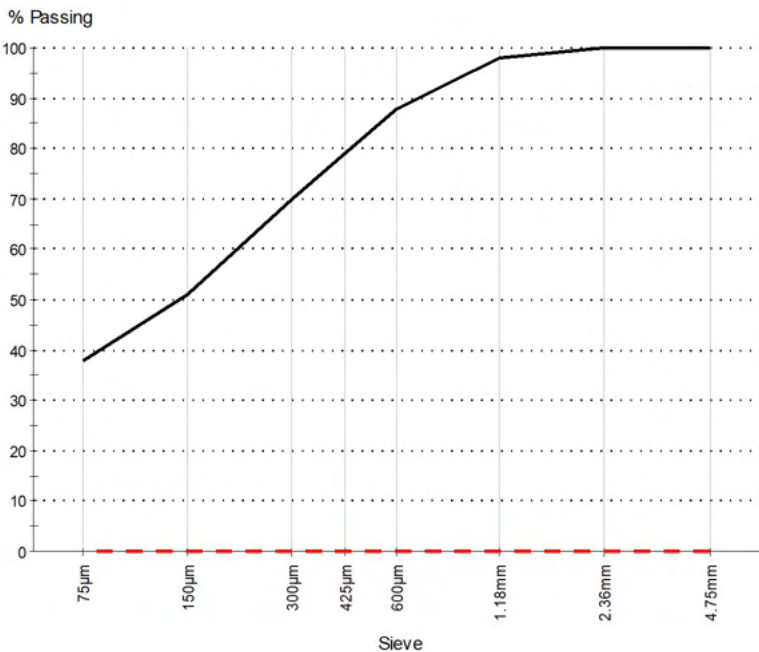
Sample Details

Sample ID MC23-00221-S12
Date Sampled 8/12/2023
Sampling Method Tested as received
Soil Description Clay
Specification AS 1289.3.6.1
Client ID BH15 - 3.5m to 3.8m
Sample Location Sleeman Ave
 BH15 - 3.5m to 3.8m

Other Test Results

Description	Method	Result	Limits
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Particle Size Distribution



Method: AS 1289.3.6.1
Drying By: Oven
Date Tested: 21/02/2023

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	-
2.36mm	100	-
1.18mm	98	-
600µm	88	-
425µm	79	-
300µm	70	-
150µm	51	-
75µm	38	-

Comments

N/A



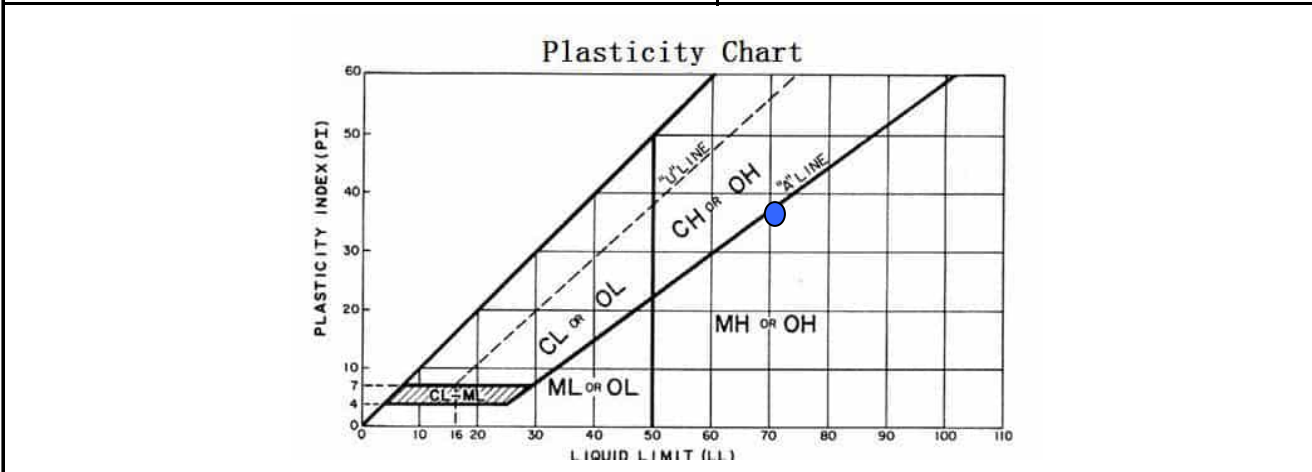
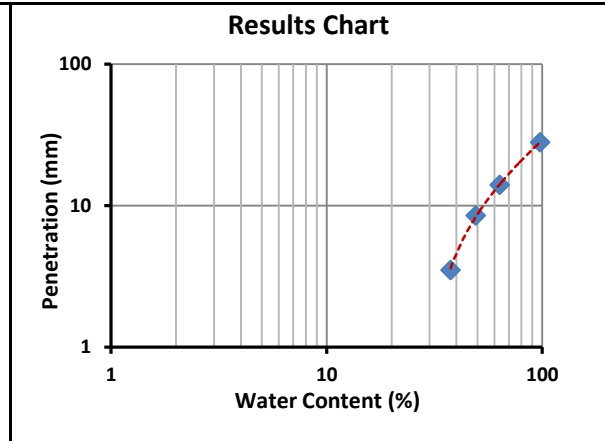
ATTERBERG LIMITS TEST REPORT

Test Method: AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	CMW Geoscience	Date Tested:	26/01/2023
Project:	Mira Mar 2023 Testing	Lab:	EPLAB
Sample No:	BH06	Job Number:	CMW
Lab ID:	BH06_4.50_4.80_ATT		
Depth(m):	4.50 - 4.80	Room Temperature at Test:	20°C

Tested by:	Tokie	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m ³):	-
		Dry Density (t/m ³):	-

Liquid Limit (%): 70.58
Plastic Limit (%): 33.61
Plasticity Index (%): 36.97
Liquidity Index (%): -
Shrinkage Limit (%): 20.05
Linear Shrinkage(%): 15.49



Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature:

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



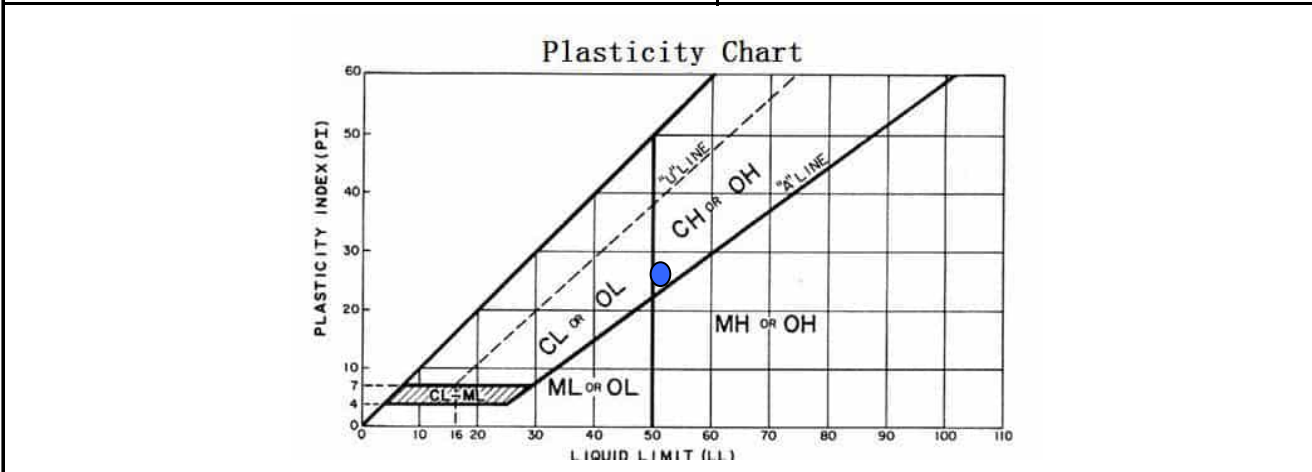
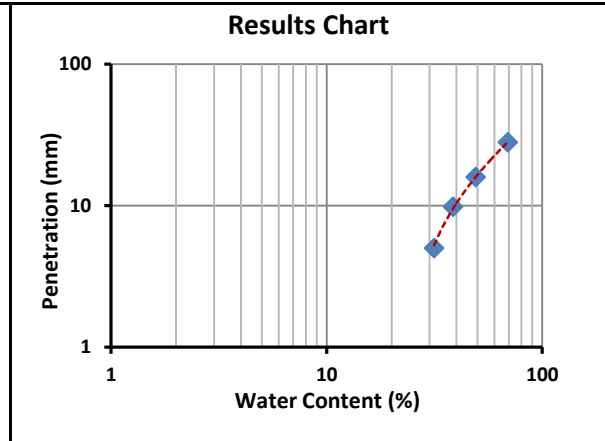
ATTERBERG LIMITS TEST REPORT

Test Method: AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	CMW Geoscience	Date Tested:	26/01/2023
Project:	Mira Mar 2023 Testing	Lab:	EPLAB
Sample No:	BH07	Job Number:	CMW
Lab ID:	BH07_3.00_3.45_ATT		
Depth(m):	3.00 - 3.45	Room Temperature at Test:	20°C

Tested by:	Tokie	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m ³):	-
		Dry Density (t/m ³):	-

Liquid Limit (%): 50.93
Plastic Limit (%): 26.15
Plasticity Index (%): 24.79
Liquidity Index (%): -
Shrinkage Limit (%): 18.10
Linear Shrinkage(%): 10.87



Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature:

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



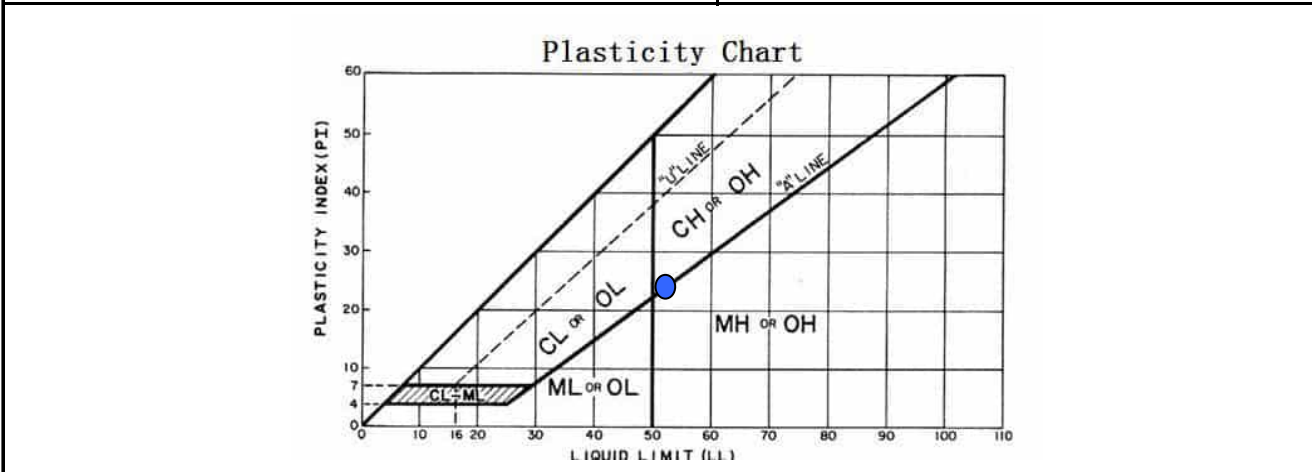
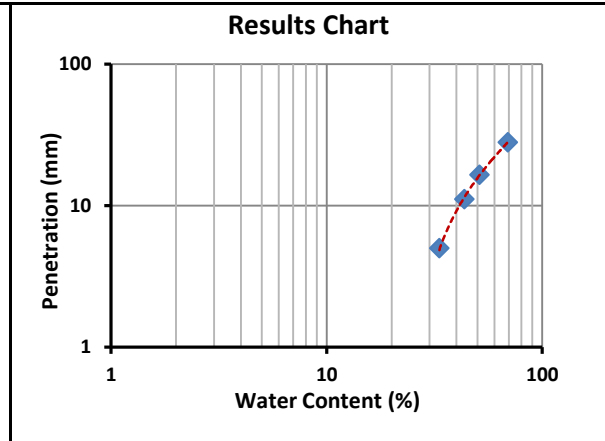
ATTERBERG LIMITS TEST REPORT

Test Method: AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	CMW Geoscience	Date Tested:	26/01/2023
Project:	Mira Mar 2023 Testing	Lab:	EPLAB
Sample No:	BH07	Job Number:	CMW
Lab ID:	BH07_4.00_4.45_ATT		
Depth(m):	4.00 - 4.45	Room Temperature at Test:	20°C

Tested by:	Tokie	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m ³):	-
		Dry Density (t/m ³):	-

Liquid Limit (%): 52.15
Plastic Limit (%): 28.87
Plasticity Index (%): 23.28
Liquidity Index (%): -
Shrinkage Limit (%): 20.24
Linear Shrinkage(%): 12.55



Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature:

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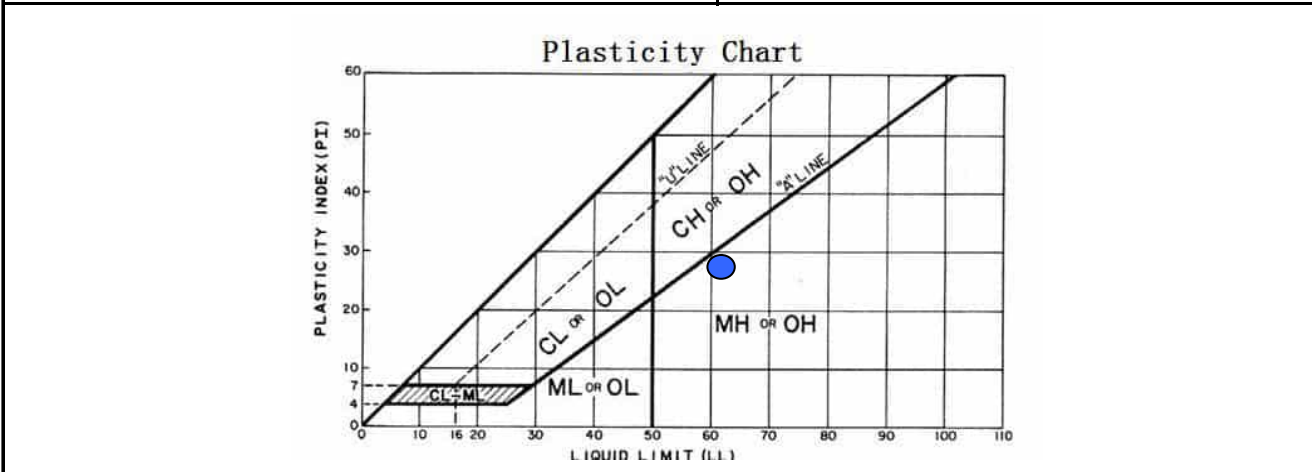
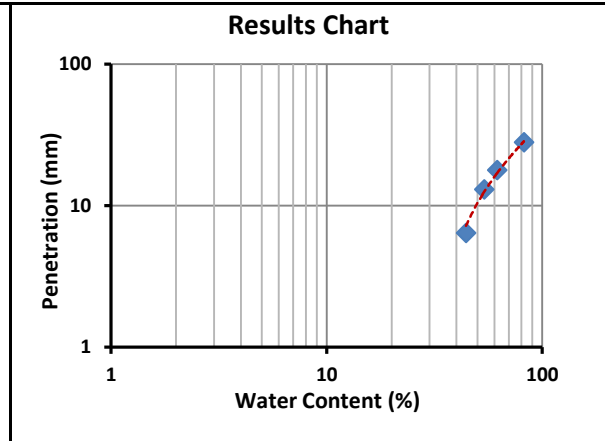
ATTERBERG LIMITS TEST REPORT

Test Method: AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	CMW Geoscience	Date Tested:	26/01/2023
Project:	Mira Mar 2023 Testing	Lab:	EPLAB
Sample No:	BH08	Job Number:	CMW
Lab ID:	BH08_3.00_3.45_ATT		
Depth(m):	3.00 - 3.45	Room Temperature at Test:	20°C

Tested by:	Tokie	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m ³):	-
		Dry Density (t/m ³):	-

Liquid Limit (%): 61.82
Plastic Limit (%): 35.05
Plasticity Index (%): 26.77
Liquidity Index (%): -
Shrinkage Limit (%): 23.34
Linear Shrinkage(%): 13.68



Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature:

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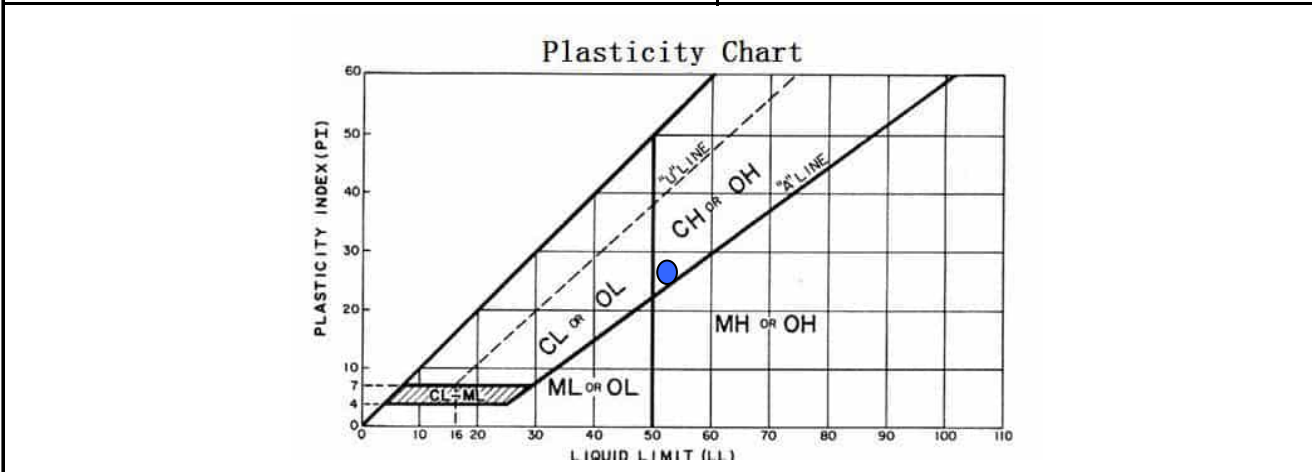
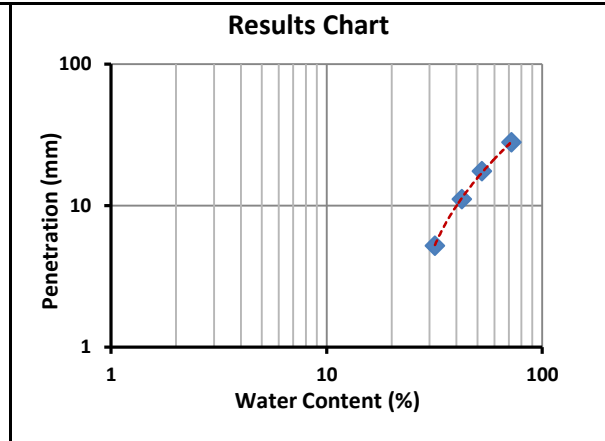
ATTERBERG LIMITS TEST REPORT

Test Method: AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	CMW Geoscience	Date Tested:	26/01/2023
Project:	Mira Mar 2023 Testing	Lab:	EPLAB
Sample No:	BH12	Job Number:	CMW
Lab ID:	BH12_3.00_3.45_ATT		
Depth(m):	3.00 - 3.45	Room Temperature at Test:	20°C

Tested by:	Tokie	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m ³):	-
		Dry Density (t/m ³):	-

Liquid Limit (%): 52.36
Plastic Limit (%): 26.04
Plasticity Index (%): 26.32
Liquidity Index (%): -
Shrinkage Limit (%): 17.71
Linear Shrinkage(%): 12.22



Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature:

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



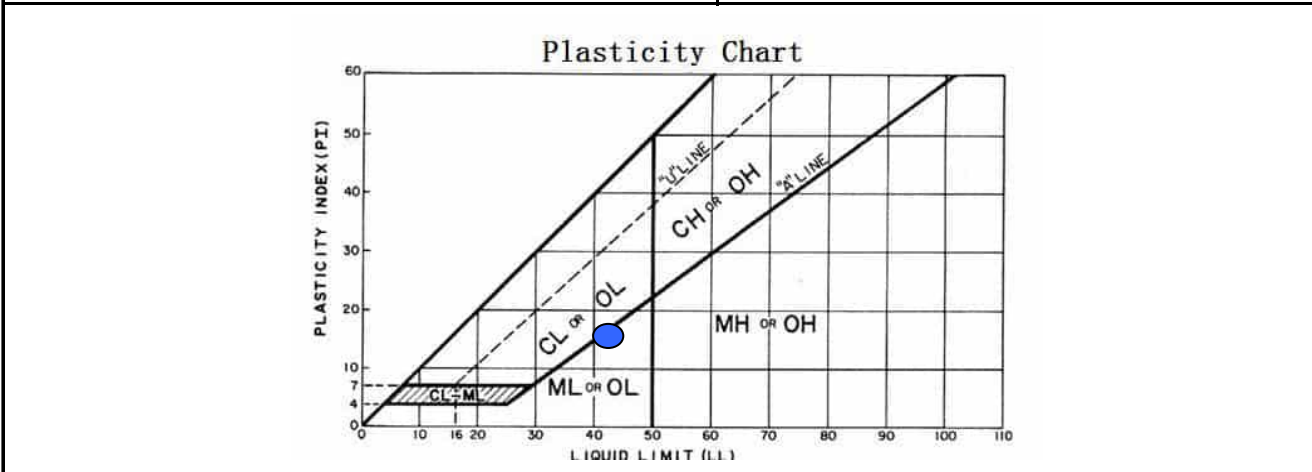
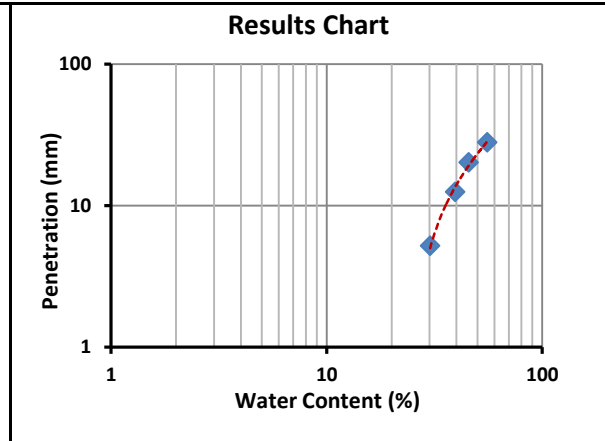
ATTERBERG LIMITS TEST REPORT

Test Method: AS1289.2.1.1 7.1.1 3.1.1 3.2.1 3.4.1

Client:	CMW Geoscience	Date Tested:	26/01/2023
Project:	Mira Mar 2023 Testing	Lab:	EPLAB
Sample No:	BH15	Job Number:	CMW
Lab ID:	BH15_3.00_3.40_ATT		
Depth(m):	3.00 - 3.40	Room Temperature at Test:	20°C

Tested by:	Tokie	Sample Description:	-
Moisture Content (%):	-	Wet Density (t/m ³):	-
		Dry Density (t/m ³):	-

Liquid Limit (%): 43.23
Plastic Limit (%): 26.92
Plasticity Index (%): 16.32
Liquidity Index (%): -
Shrinkage Limit (%): 20.70
Linear Shrinkage(%): 6.58



Notes: The sample/s were tested oven dried, dry sieved and in a 125-250mm mould.

Stored and Tested the Sample as received

Samples supplied by the Client

Authorised Signature:

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



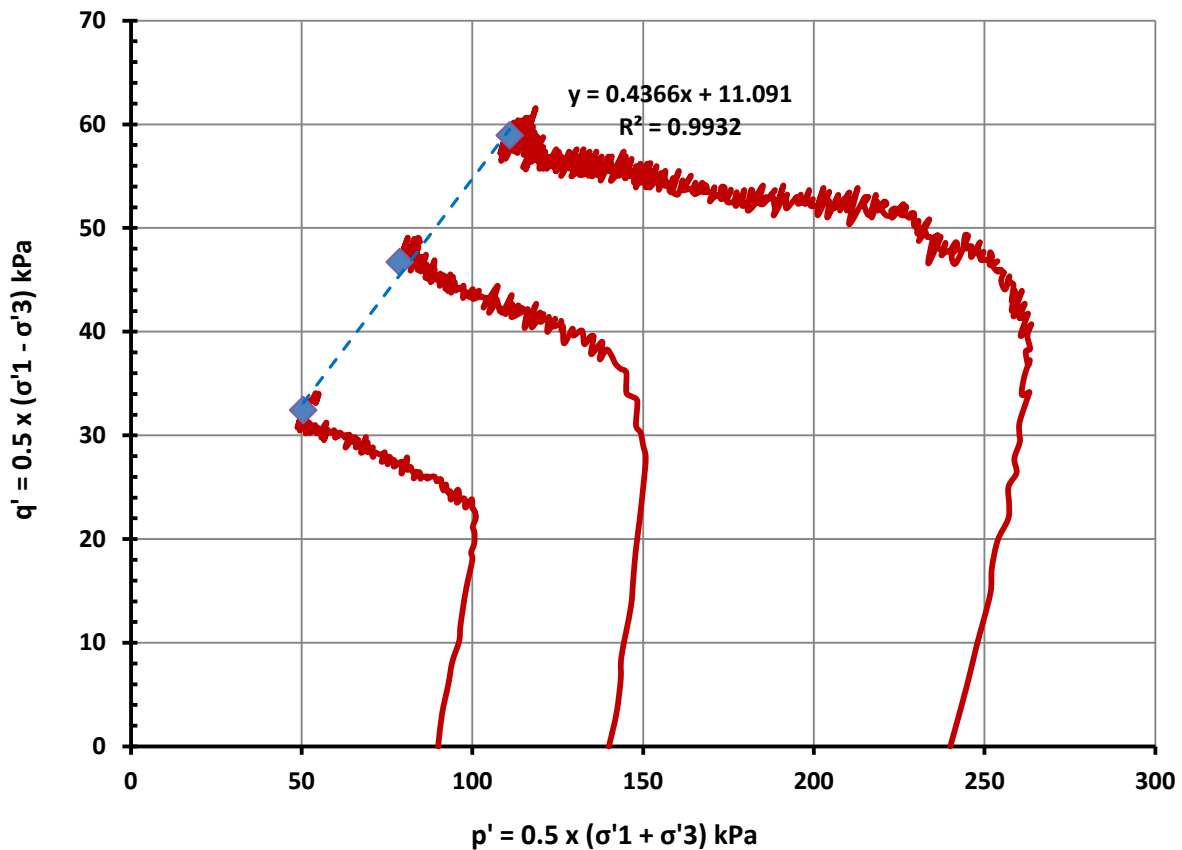
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH06	Lab:	EPLab
Sample ID:	BH06_1_CU3		
Depth (m):	4.50 - 4.80	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	12.35
Angle of Shear Resistance Φ' (Deg) :	26.10



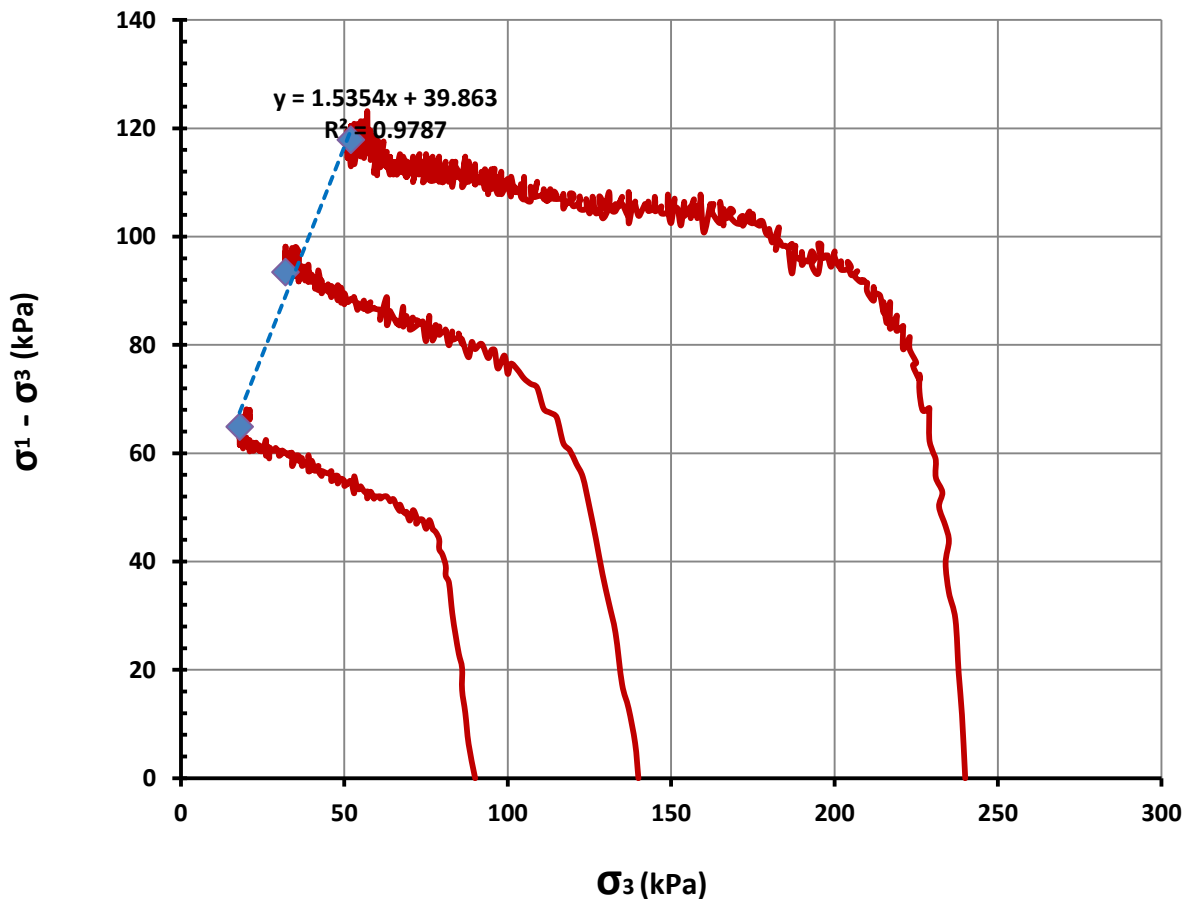
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH06	Lab:	EPLab
Sample ID:	BH06_1_CU3		
Depth (m):	4.50 - 4.80	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	12.51
Angle of Shear Resistance Φ' (Deg) :	25.79



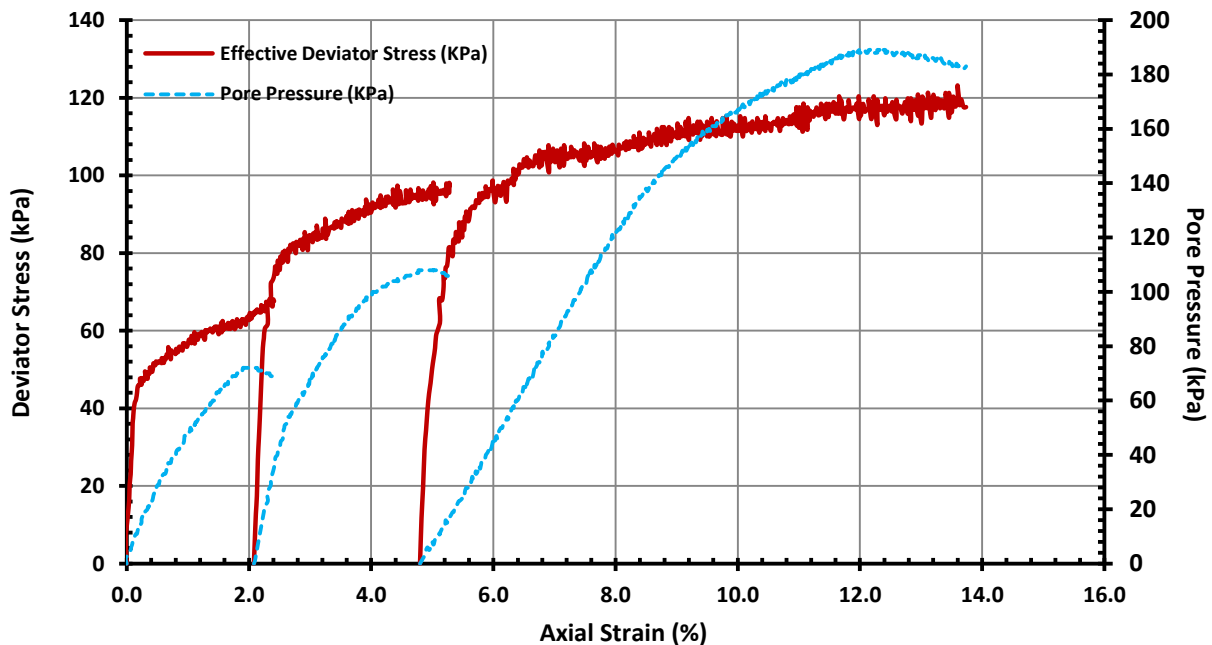
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH06	Lab:	EPLab
Sample ID:	BH06_1_CU3		
Depth (m):	4.50 - 4.80	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U ₀	U _f	Principal Effective Stresses			σ ₁ ' - σ ₃ '	Strain (%)
				σ ₁ '	σ ₃ '	σ ₁ ' / σ ₃ '		
1	90	0	72	83	18	4.60	65	2.10
2	140	0	108	125	32	3.92	93	5.06
3	240	0	188	170	52	3.27	118	12.71



MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH06	Lab:	EPLab
Sample ID:	BH06_1_CU3		
Depth (m):	4.50 - 4.80	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID: BH06
Lab ID: BH06_1_CU3

Depth (m): 4.50 - 4.80
Date Tested: 21/01/2023



Failure Mode: Shear Failure to Vertical @ 46.6°

Notes:

Stored and Tested the Sample as received
Samples supplied by the Client

NATA: 19078

Authorised Signatory (Geotechnical Engineer):



The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



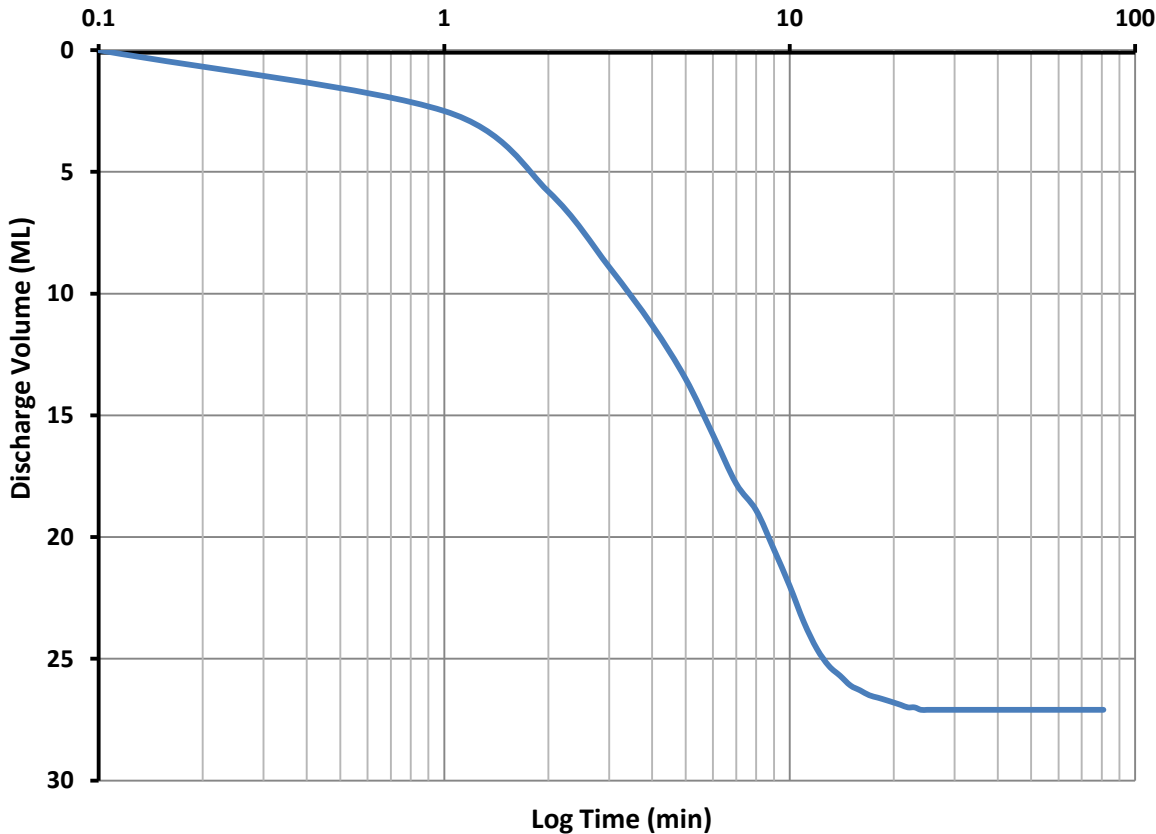
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH06	Lab:	EPLab
Sample ID:	BH06_1_CU3		
Depth (m):	4.50 - 4.80	Room Temperature at Test:	~ 18°C

Discharge Volume (ML) Vs Log Time (min)



Cv (cm²/s): 0.053 based on t₉₀



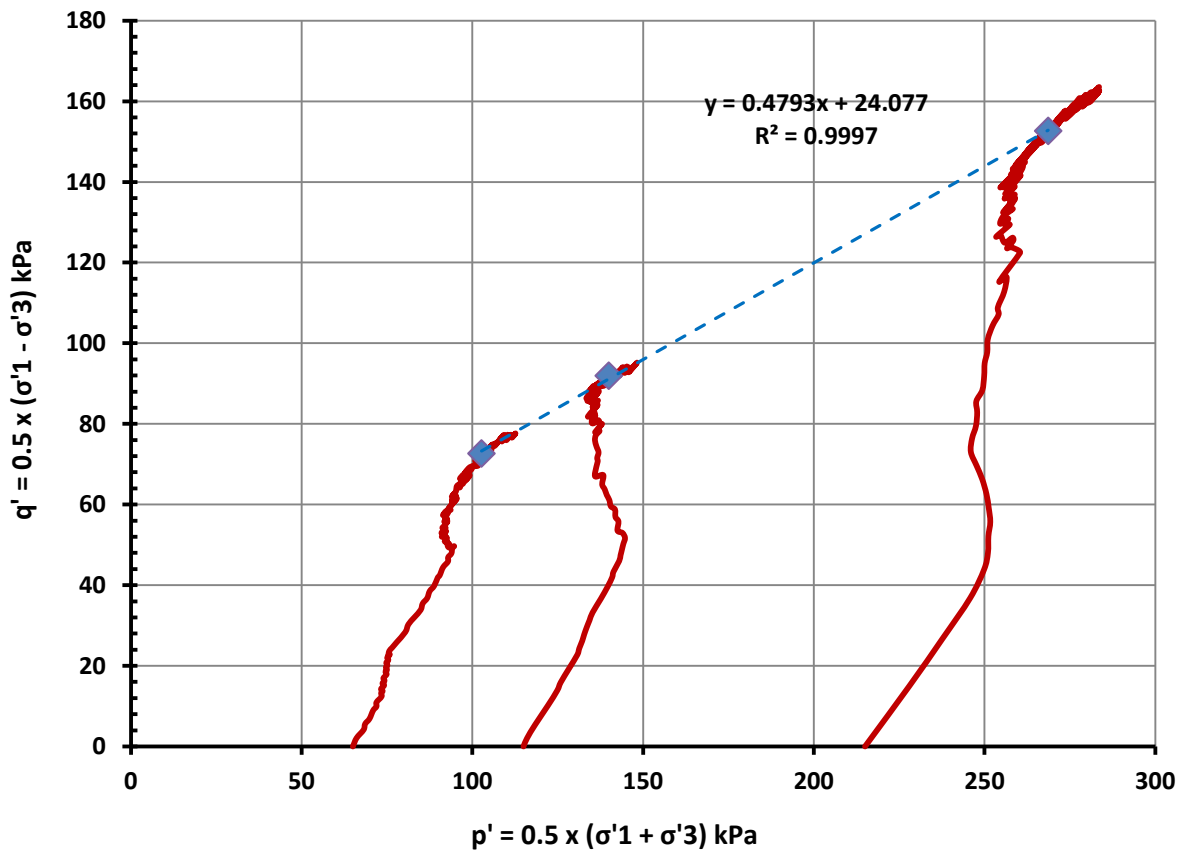
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	27.45
Angle of Shear Resistance Φ' (Deg) :	28.69



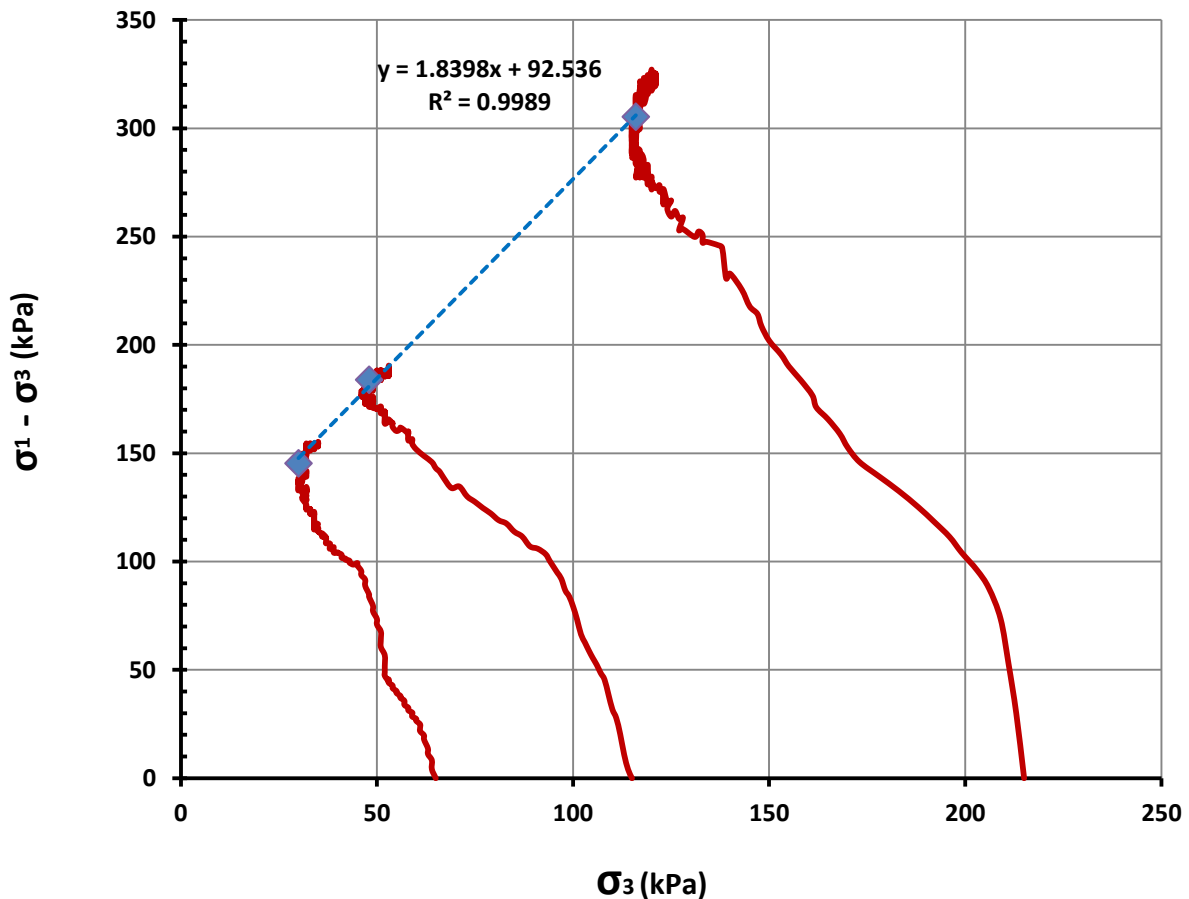
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	27.46
Angle of Shear Resistance Φ' (Deg) :	28.63

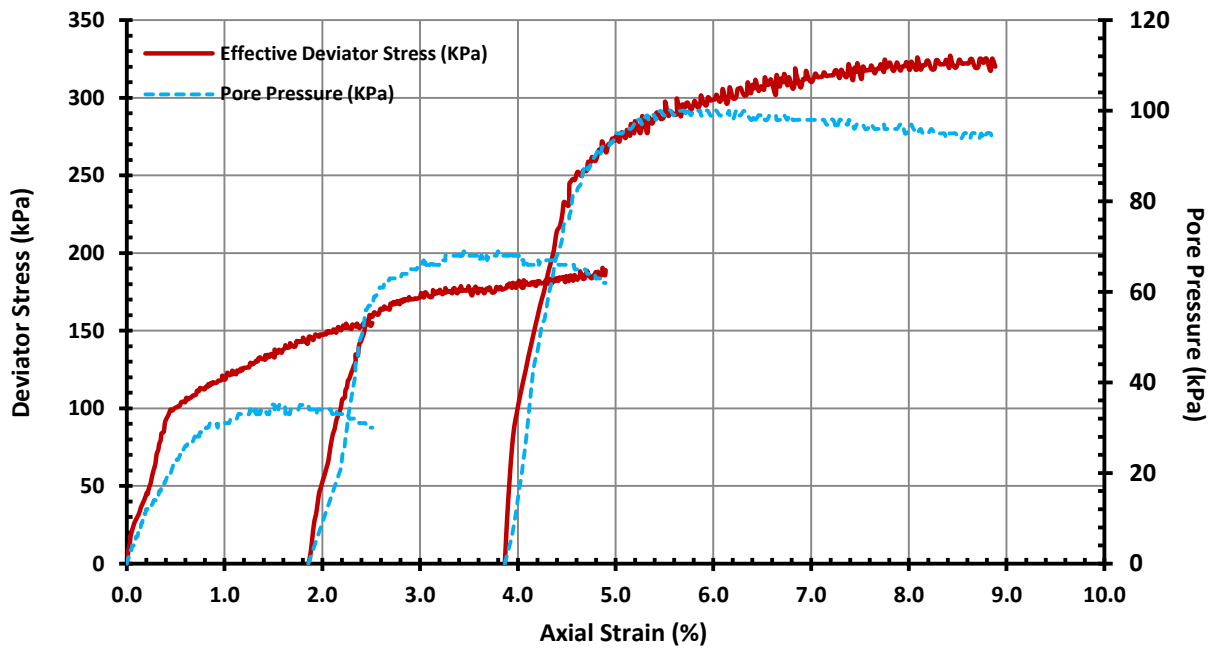


MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client: CMW Geosciences	Date Tested: 21/01/2023
Project: Mira Mar 2023 Testing	EP Lab Job Number: CMW
Sample No: BH07	Lab: EPLab
Sample ID: BH07_1_CU3	
Depth (m): 3.00 - 3.45	Room Temperature at Test: ~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U ₀	U _f	Principal Effective Stresses			σ ₁ - σ ₃	Strain (%)
				σ ₁	σ ₃	σ ₁ / σ ₃		
1	65	0	35	175	30	5.84	145	1.86
2	115	0	67	232	48	4.83	184	4.40
3	215	0	99	421	116	3.63	305	6.52



MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID: BH07
Lab ID: BH07_1_CU3

Depth (m): 3.00 - 3.45
Date Tested: 21/01/2023



Failure Mode: Shear Failure to Vertical @ 29.9°

Notes:

Stored and Tested the Sample as received
Samples supplied by the Client

NATA: 19078

Authorised Signatory (Geotechnical Engineer):



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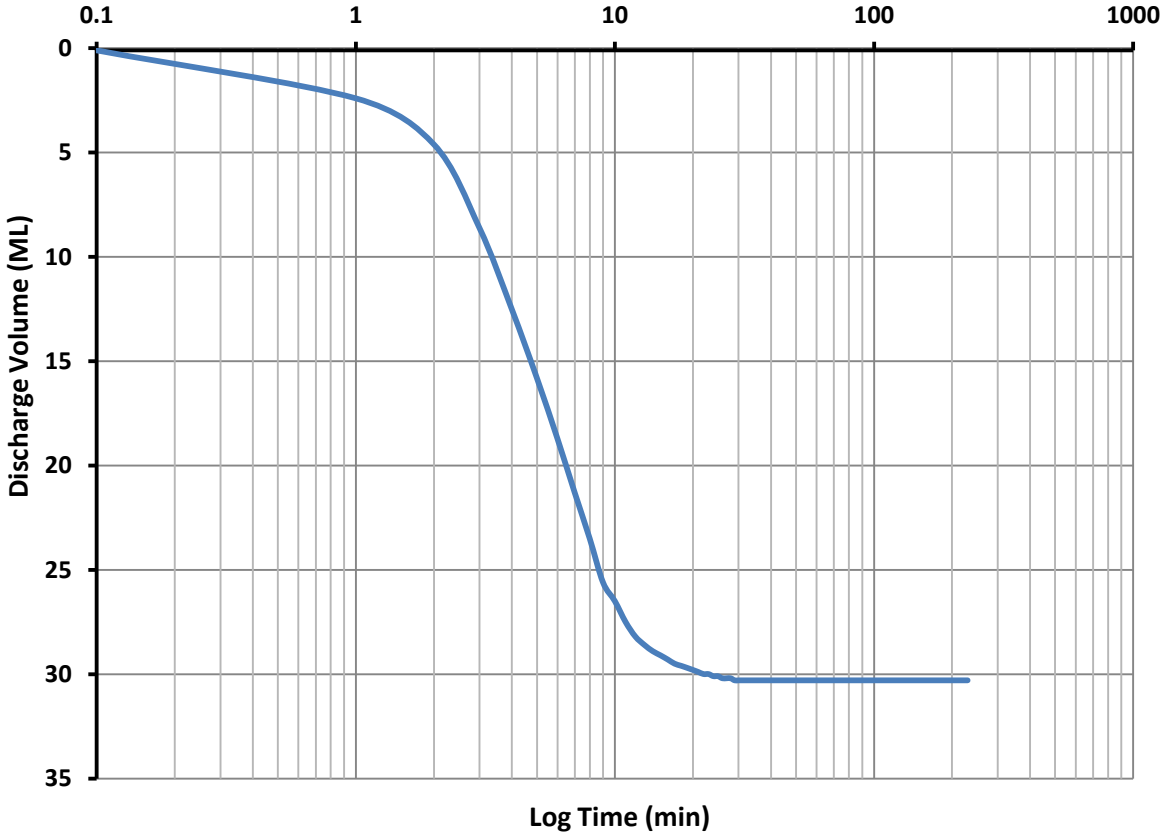
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Discharge Volume (ML) Vs Log Time (min)



Cv (cm²/s): 0.064 based on t₉₀



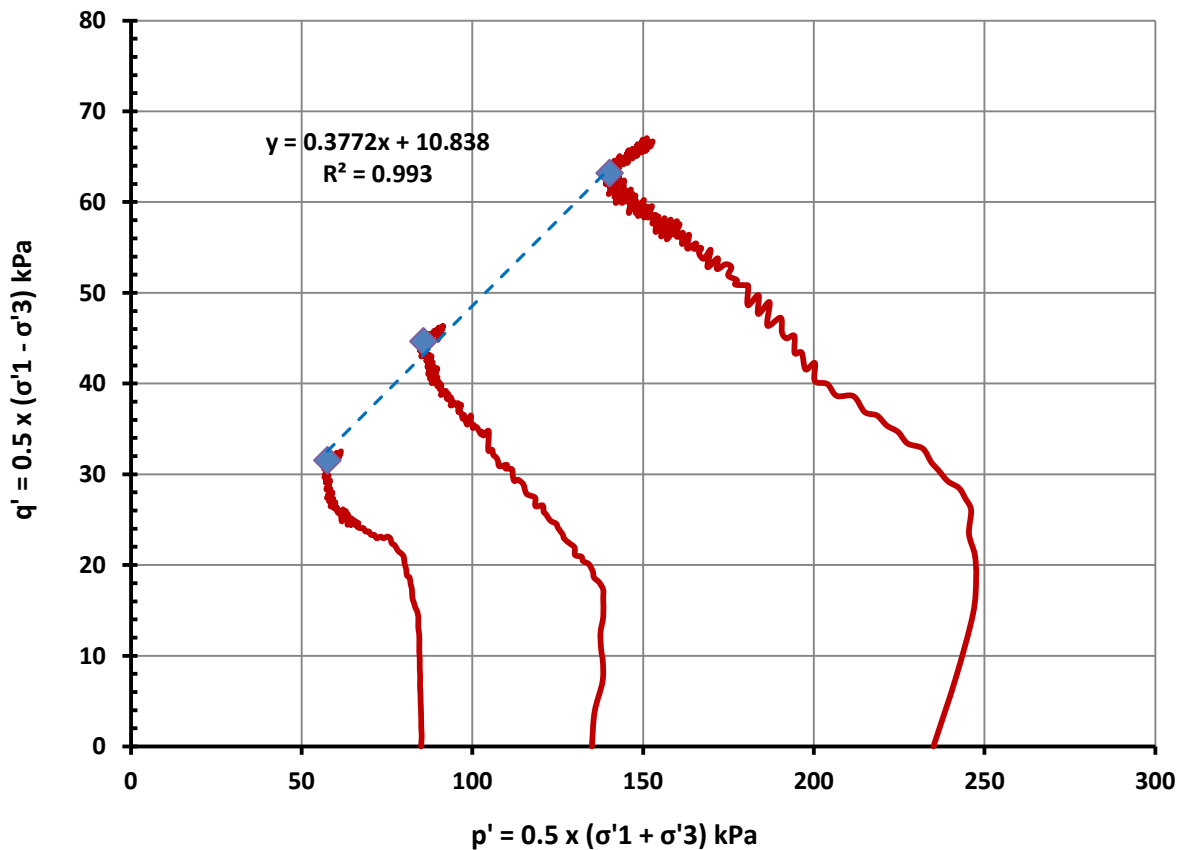
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_2_CU3		
Depth (m):	4.00 - 4.45	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : 11.72
 Angle of Shear Resistance Φ' (Deg) : 22.33



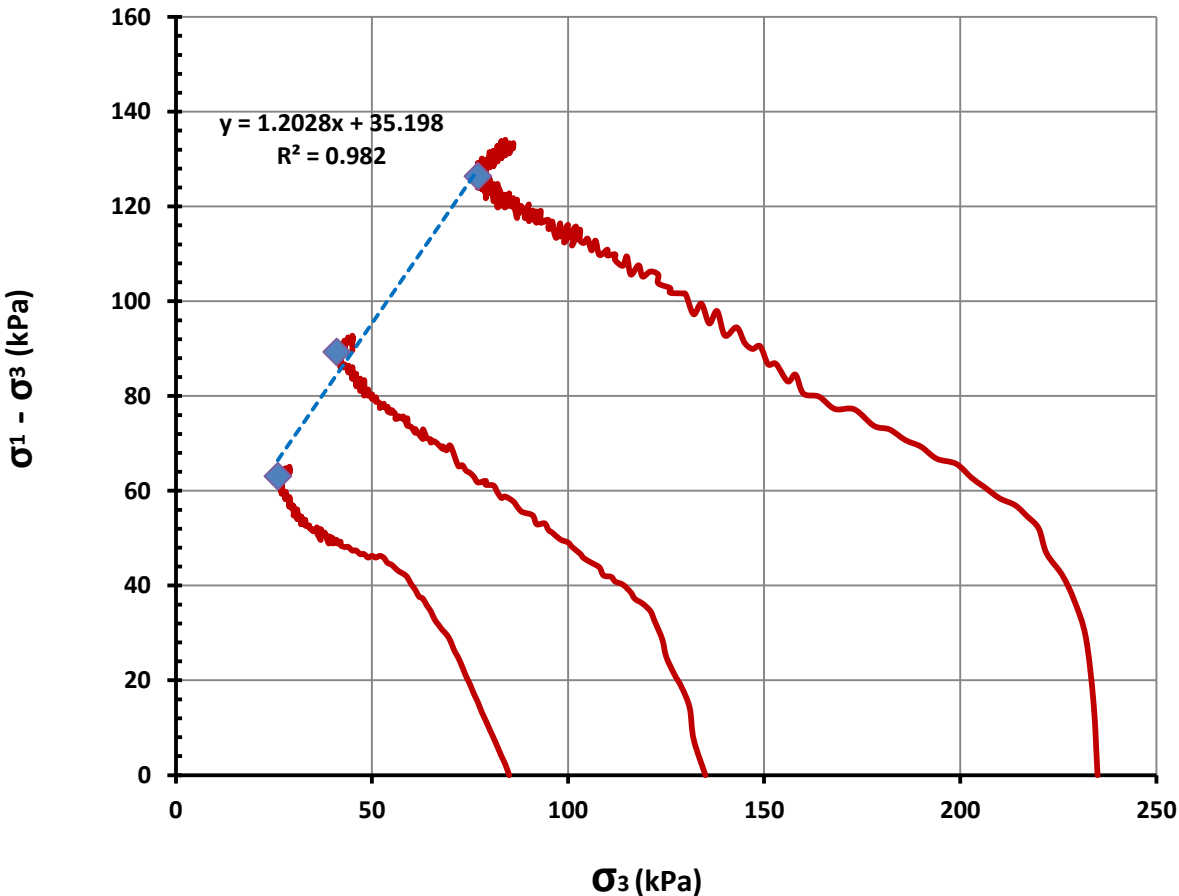
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_2_CU3		
Depth (m):	4.00 - 4.45	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : 11.84
 Angle of Shear Resistance Φ' (Deg) : 22.14

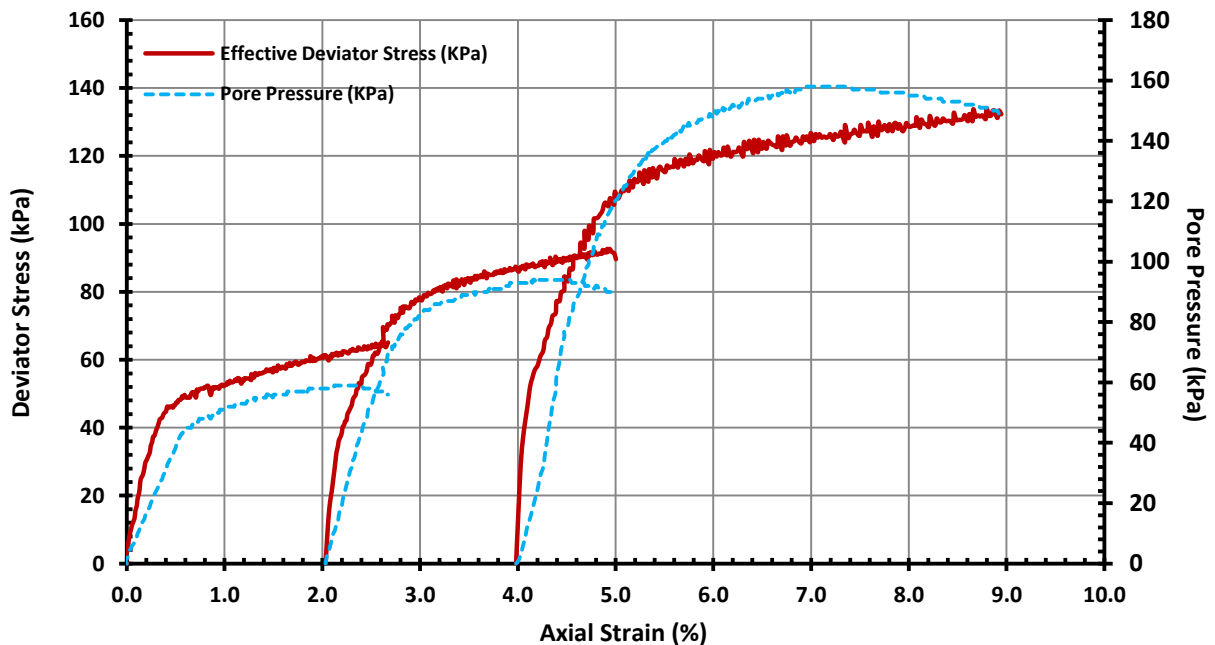


MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_2_CU3		
Depth (m):	4.00 - 4.45	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U ₀	U _f	Principal Effective Stresses			σ ₁ - σ ₃	Strain (%)
				σ ₁	σ ₃	σ ₁ / σ ₃		
1	85	0	59	89	26	3.43	63	2.40
2	135	0	94	130	41	3.18	89	4.52
3	235	0	158	203	77	2.64	126	7.40



MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_2_CU3		
Depth (m):	4.00 - 4.45	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID: BH07
Lab ID: BH07_2_CU3

Depth (m): 4.00 - 4.45
Date Tested: 21/01/2023



Failure Mode: Bulging Failure

Notes:

Stored and Tested the Sample as received
Samples supplied by the Client

NATA: 19078

Authorised Signatory (Geotechnical Engineer):



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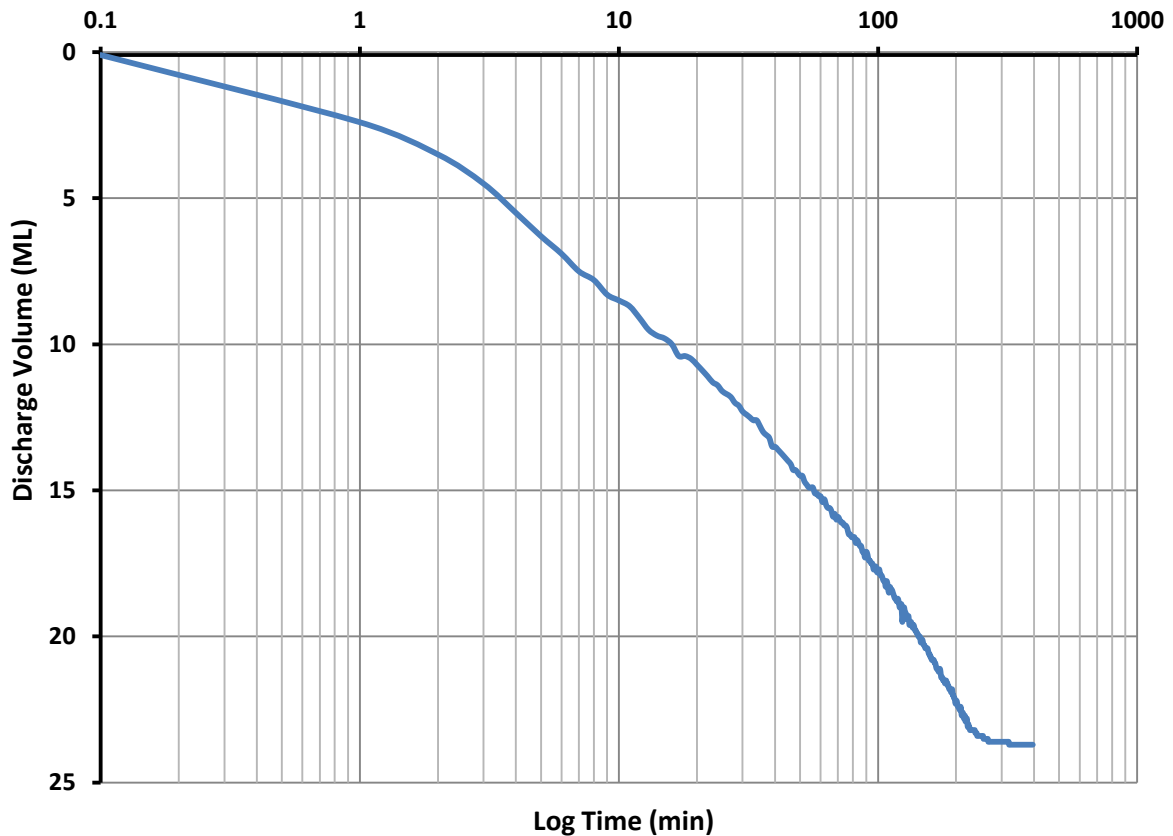
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH07	Lab:	EPLab
Sample ID:	BH07_2_CU3		
Depth (m):	4.00 - 4.45	Room Temperature at Test:	~ 18°C

Discharge Volume (ML) Vs Log Time (min)



C_v (cm²/s): 0.019 based on t_{90}

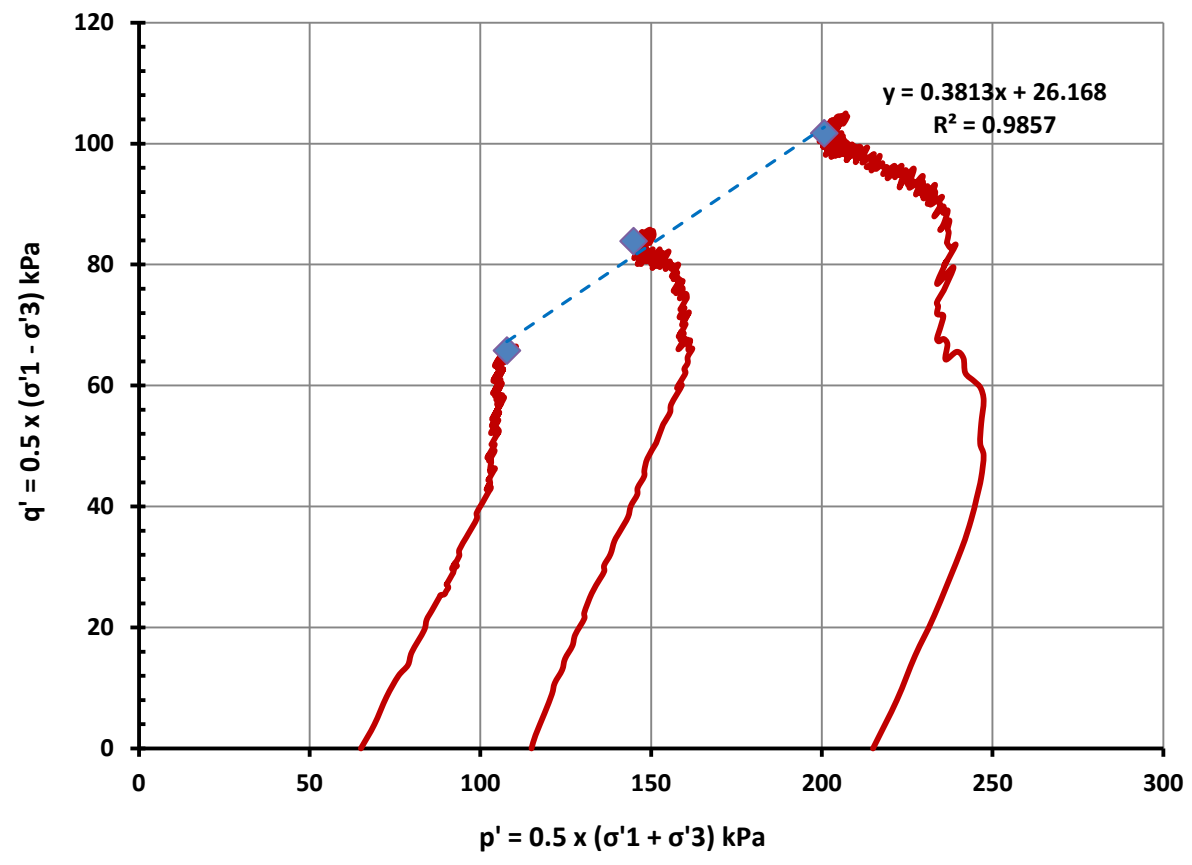


MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH08	Lab:	EPLab
Sample ID:	BH08_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : **28.29**
 Angle of Shear Resistance Φ' (Deg) : **22.33**



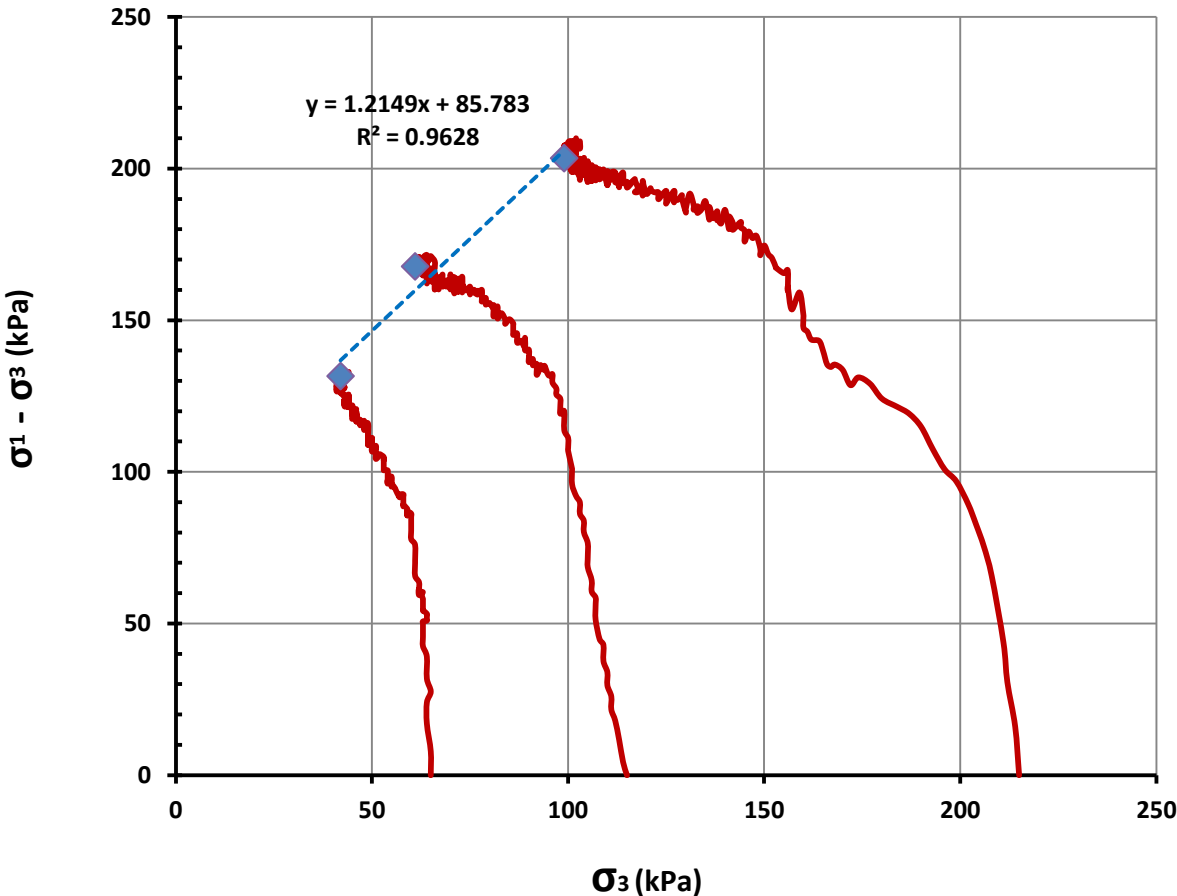
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH08	Lab:	EPLab
Sample ID:	BH08_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : 28.85
 Angle of Shear Resistance Φ' (Deg) : 22.14

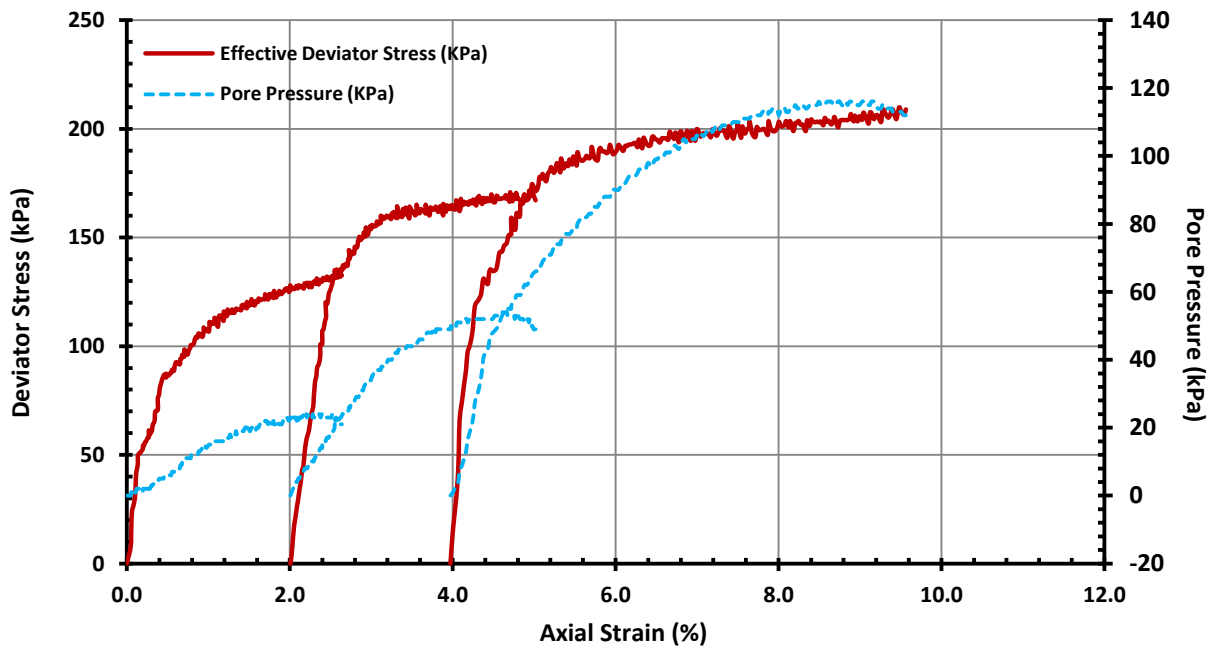


MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH08	Lab:	EPLab
Sample ID:	BH08_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U' ₀	U' _f	Principal Effective Stresses			σ' ₁ - σ' ₃	Strain (%)
				σ' ₁	σ' ₃	σ' ₁ / σ' ₃		
1	65	0	23	174	42	4.13	132	2.50
2	115	0	54	229	61	3.75	168	4.67
3	215	0	116	302	99	3.05	203	8.92



MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH08	Lab:	EPLab
Sample ID:	BH08_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID: BH08
Lab ID: BH08_1_CU3

Depth (m): 3.00 - 3.45
Date Tested: 21/01/2023



Failure Mode: Shear Failure to Vertical @ 44.1°

Notes:

Stored and Tested the Sample as received
Samples supplied by the Client

NATA: 19078

Authorised Signatory (Geotechnical Engineer):



The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



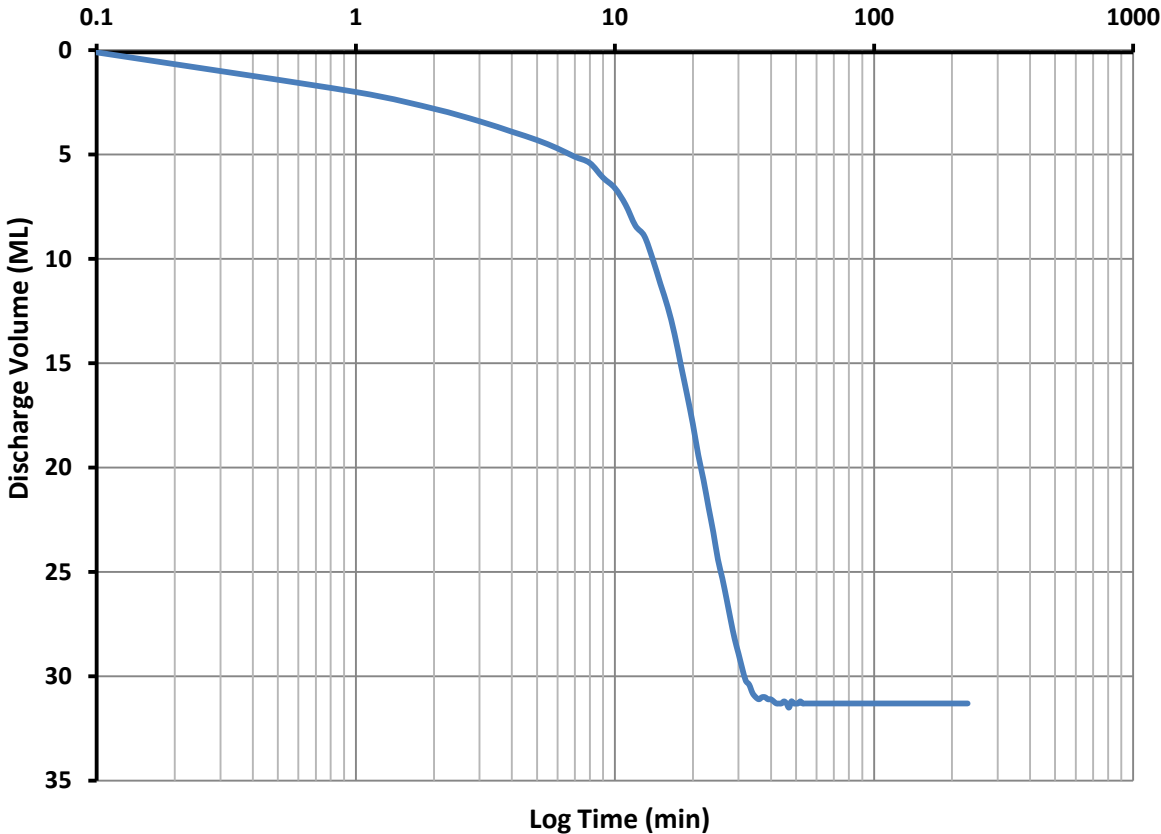
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH08	Lab:	EPLab
Sample ID:	BH08_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Discharge Volume (ML) Vs Log Time (min)



Cv (cm²/s): 0.031 based on t₉₀



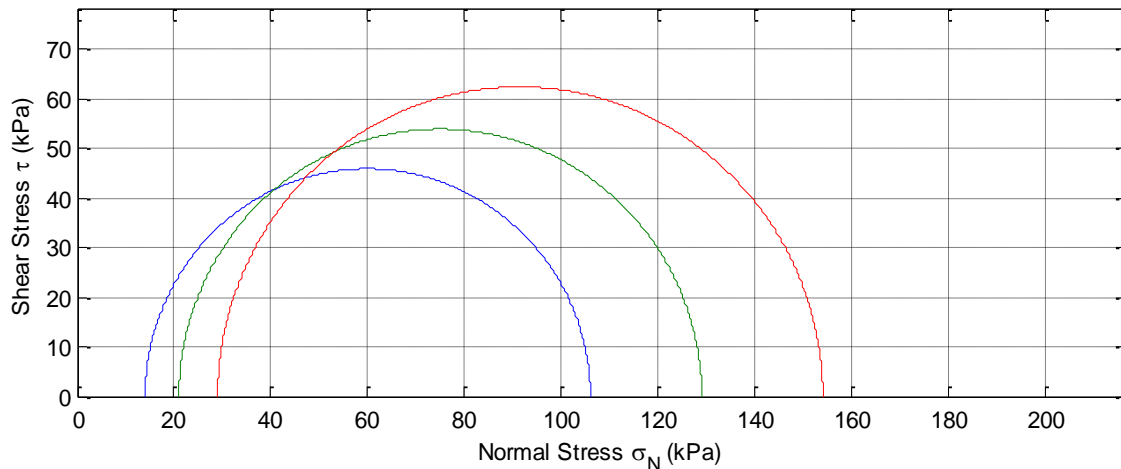
MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH12	Lab:	EPLab
Sample ID:	BH12_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C
Tested by:	Phil Li	Initial Moisture (%):	40.95
		Strain Rate (mm/min):	0.006
Height (mm):	133.95	Final Moisture (%):	33.81
		Skempton's (B):	0.98
Diameter (mm):	62.91	Bulk Density (t/m ³):	1.85
		Geology:	-
L/D Ratio:	2.13	Dry Density (t/m ³):	1.31
		Particle Density (t/m ³):	2.662

Failure Criteria used: Peak Principle Stress Ratio

Mohr Circle Diagram



Interpretations conducted using Matlab

Initial Void Ratio **1.029**

Final Void Ratio **0.900**

Interpretation from Mohr Circle:	Stage 1 & 2	Stage 1 & 3	Stage 2 & 3
Cohesion C' (kPa):	16.55	17.11	17.93
Angle of Shear Resistance Φ' (Degrees) :	32.21	31.38	30.96

Accredited for compliance with ISO/IEC 17025-TESTING

NATA: 19078

Authorised Signatory (Geotechnical Engineer):





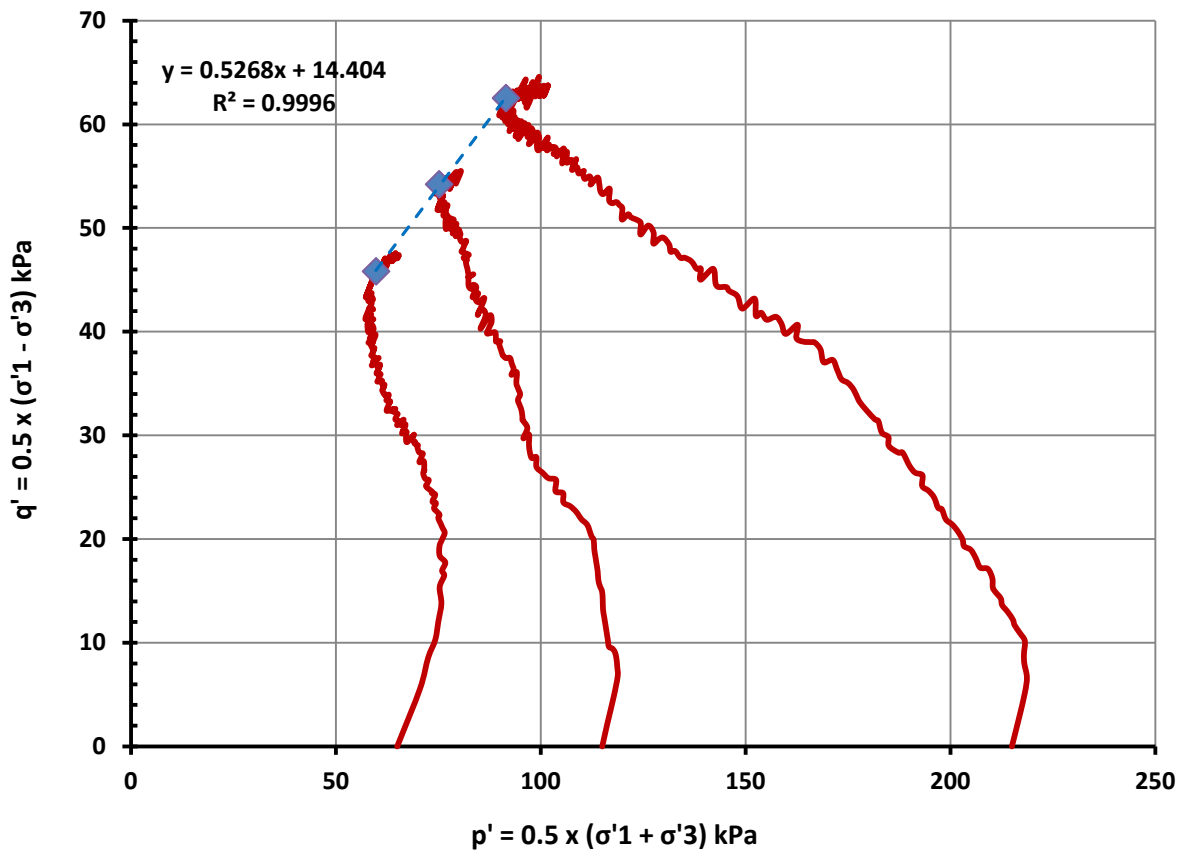
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH12	Lab:	EPLab
Sample ID:	BH12_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	16.98
Angle of Shear Resistance Φ' (Deg) :	32.01



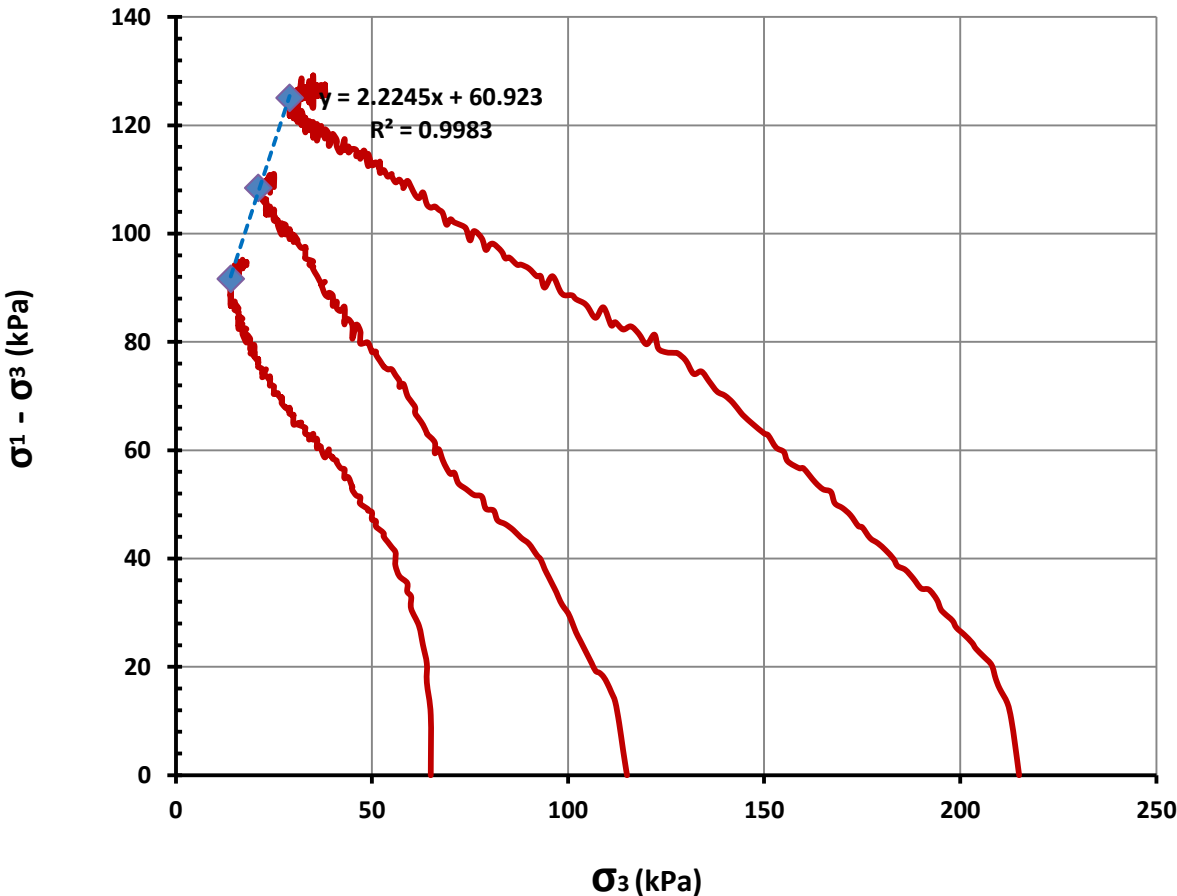
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH12	Lab:	EPLab
Sample ID:	BH12_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : 16.97
 Angle of Shear Resistance Φ' (Deg) : 31.74



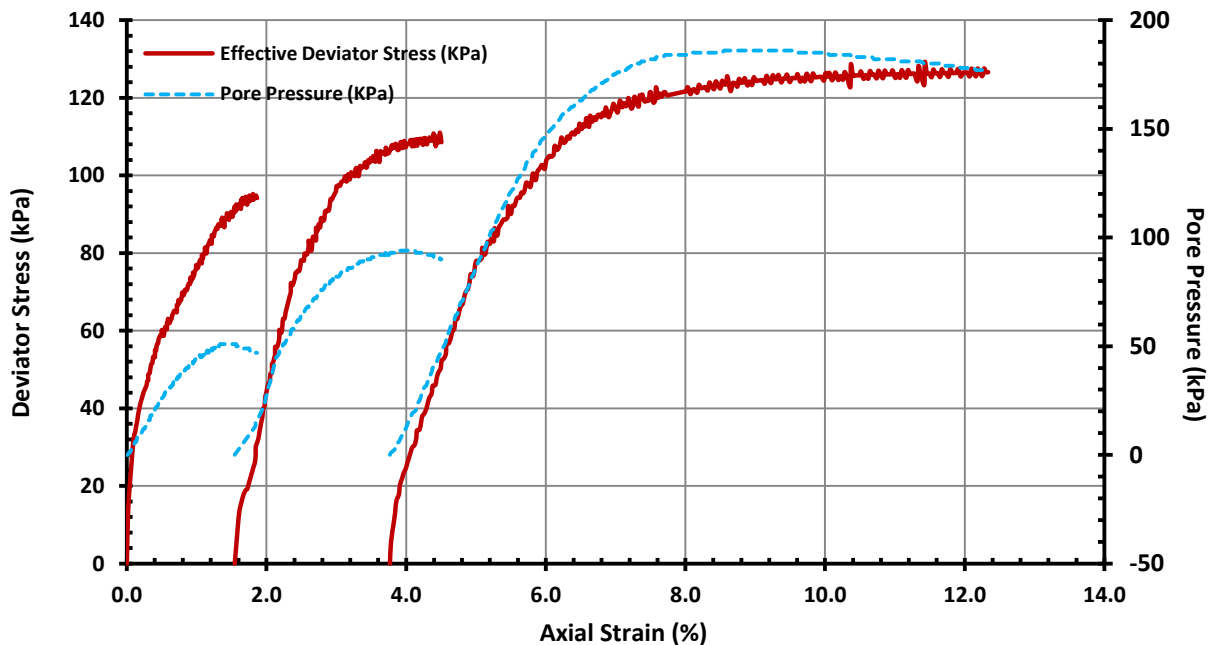
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH12	Lab:	EPLab
Sample ID:	BH12_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U ₀	U _f	Principal Effective Stresses			σ ₁ - σ ₃	Strain (%)
				σ ₁	σ ₃	σ ₁ / σ ₃		
1	65	0	51	106	14	7.55	92	1.57
2	115	0	94	129	21	6.16	108	4.13
3	215	0	186	154	29	5.31	125	9.55



MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH12	Lab:	EPLab
Sample ID:	BH12_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID: BH12
Lab ID: BH12_1_CU3

Depth (m): 3.00 - 3.45
Date Tested: 21/01/2023



Failure Mode: Bulging Failure

Notes:

Stored and Tested the Sample as received
Samples supplied by the Client

NATA: 19078

Authorised Signatory (Geotechnical Engineer):



The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



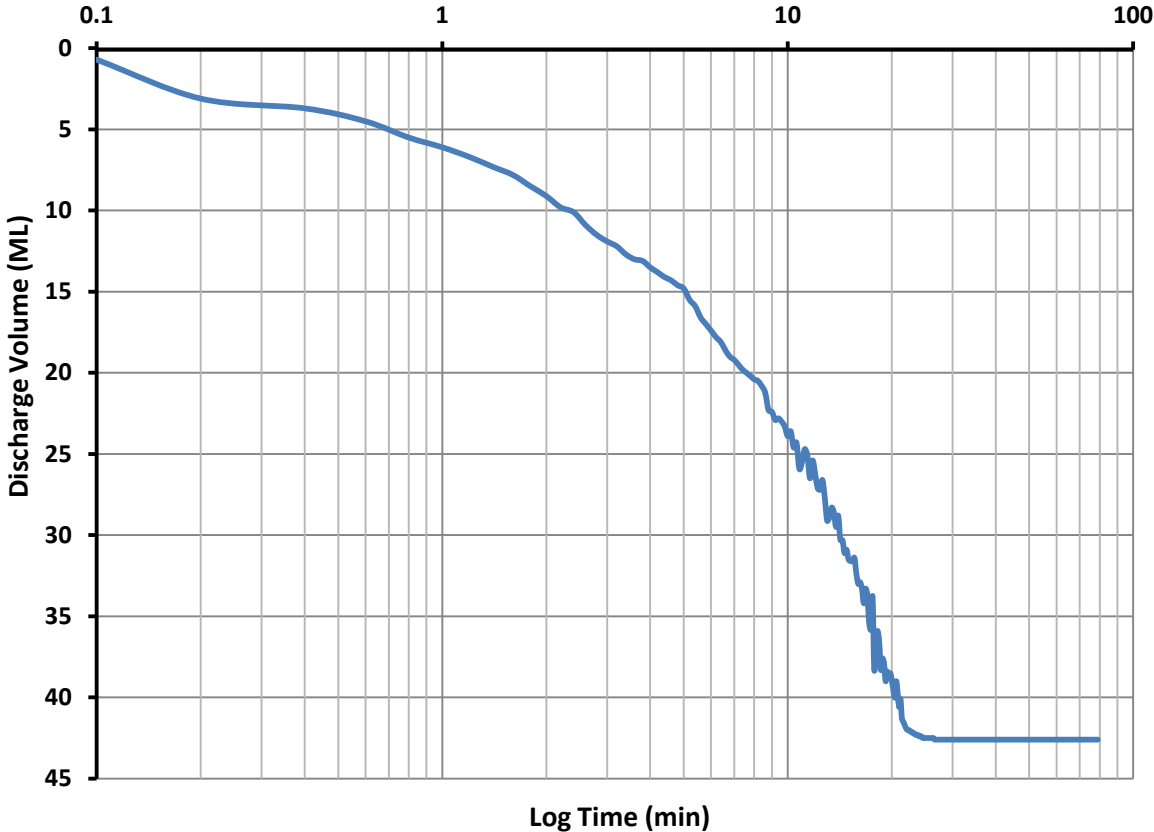
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH12	Lab:	EPLab
Sample ID:	BH12_1_CU3		
Depth (m):	3.00 - 3.45	Room Temperature at Test:	~ 18°C

Discharge Volume (ML) Vs Log Time (min)



Cv (cm²/s): 0.050 based on t₉₀



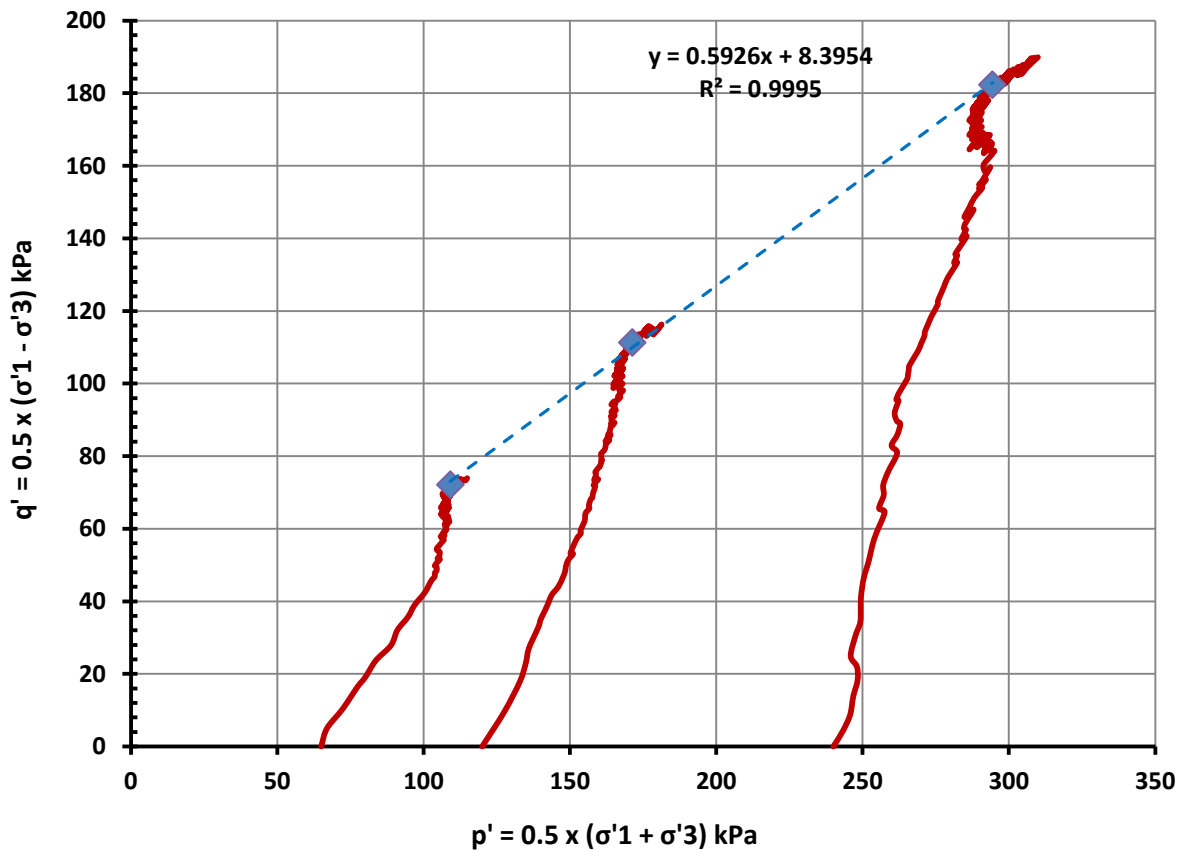
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH15	Lab:	EPLab
Sample ID:	BH15_1_CU3		
Depth (m):	3.00 - 3.40	Room Temperature at Test:	~ 18°C

MIT Effective Stress Path (q' vs p' diagram)



MIT Stress Path - Using Stress Path Tangency Method

Cohesion C' (kPa) :	10.39
Angle of Shear Resistance Φ' (Deg) :	36.16



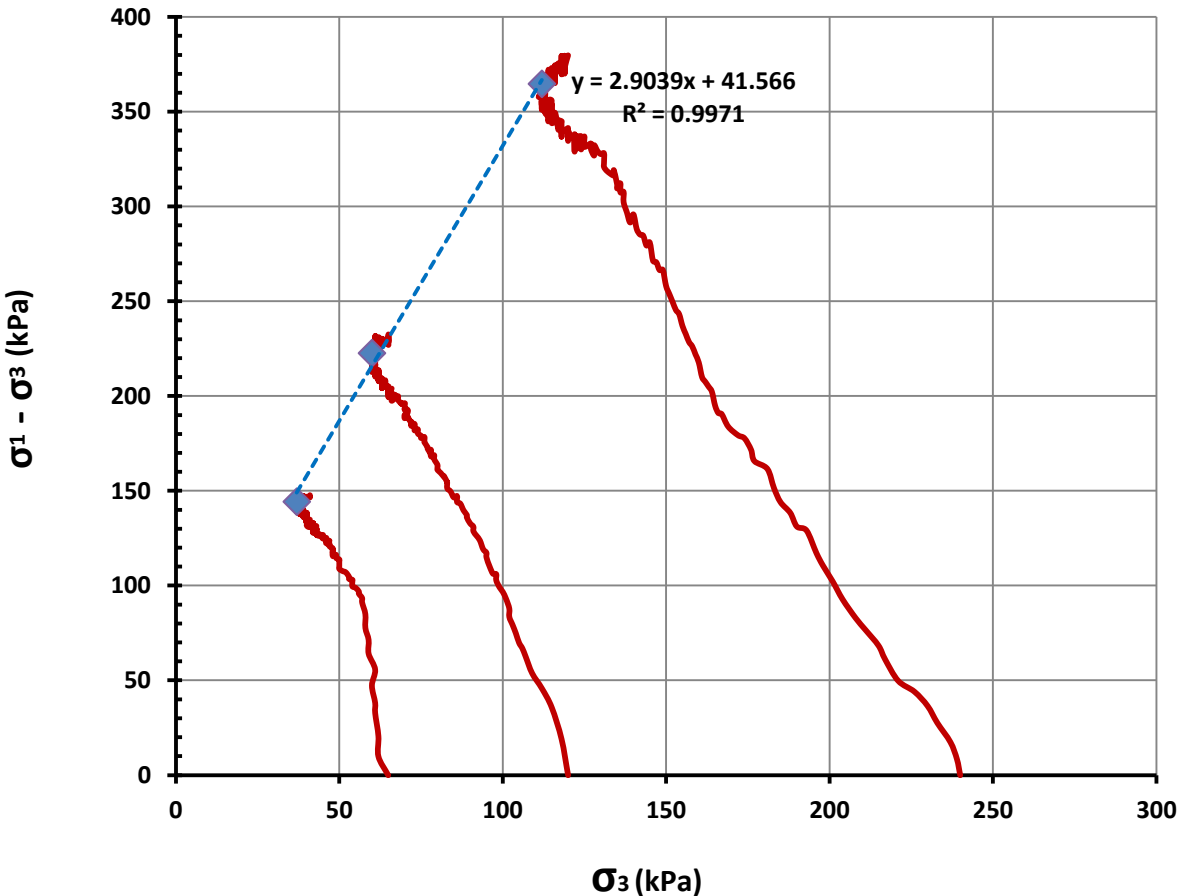
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH15	Lab:	EPLab
Sample ID:	BH15_1_CU3		
Depth (m):	3.00 - 3.40	Room Temperature at Test:	~ 18°C

Modified Mohr Coulomb Stress Path



Modified Mohr Coulomb Path - Using Stress Path Tangency Method

Cohesion C' (kPa) : 10.52
 Angle of Shear Resistance Φ' (Deg) : 36.29



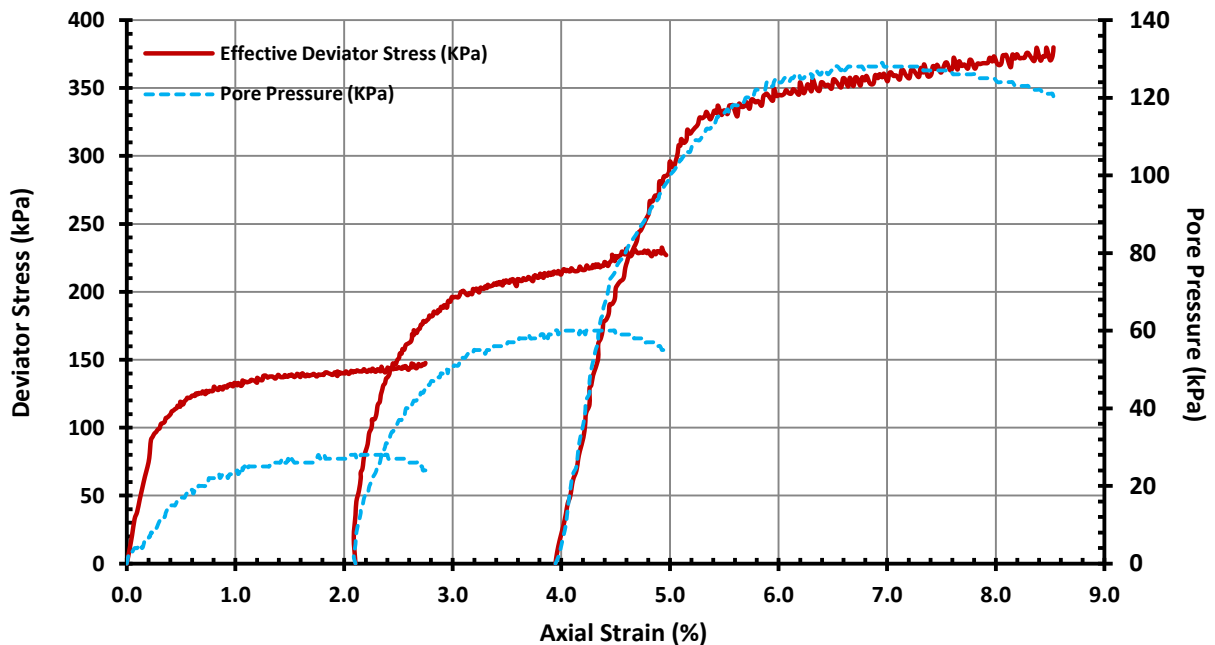
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH15	Lab:	EPLab
Sample ID:	BH15_1_CU3		
Depth (m):	3.00 - 3.40	Room Temperature at Test:	~ 18°C

Deviator Stress Vs Strain Diagram



SHEAR STAGE DATA AND STRESS MEASUREMENTS (kPa)

Shear Stage	Confining Pressure	U ₀	U _f	Principal Effective Stresses			σ ₁ ' - σ ₃ '	Strain (%)
				σ ₁ '	σ ₃ '	σ ₁ ' / σ ₃ '		
1	65	0	28	181	37	4.90	144	2.40
2	120	0	60	283	60	4.71	223	4.49
3	240	0	128	477	112	4.26	365	7.31



MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH15	Lab:	EPLab
Sample ID:	BH15_1_CU3		
Depth (m):	3.00 - 3.40	Room Temperature at Test:	~ 18°C

Photo After Test

Sample ID: BH15
Lab ID: BH15_1_CU3

Depth (m): 3.00 - 3.40
Date Tested: 21/01/2023



Failure Mode: Bulging Failure

Notes:

Stored and Tested the Sample as received
Samples supplied by the Client

NATA: 19078

Authorised Signatory (Geotechnical Engineer):



The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87



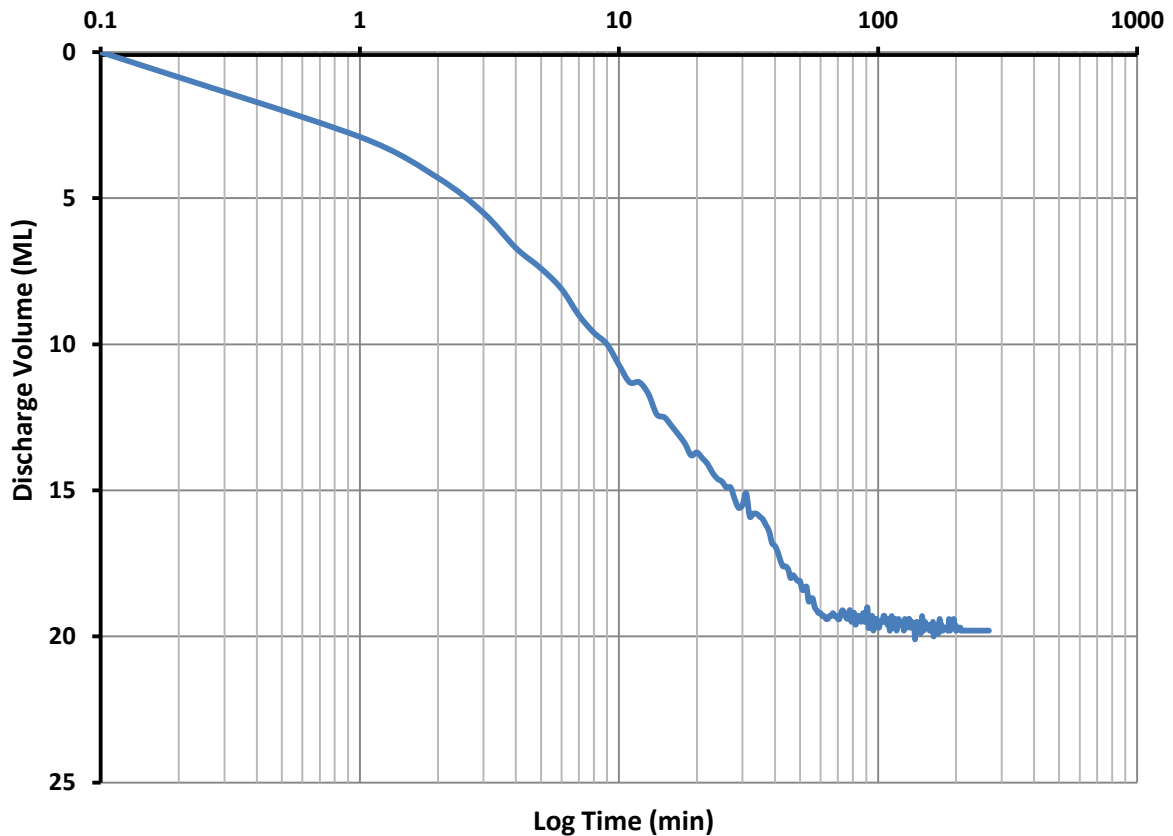
E-PRECISION LABORATORY

MULTI-STAGE CONSOLIDATED UNDRAINED TRIAXIAL TEST

Method: AS1289.6.4.2 / In-house Method

Client:	CMW Geosciences	Date Tested:	21/01/2023
Project:	Mira Mar 2023 Testing	EP Lab Job Number:	CMW
Sample No:	BH15	Lab:	EPLab
Sample ID:	BH15_1_CU3		
Depth (m):	3.00 - 3.40	Room Temperature at Test:	~ 18°C

Discharge Volume (ML) Vs Log Time (min)



C_v (cm²/s): 0.073 based on t_{90}

APPENDIX E

Oblique Images from Drone Survey Data Presentation

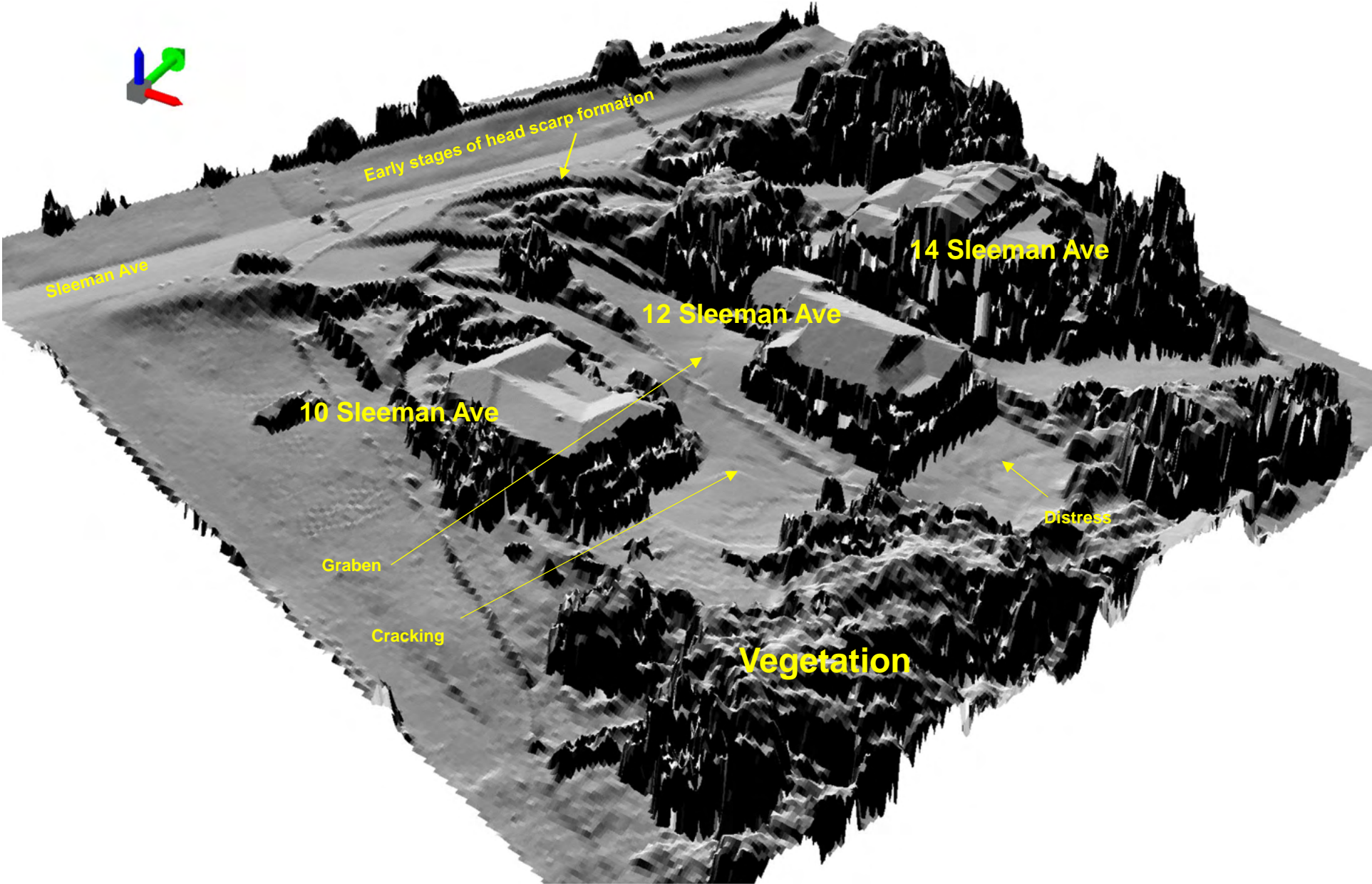


Oblique Images from Drone Survey Data Mira Mar Landslide

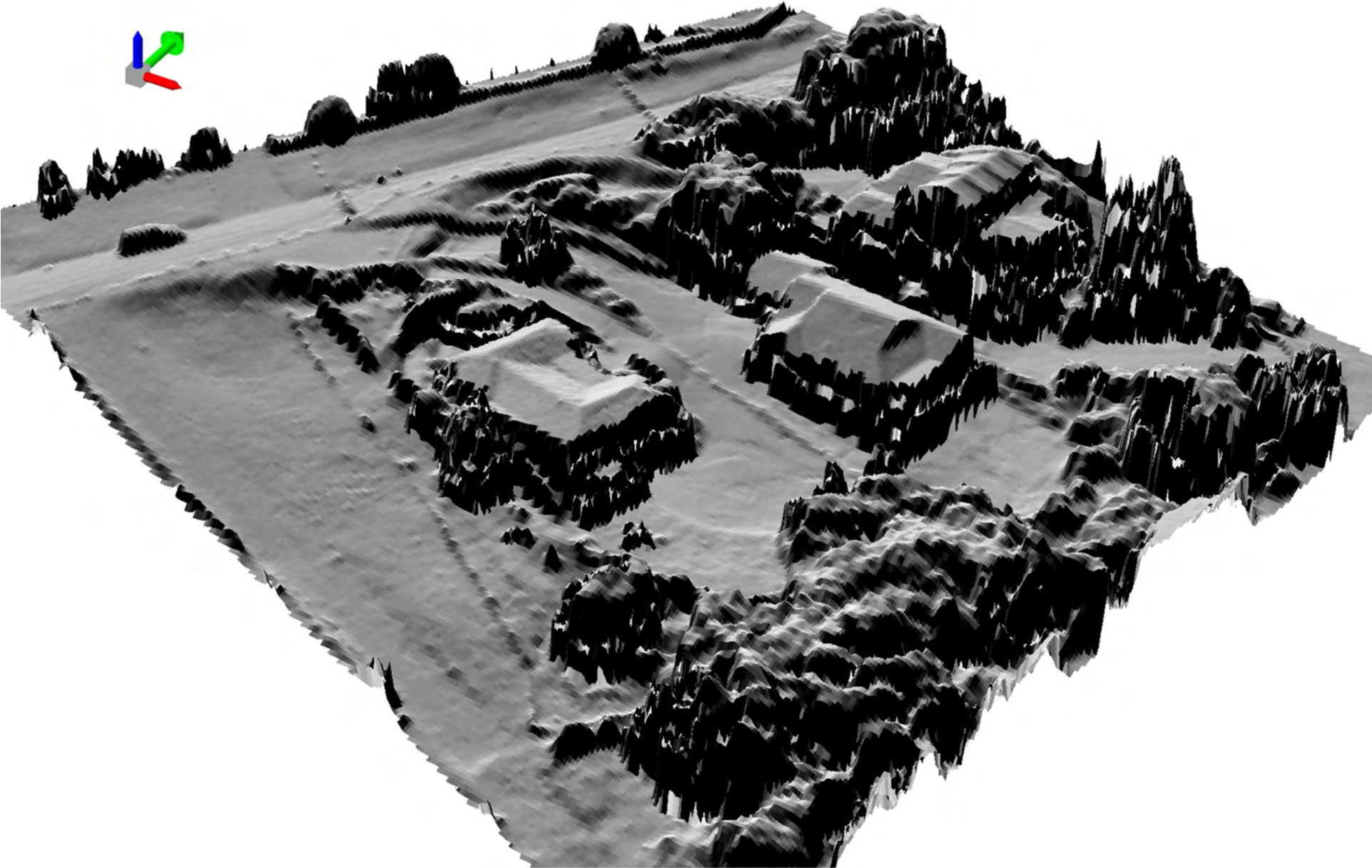
27 February 2023



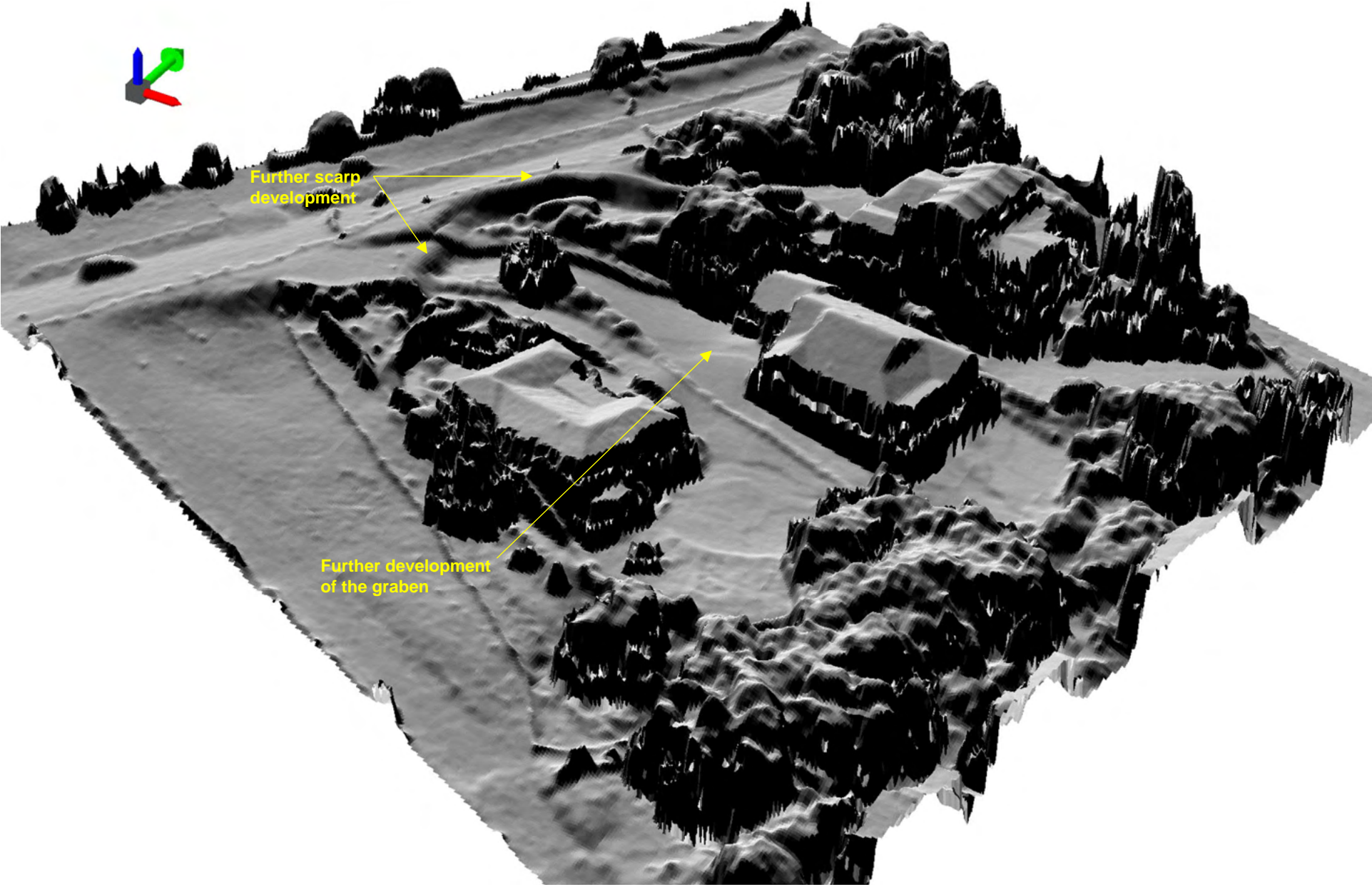
Survey Date: 14 September 2021



Survey Date: 21 September 2021



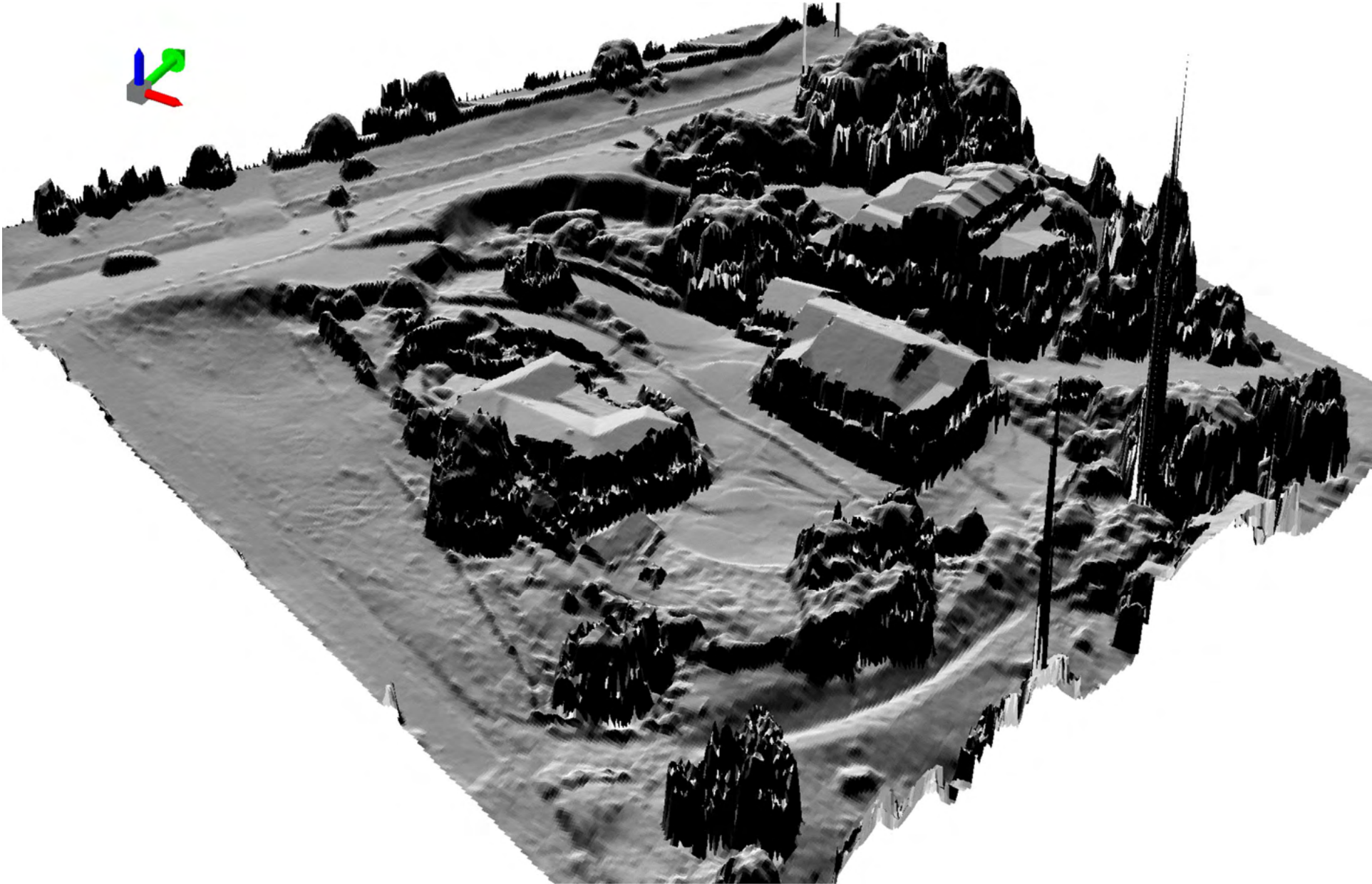
Survey Date: 5 October 2021



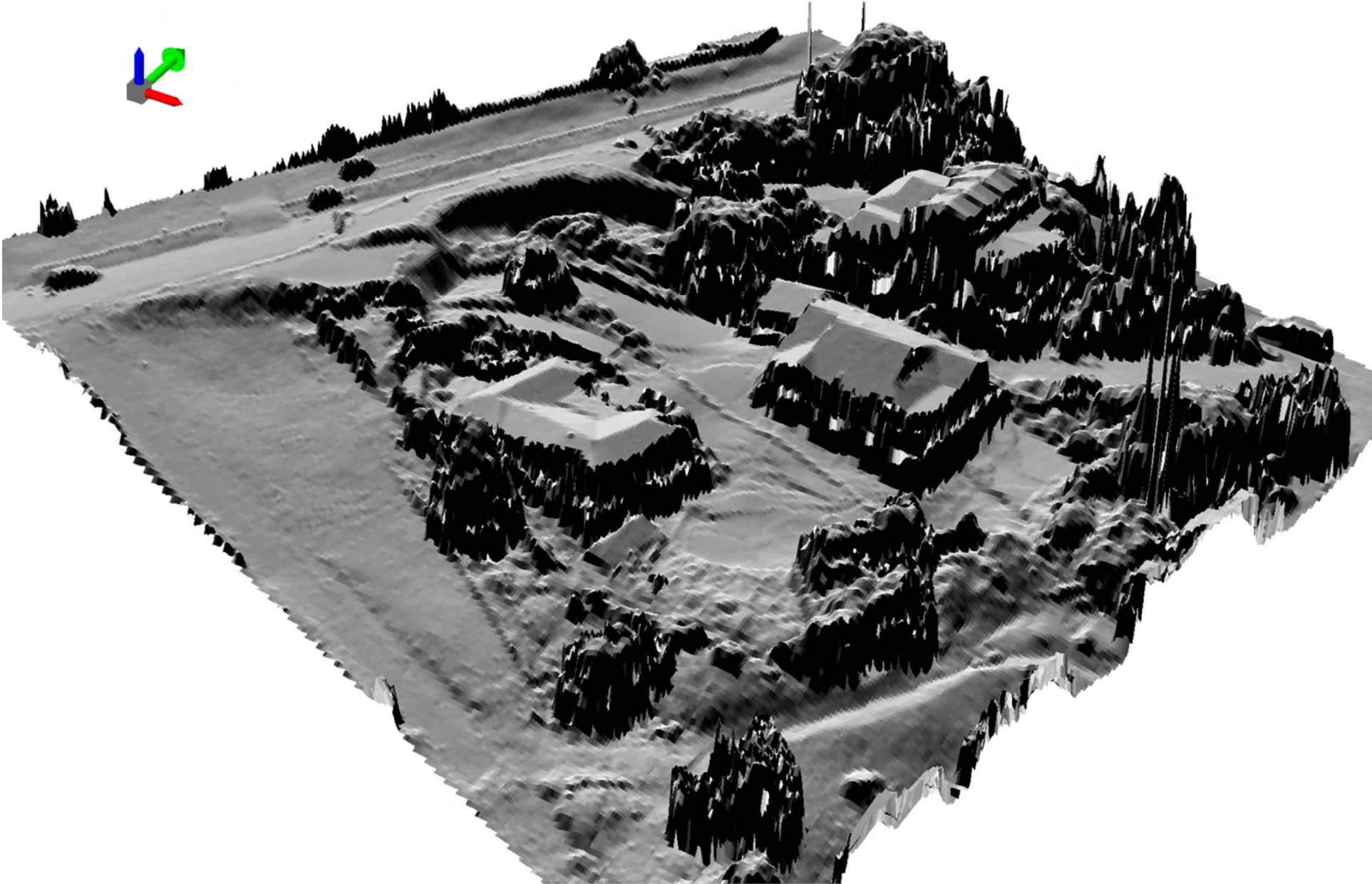
Further scarp development

Further development of the graben

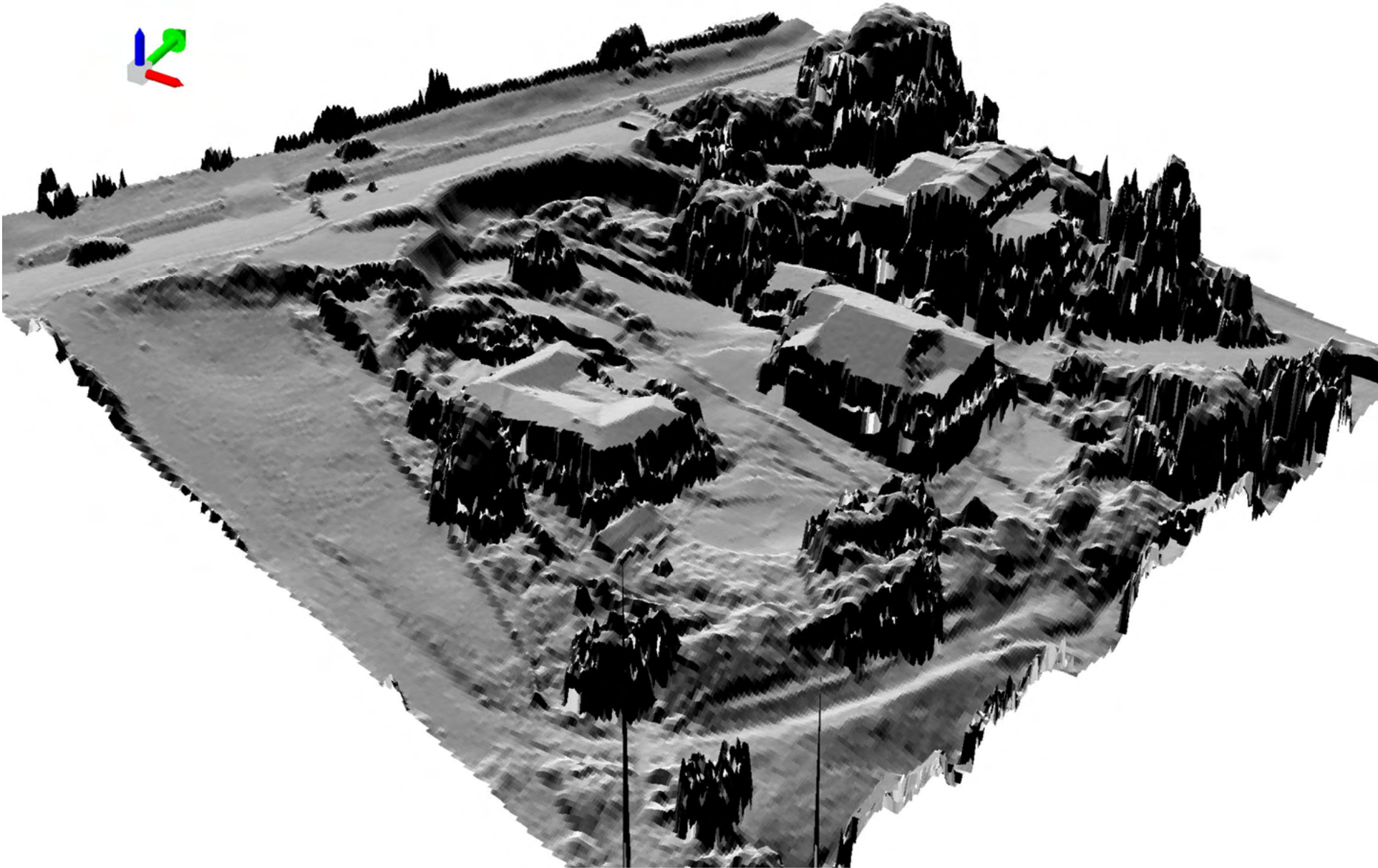
Survey Date: 4 November 2021



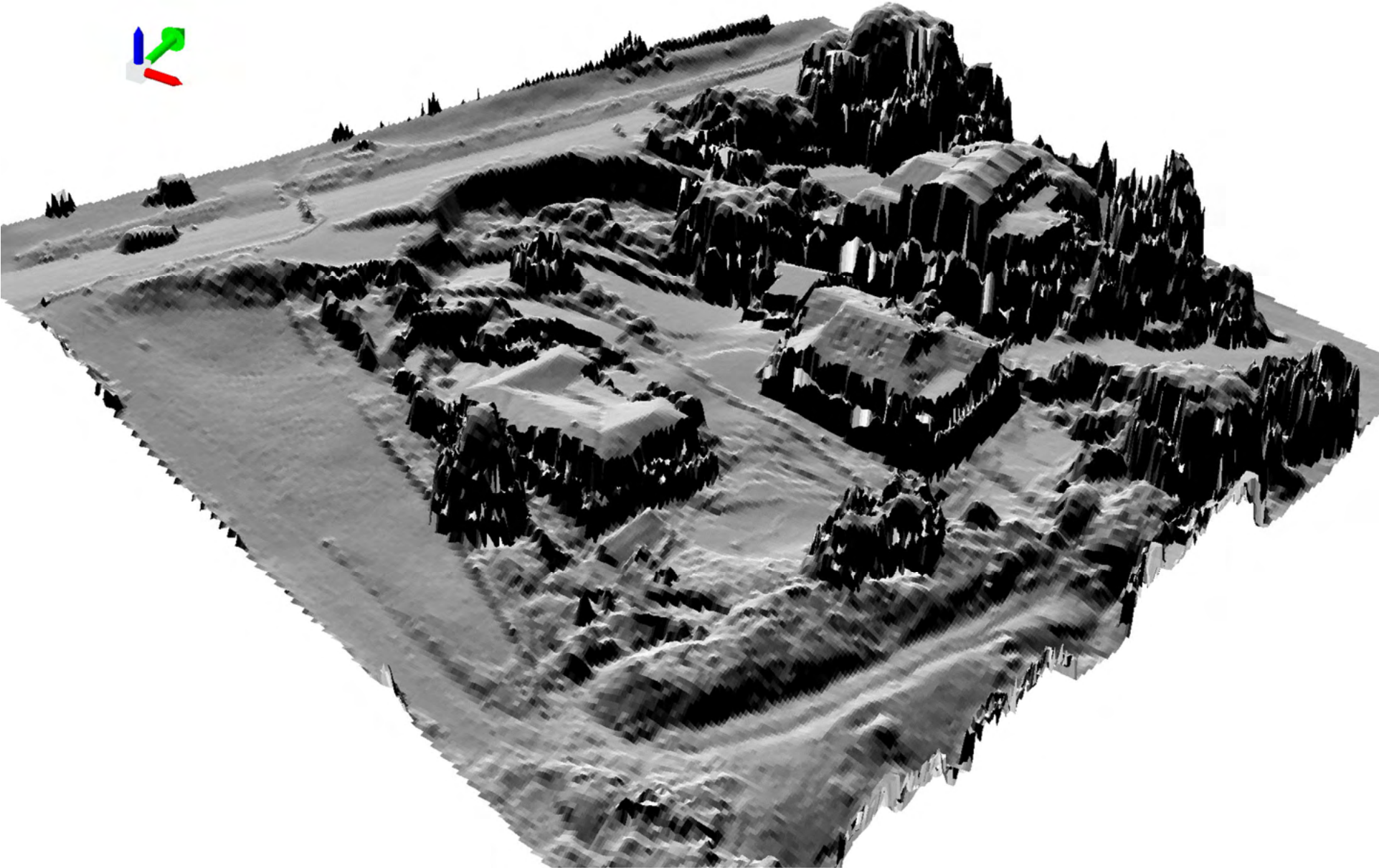
Survey Date: 24 November 2021



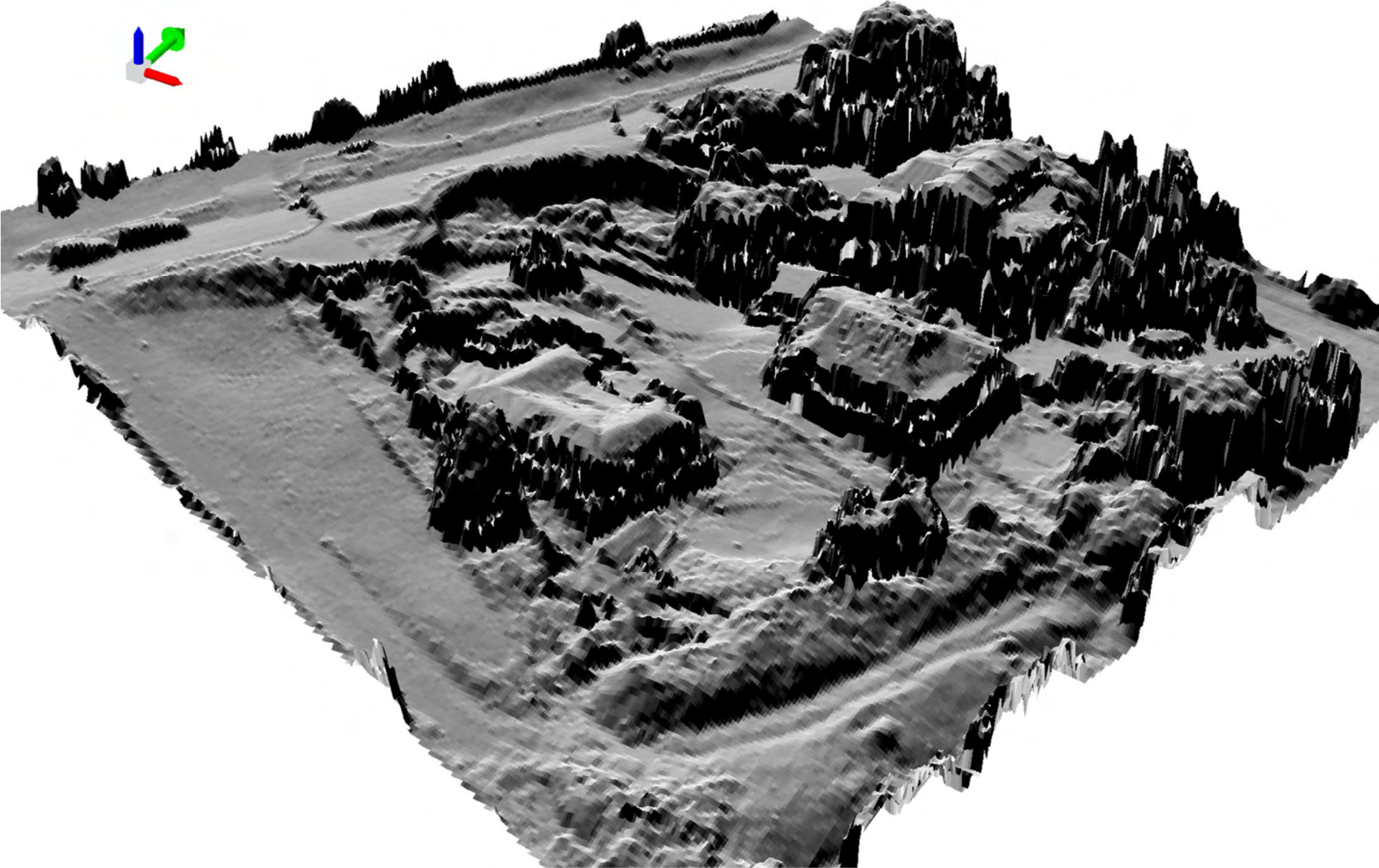
Survey Date: 16 December 2021



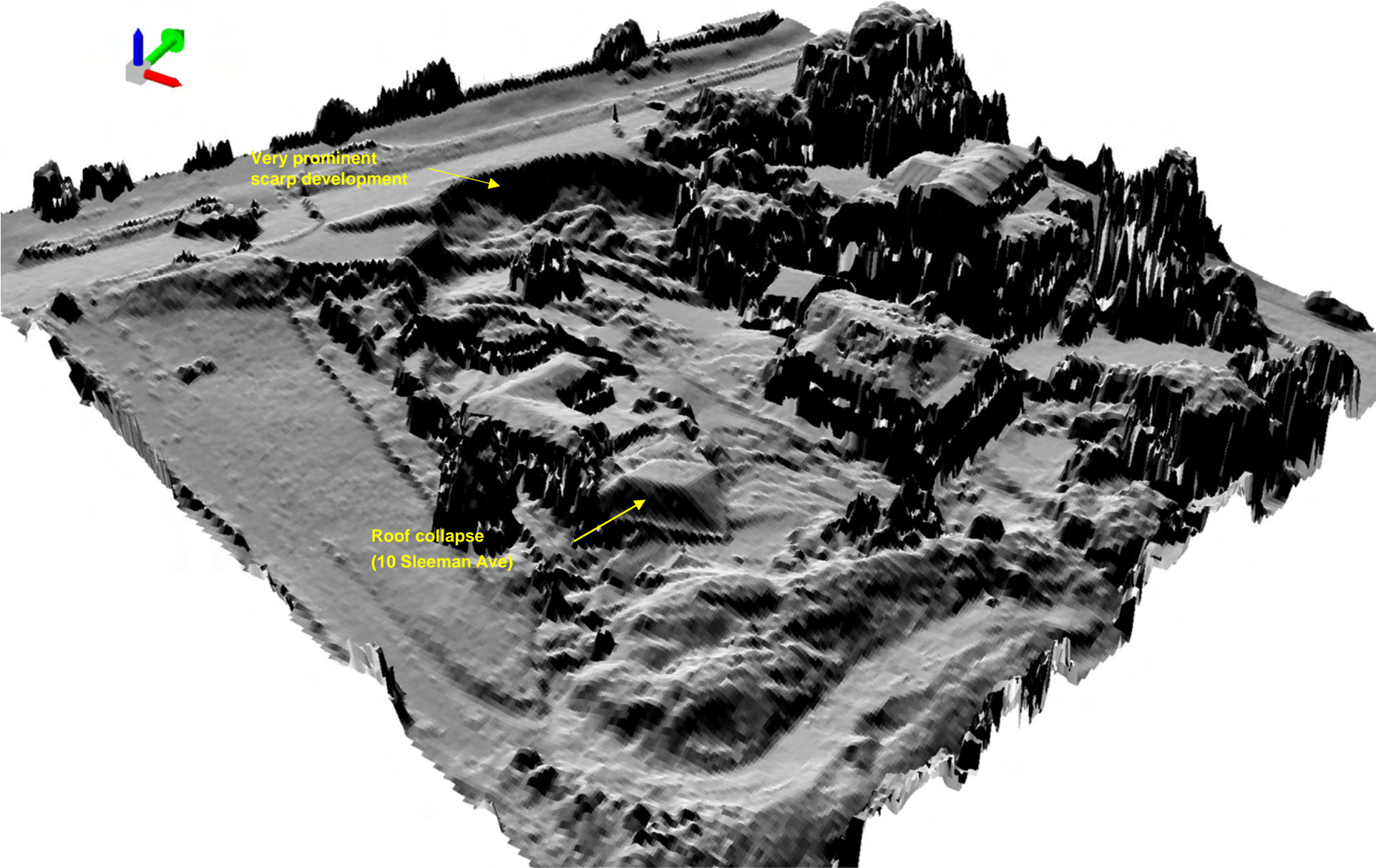
Survey Date: 25 January 2022



Survey Date: 16 February 2022



Survey Date: 29 April 2022



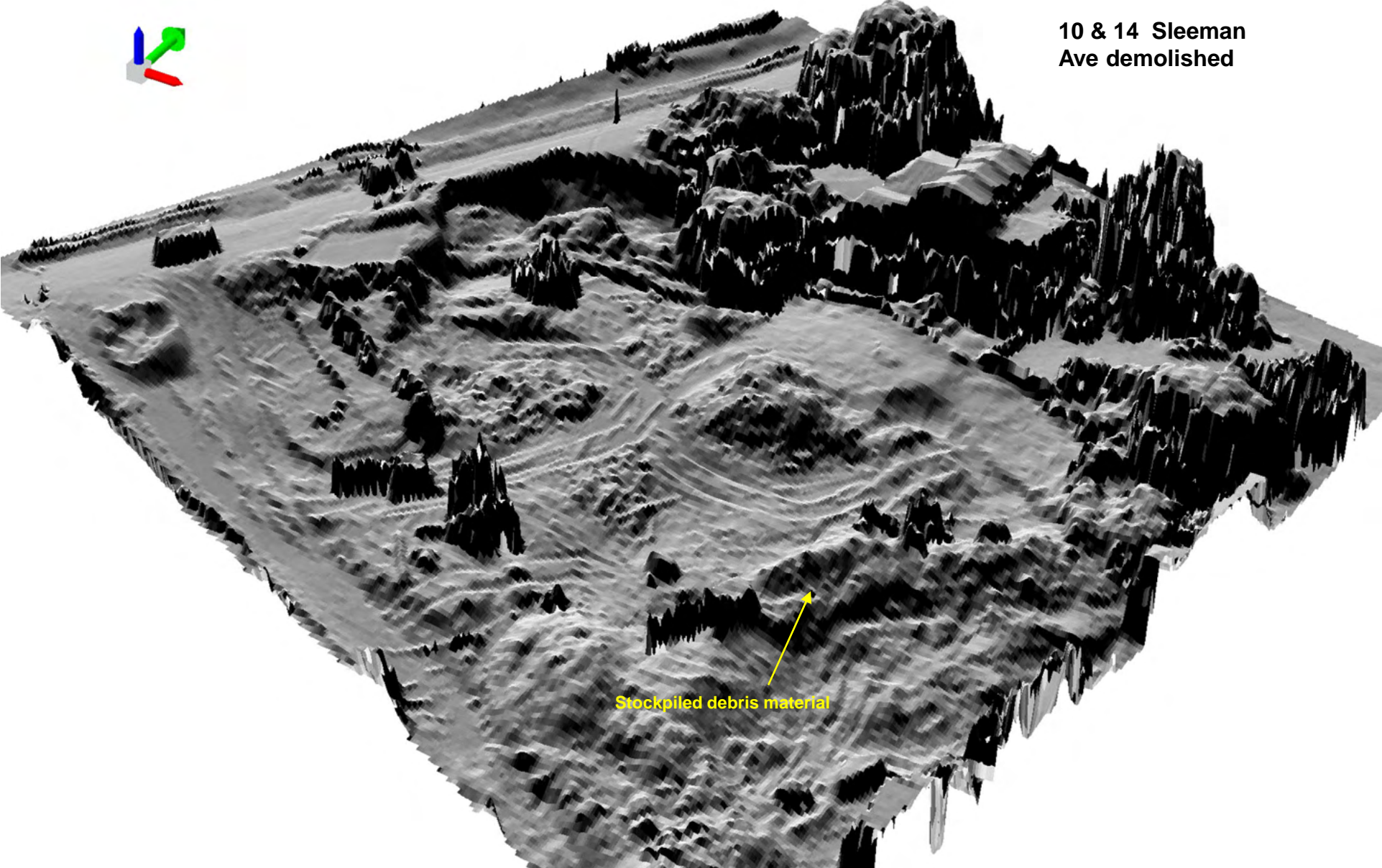
Very prominent scarp development

Roof collapse (10 Sleeman Ave)

Survey Date: 16 May 2022

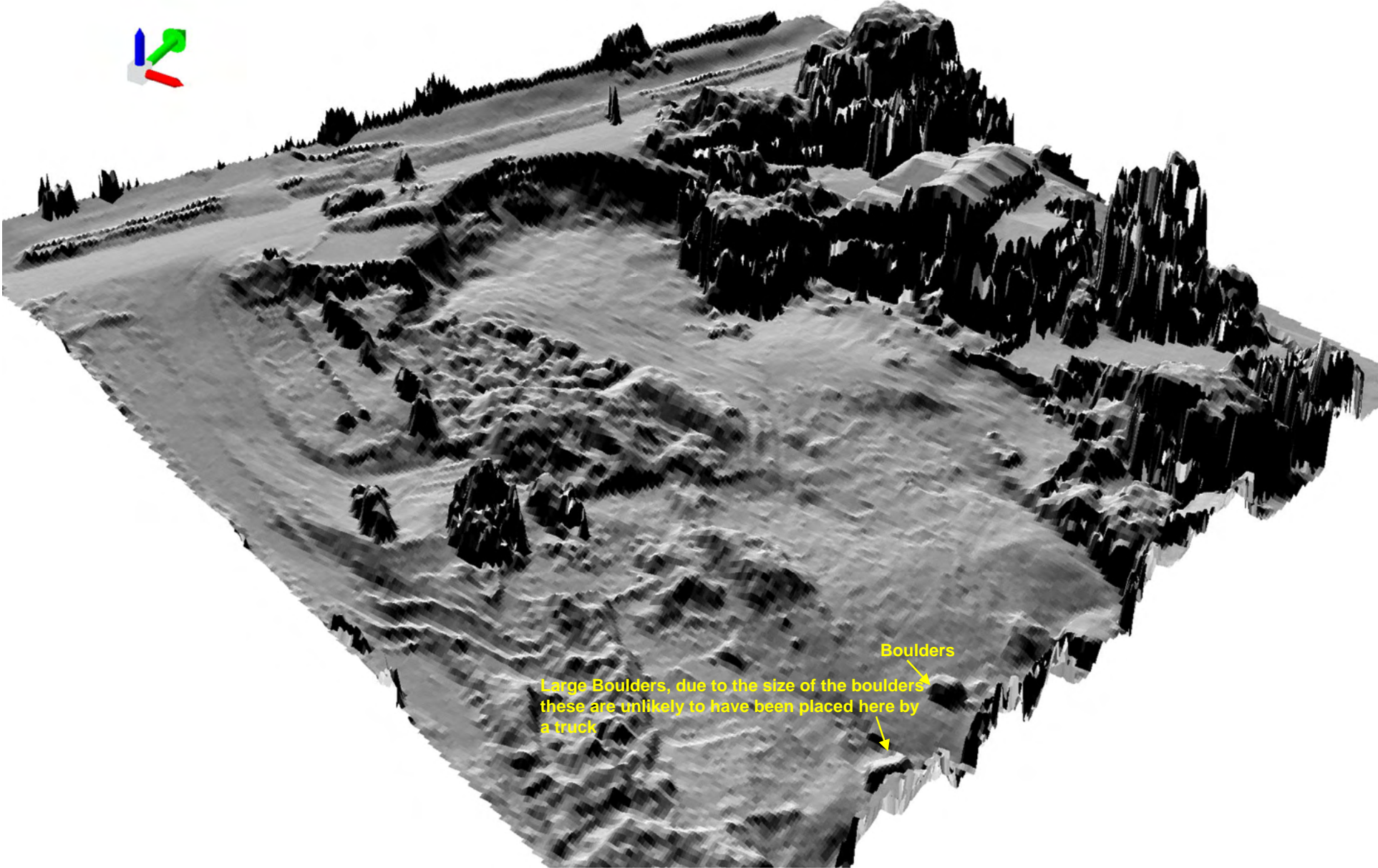


10 & 14 Sleeman Ave demolished



Stockpiled debris material

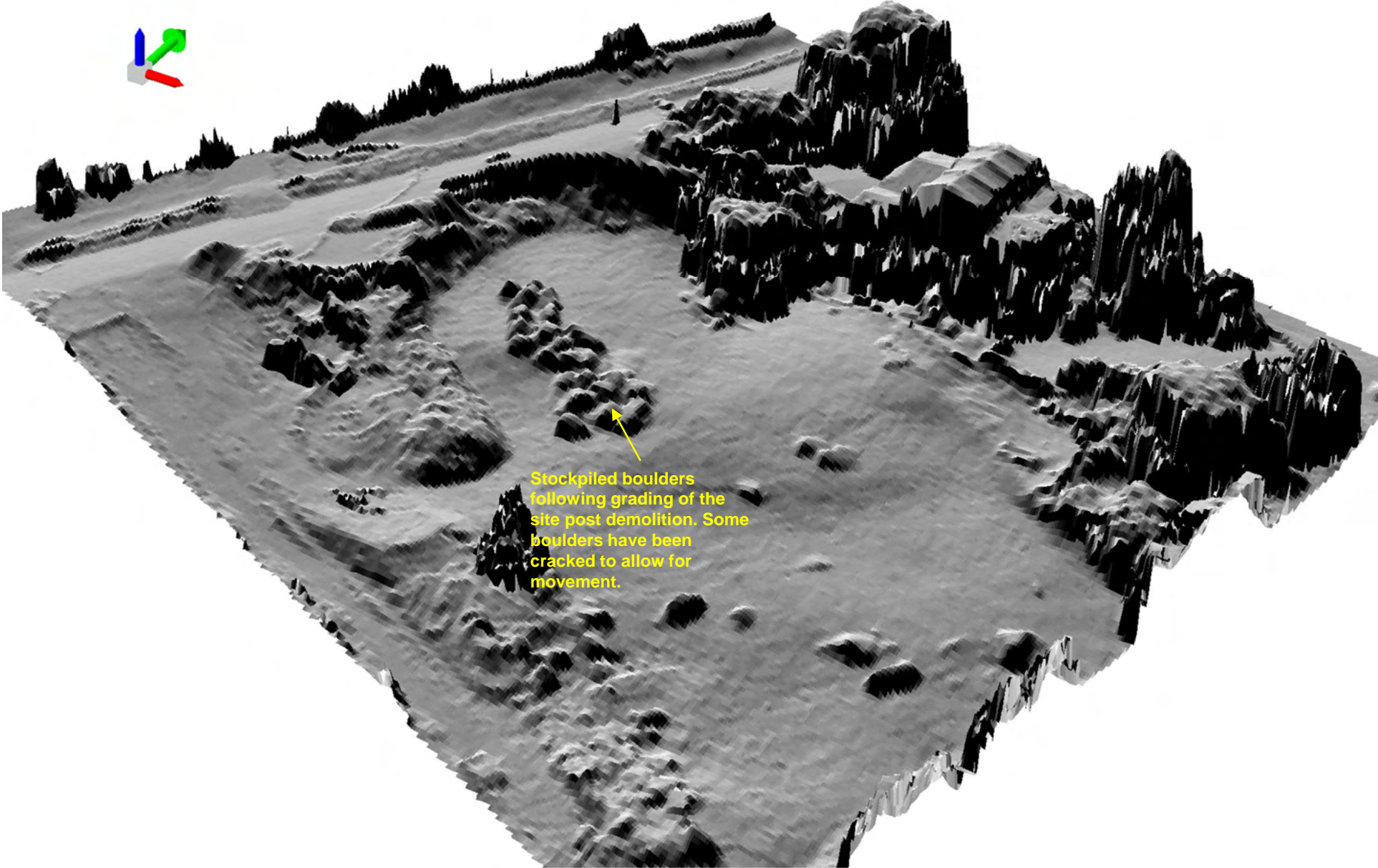
Survey Date: 25 May 2022



Boulders

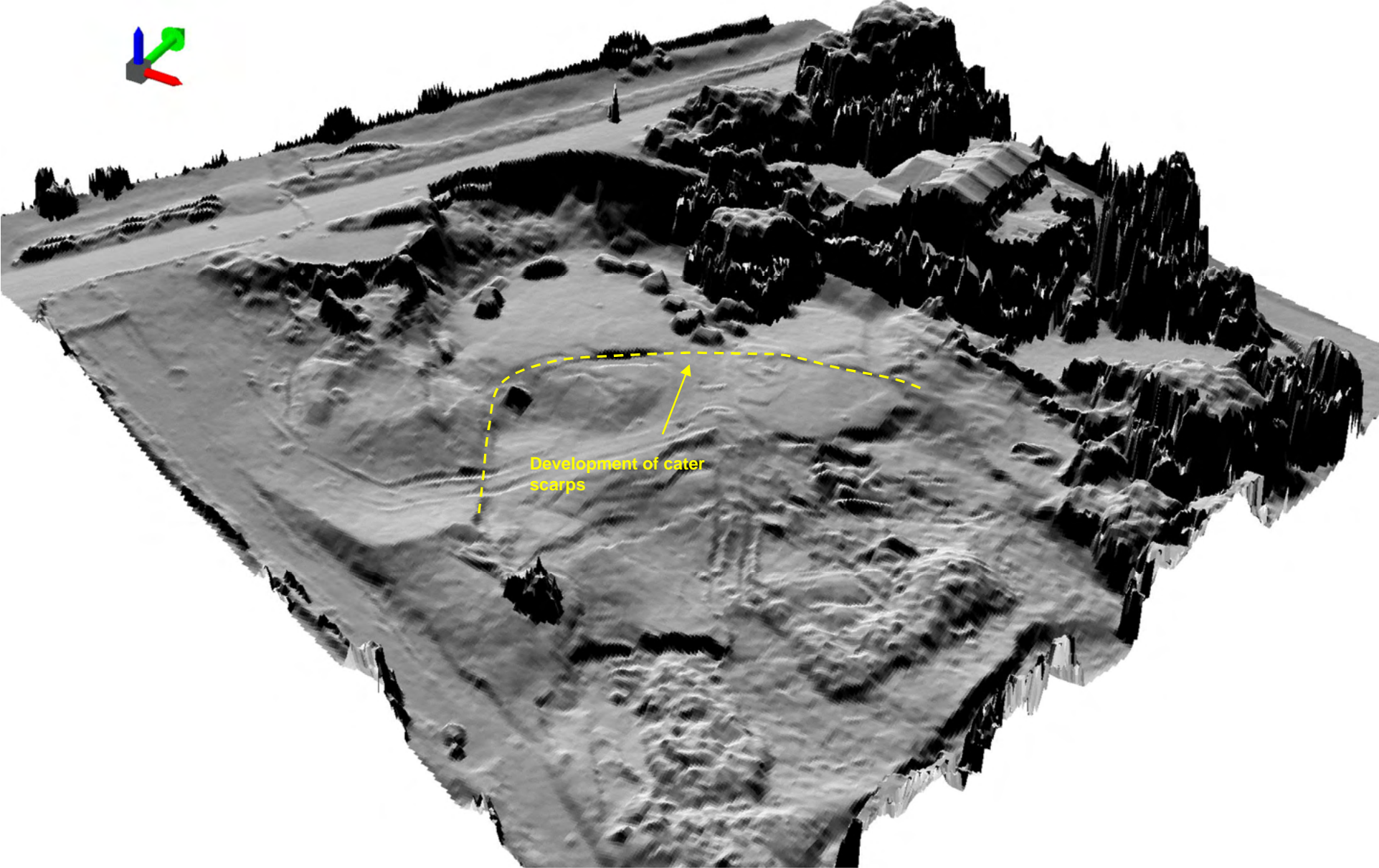
Large Boulders, due to the size of the boulders these are unlikely to have been placed here by a truck

Survey Date: 9 June 2022

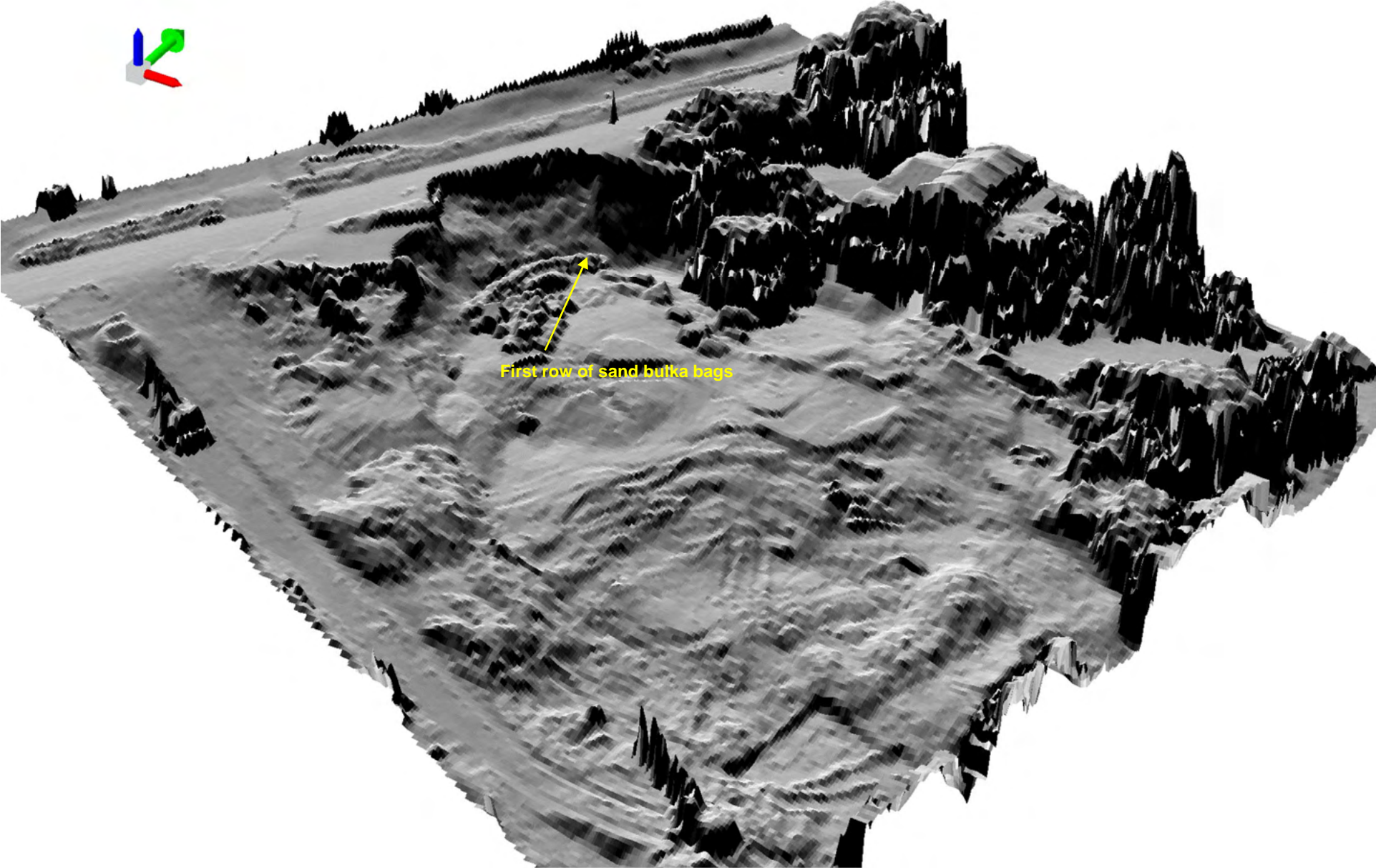


Stockpiled boulders following grading of the site post demolition. Some boulders have been cracked to allow for movement.

Survey Date: 6 July 2022

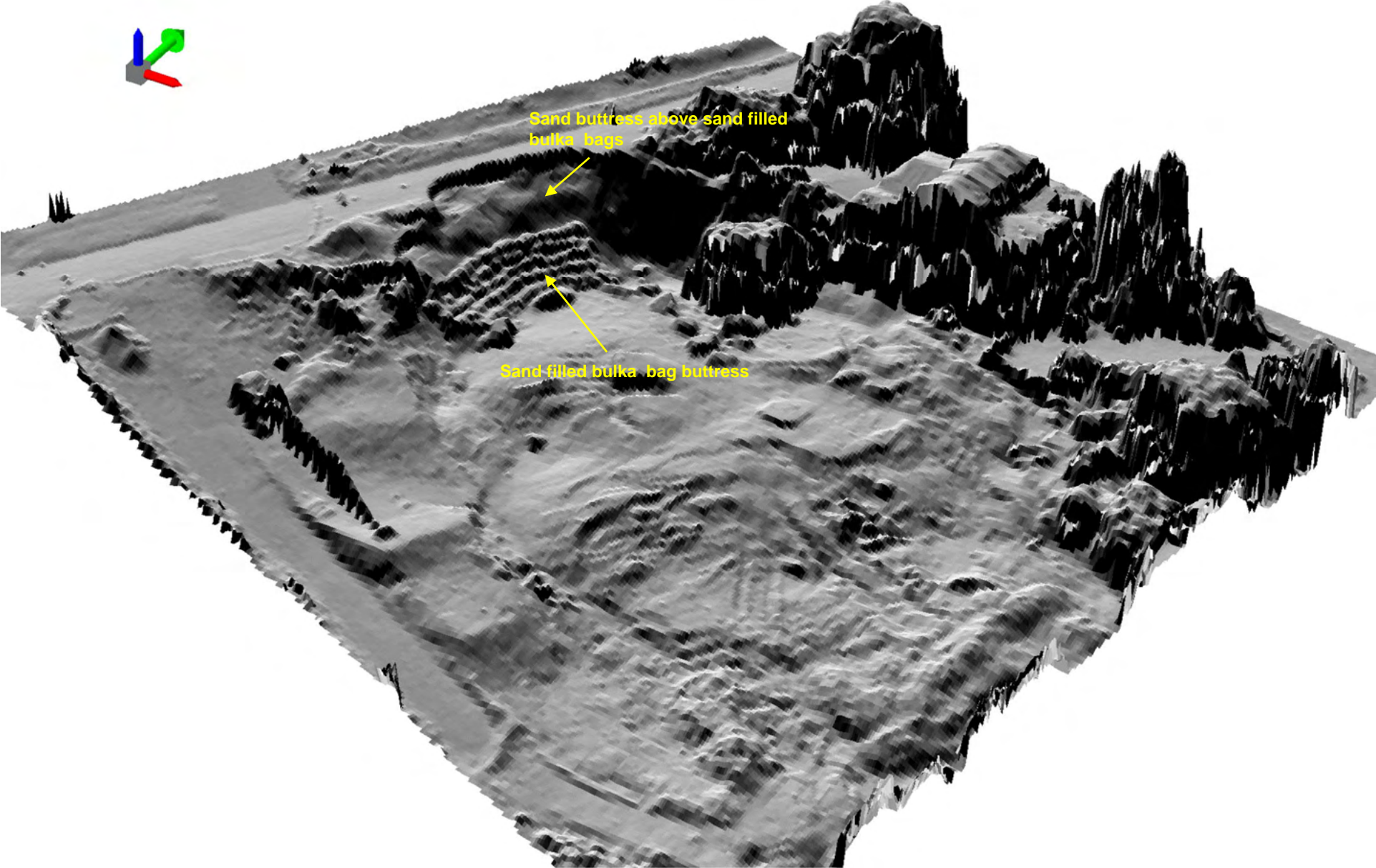


Survey Date: 23 August 2022



First row of sand bulka bags

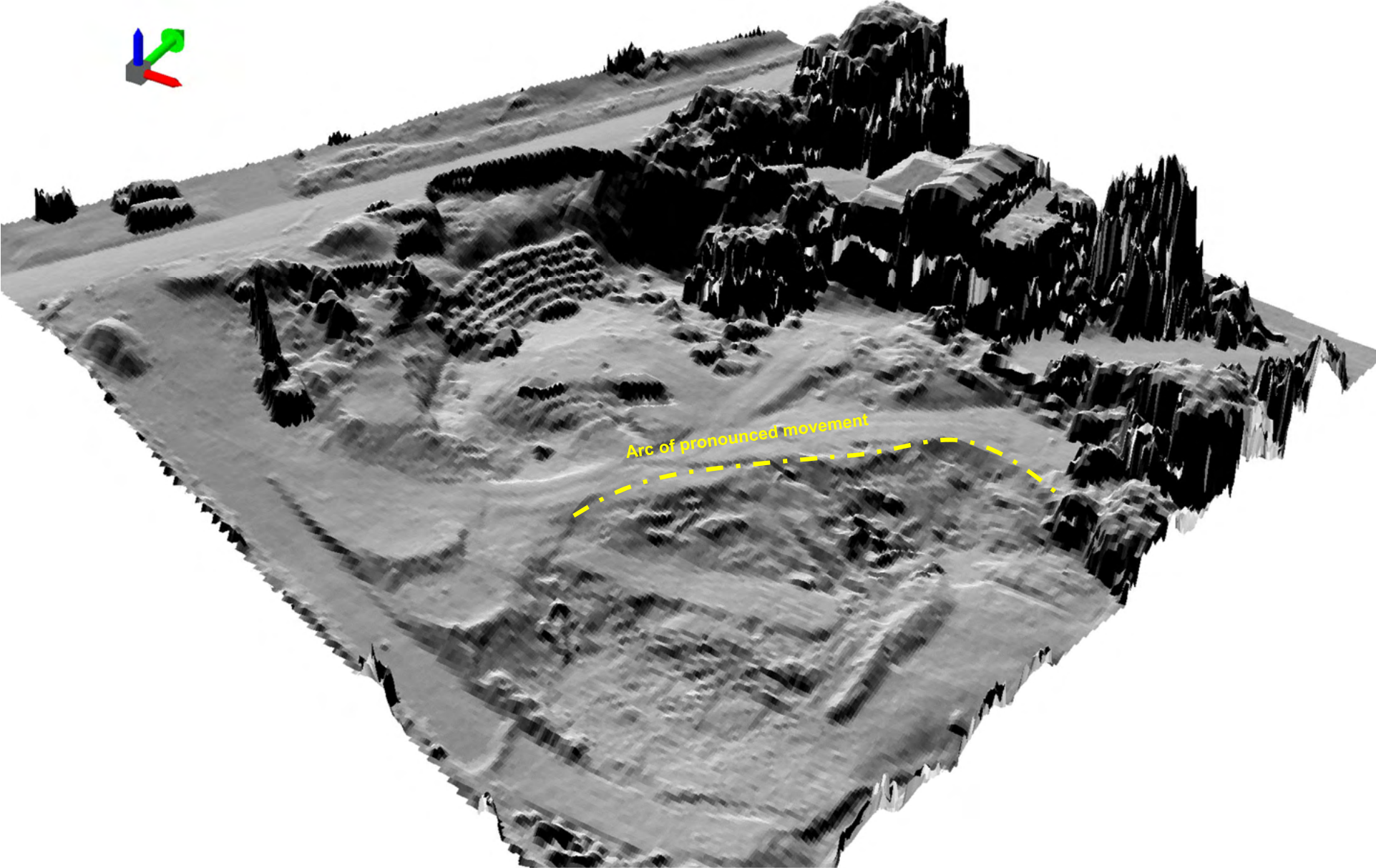
Survey Date: 2 November 2022



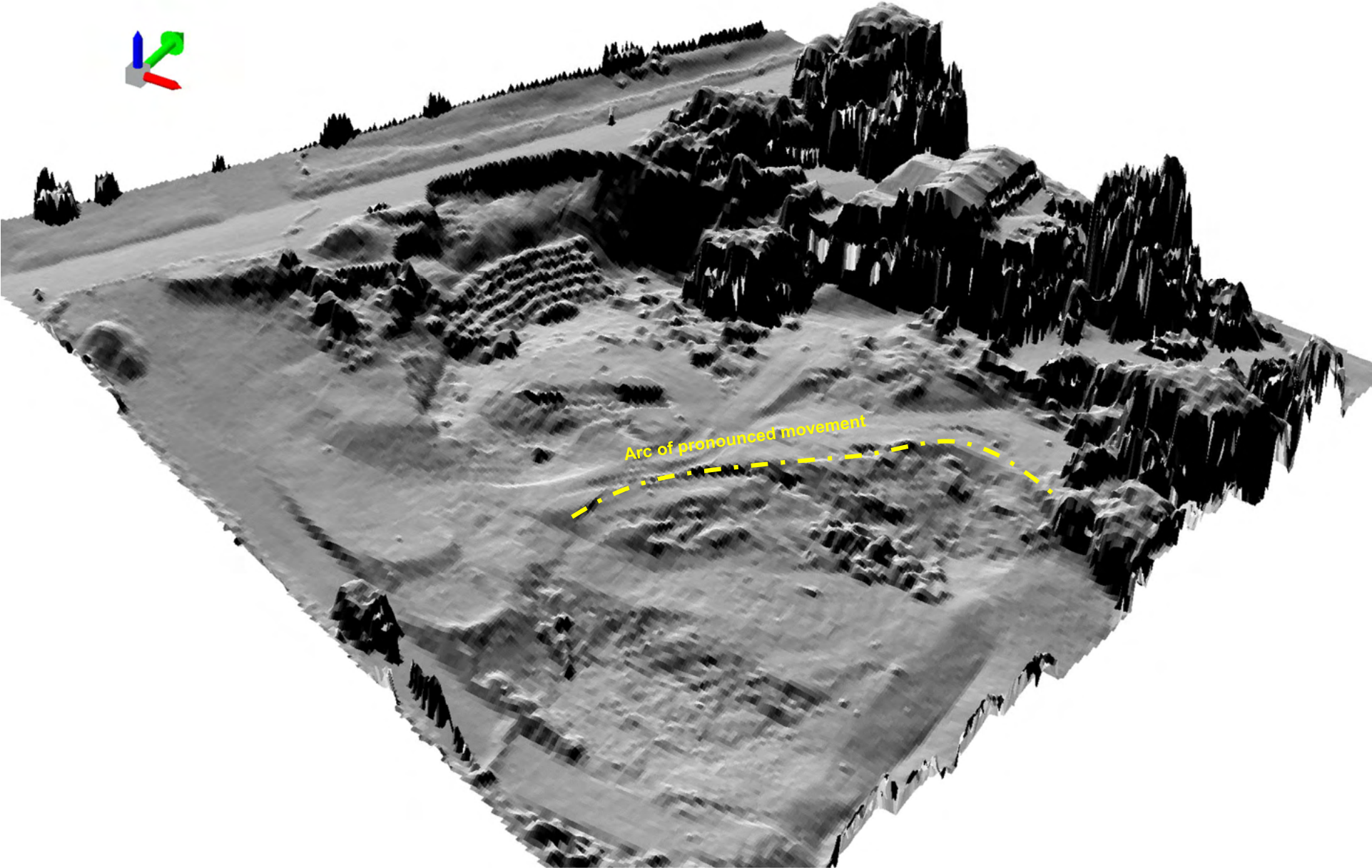
Sand butress above sand filled bulka bags

Sand filled bulka bag butress

Survey Date: 23 December 2022



Survey Date: 9 February 2023



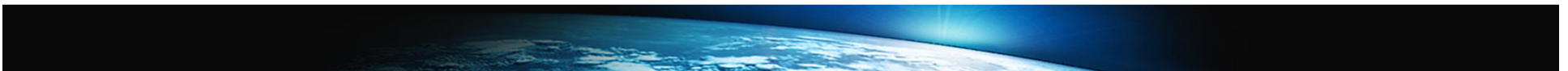
APPENDIX F

Slope Stability Analysis Results

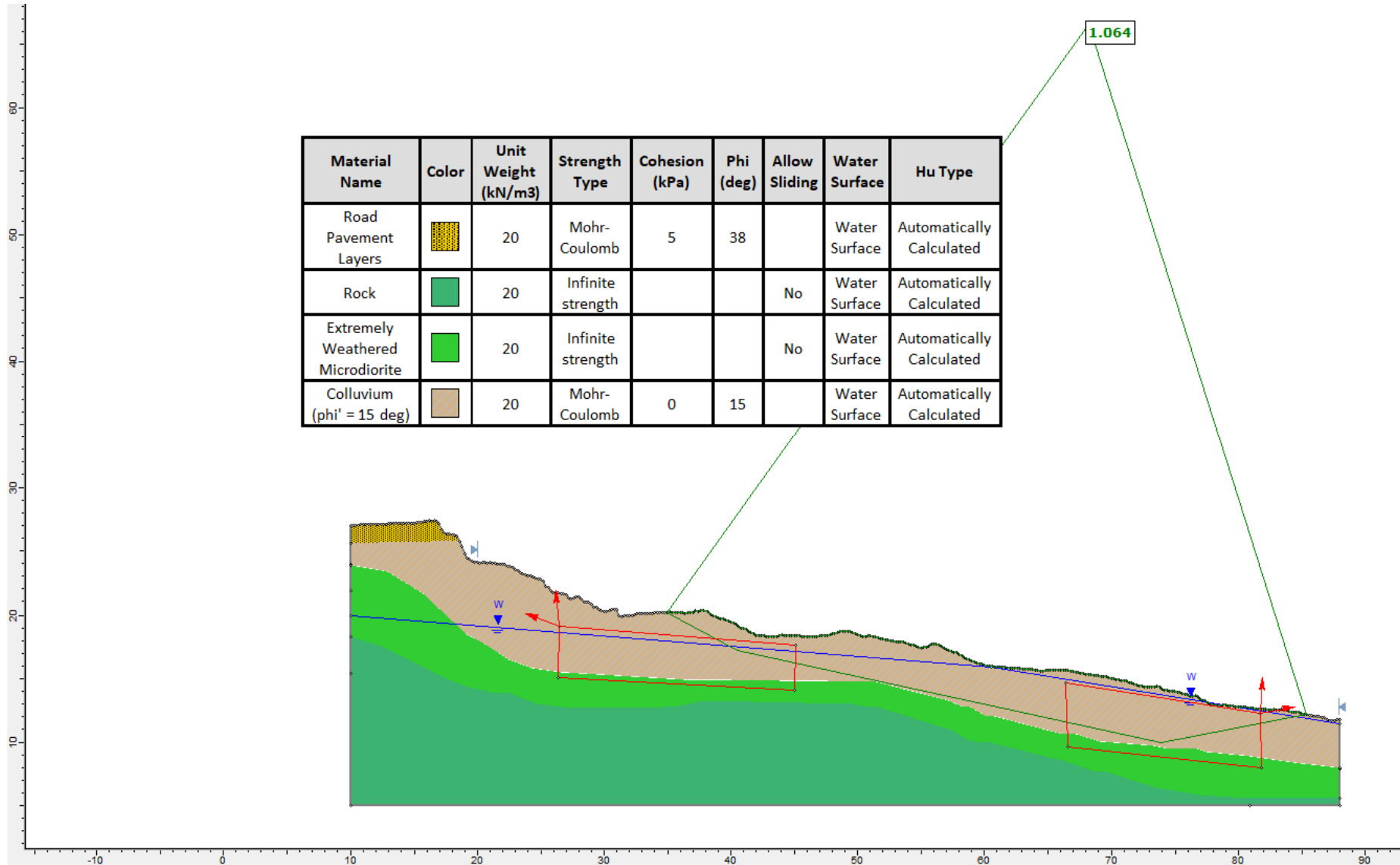


Slope Stability Analysis Mira Mar Landslide

27 March 2023



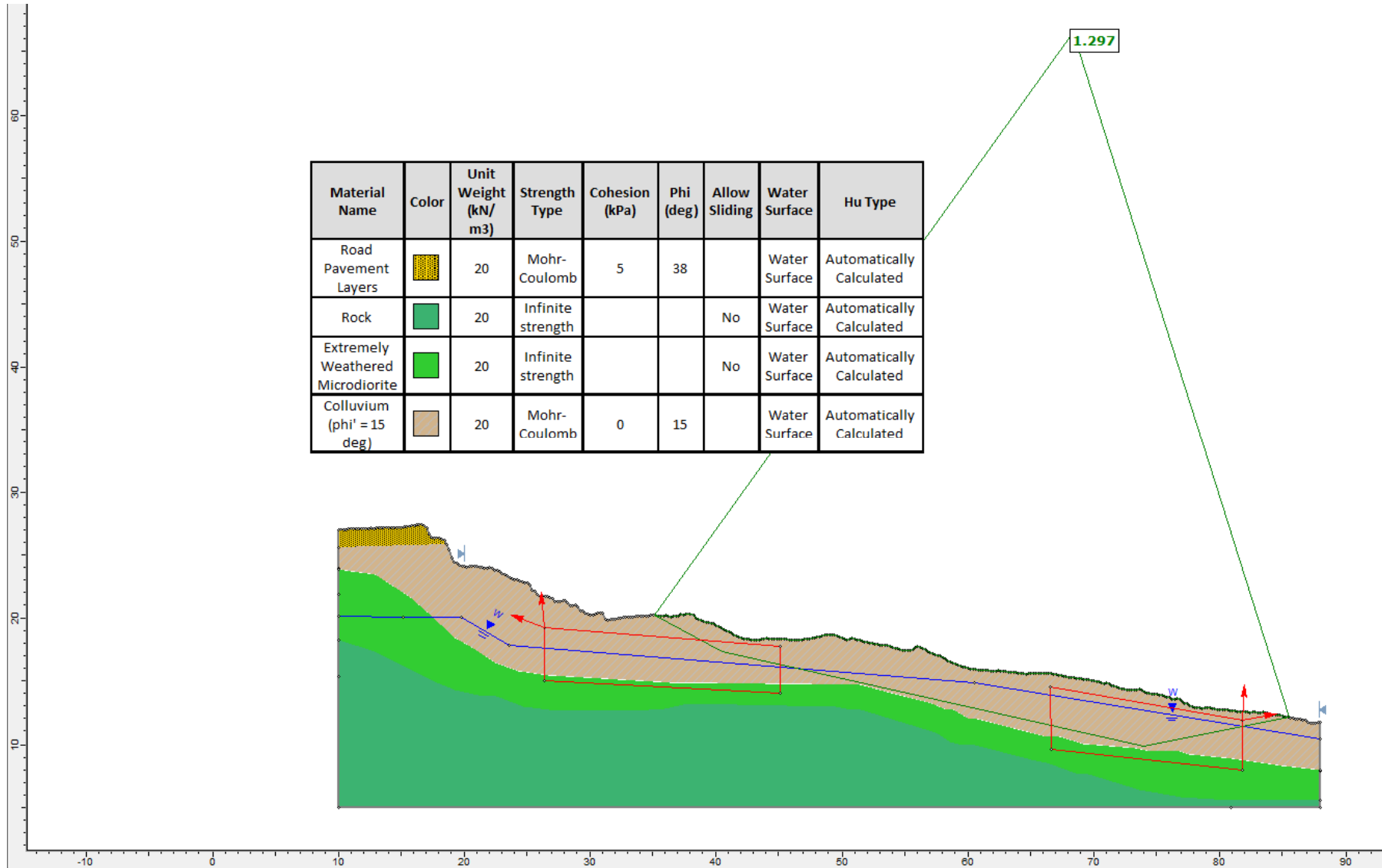
Analysis Case 1: Existing surface topography Existing groundwater level



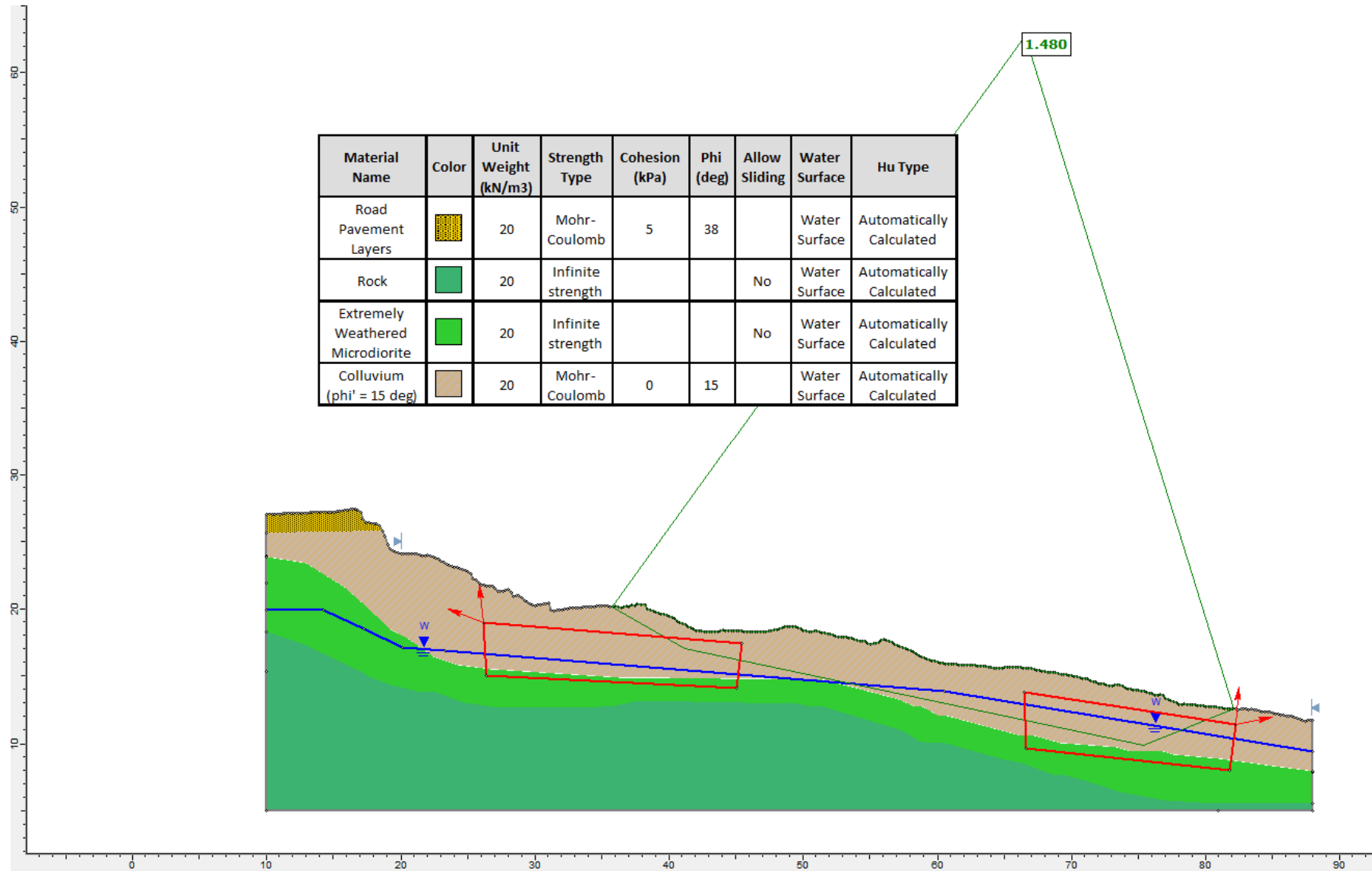
Analysis Case 2 :

Existing surface topography

Existing groundwater level reduced by 1m

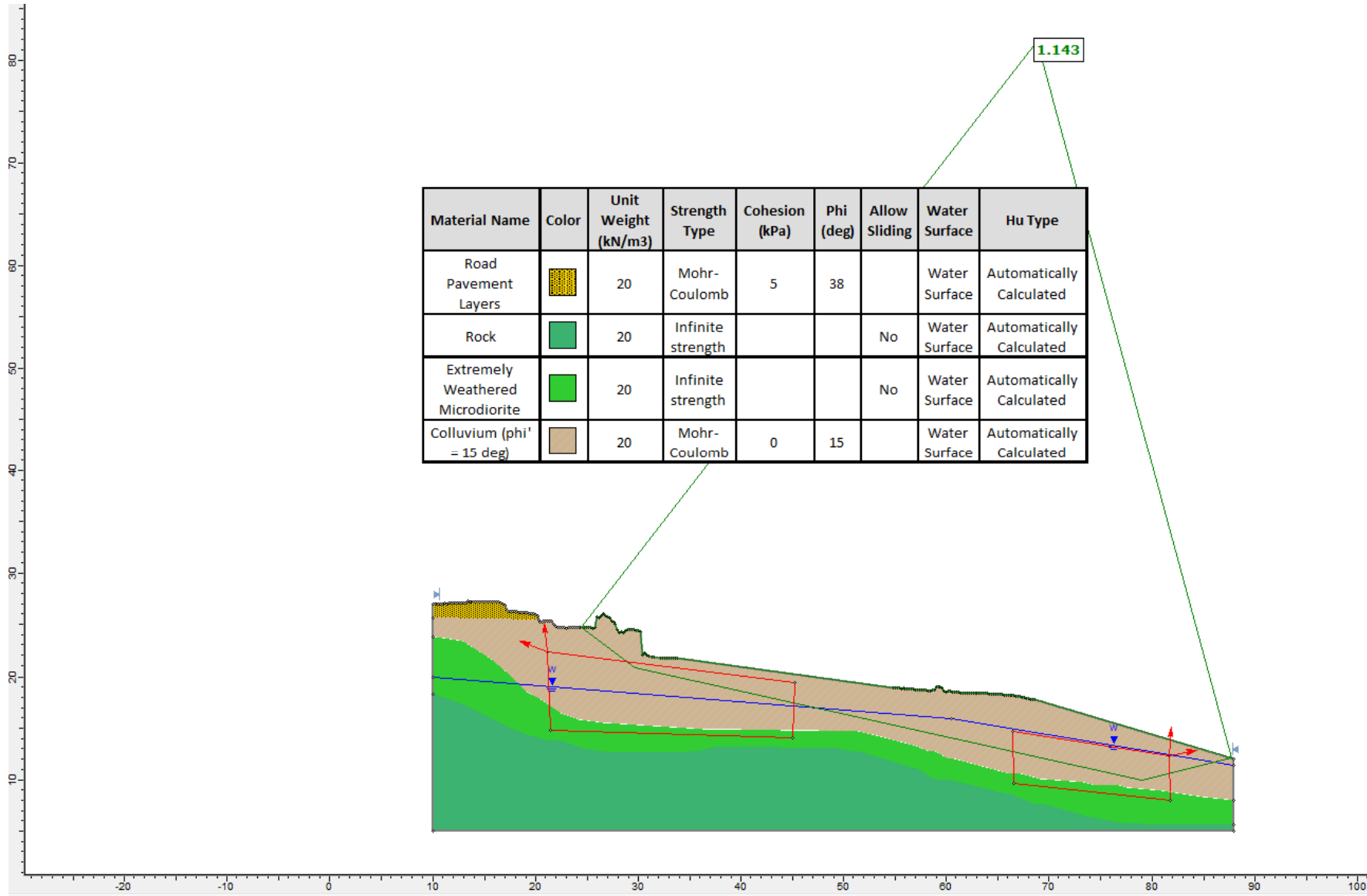


Analysis Case 3: Existing surface topography Existing groundwater level reduced by 2m



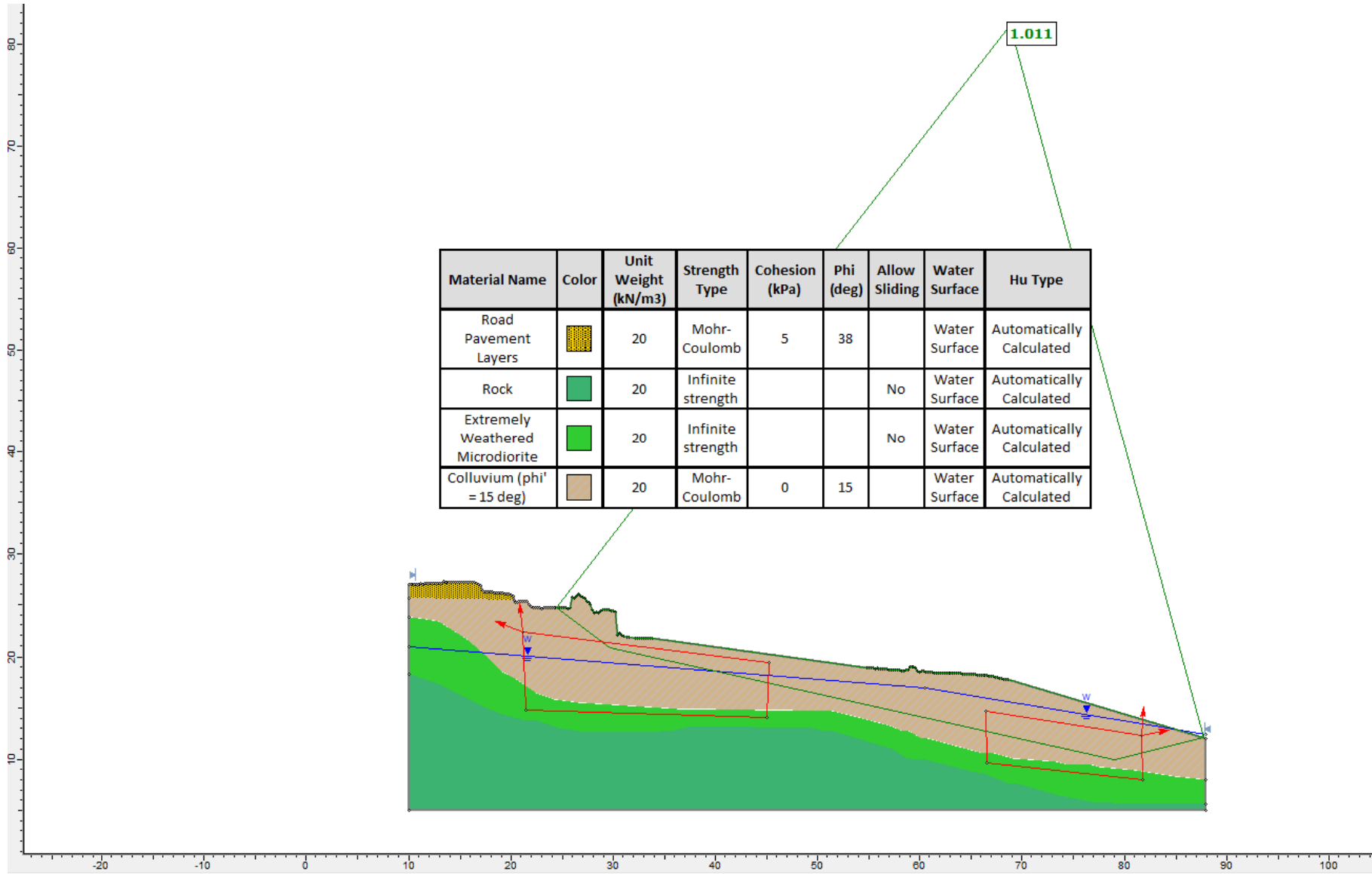
Analysis Case 4: September 2021 surface topography February 2023 groundwater level

Analysis based on back calculated residual values from Feb 2023 geometry – actual shear strength parameters likely higher at the time of the 2021 landslide before significant shear occurred.



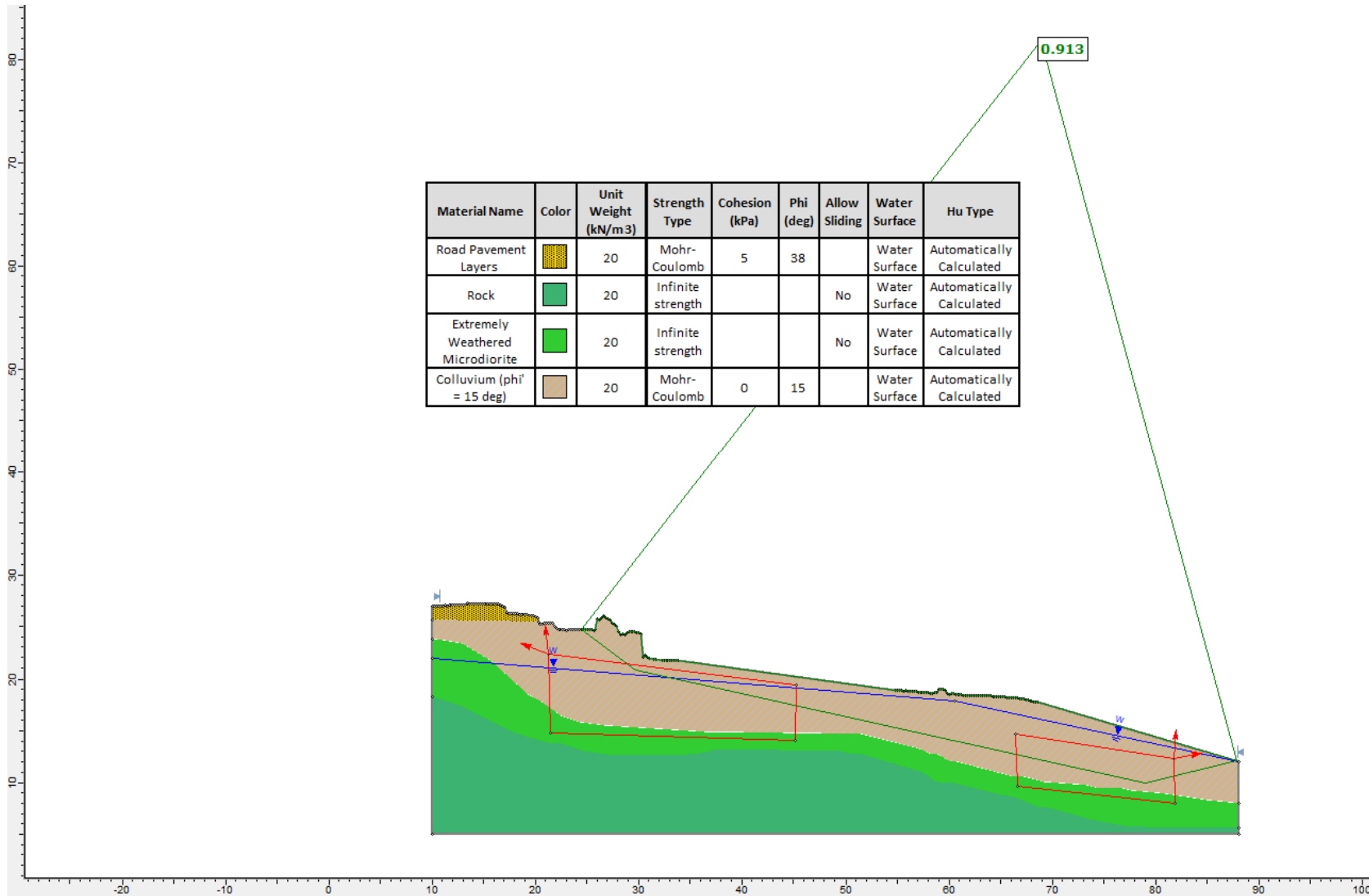
Analysis Case 5: September 2021 surface topography February 2023 groundwater level raised by 1 m

Analysis based on back calculated residual values from Feb 2023 geometry – actual shear strength parameters likely higher at the time of the 2021 landslide before significant shear occurred.

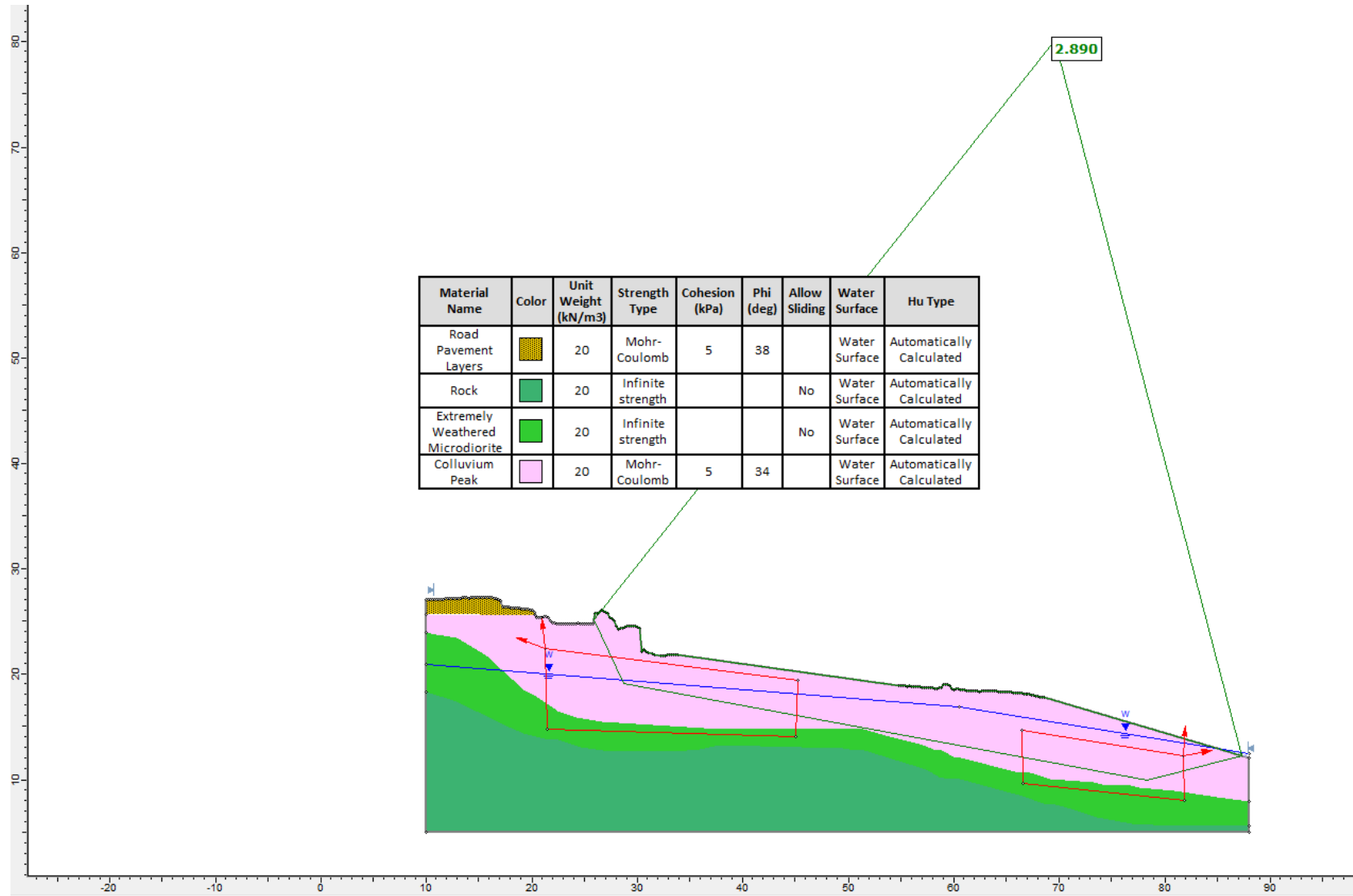


Analysis Case 6: September 2021 surface topography February 2023 groundwater level raised by 2 m

Analysis based on back calculated residual values from Feb 2023 geometry – actual shear strength parameters likely higher at the time of the 2021 landslide before significant shear occurred.



**Analysis Case 7:
September 2021 surface topography
February 2023 groundwater level raised by 1 m
Peak Strength – Colluvium**



Analysis Case 8: Remediated Topography using shear key concept

