REPORT

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Tonkin+Taylor

Tahunanui Slump

August 2022 Nelson Storm Event Geotechnical Assessment

Prepared for
Earthquake Commission
Prepared by
Tonkin & Taylor Ltd
Date
June 2023
Job Number
1089612 v2

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Document control

Title: Tahunanui Slump					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
24/04/2023	1	Draft report	s9(2)(a)		
23/06/2023	2	Final report			

Distribution:

Earthquake Commission	1 PDF copy
Tonkin & Taylor Ltd (FILE)	1 PDF copy

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Client summary

A high intensity rainfall event affected the Nelson region on 15-17 August 2022 causing natural disaster damage including flooding and landslides. One such area of natural disaster land damage was the deep-seated Tahunanui Slump (TS). In addition to the movement observed of the deep-seated TS, the August 2022 event (the *event*) also triggered shallower instability in various areas within the TS, across a range of depths. Ground movement in these Land Damage Areas led to local evacuation of residents in the northern part of the Tahunanui Slump during the Civil Defence emergency, and approximately forty-five claims to the Earthquake Commission (EQC) for natural disaster damage.

Prior to the *event*, the general mechanisms controlling landslide movement have not been well documented, with the depth of movement having only been confirmed by monitoring of two boreholes drilled on behalf of EQC in 2012 at locations on and downslope of Grenville Terrace.

Following the August 2022 event, a surface and subsurface investigation and installation of instrumentation has been undertaken in the northern part of the TS (the main area of damage resulting from the event) on behalf of EQC. As part of this investigation, ground movement (inclinometers) and groundwater monitoring instruments (piezometers) were installed in boreholes, and monitoring carried out prior to preparation of this report to assist in the interpretation of the mechanisms controlling ground movement within the TS. This includes real-time telemetered ground movement and groundwater monitoring instruments.

The EQC investigation and monitoring has:

- Significantly improved the understanding of the depth, extent and mechanisms controlling deep-seated instability in the northern part of the TS.
- Highlighted that the area affected by deep-seated landslide is not as extensive as previously thought.
- Improved the understanding of the extent and mechanisms controlling subsidiary areas of movement observed within the TS following the event.
- Penetrated the inferred base of the TS in a further four (4) locations (though the inclinometers are yet to record definitive deep-seated displacements at all locations confirming the inferred failure depth).
- Confirmed that groundwater levels have returned to pre-event levels.
- Allowed a less conservative approach and greater level of consistency of individual assessments with respect to the determination of natural disaster damage and imminent risk relating to individual EQC claims stemming from the current event.
- Provided a source of further data on which future assessment can be carried out (following further monitoring) to allow refinement of the engineering geological model. Ongoing collection and analysis of real-time ground movement and groundwater data from instruments installed on behalf of EQC will assist predictions of ground displacements resulting from future likely natural hazard events (and damage to insured property and civic infrastructure).
- Allowed discussion around potential remedial solutions to manage future natural disaster risk for the various areas of land movement within the TS.

This geotechnical summary report has been prepared to summarize existing subsurface investigations and monitoring, knowledge on the mechanisms controlling landslide movement in the land damage areas, and an interpretive geotechnical model of the TS based on data up until the time of preparation of this report (19 April 2203). No interpretation of telemetered groundwater and

ground movement monitoring data received after preparation, but prior to finalization of this report is provided within this report, however the factual data is attached in Appendix E for completeness.

Based on available investigation and monitoring data, inferred mechanisms controlling the areas of observed land movement within the TS are presented. The feasibility of potential instability mitigation measures relating to each of the land damage areas is discussed.

Recommendations for further work are presented within this report, including ongoing monitoring of ground movement and groundwater levels, and modelling of likely future natural hazard scenarios.

It is also recommended that further assessment be carried out to establish the downslope extent of deep-seated instability in the Grenville Terrace area where our assessment has confirmed historic observations of a zone of compression at the northern end of Grenville Terrace that may define the toe of the active deep-seated displacements of the TS.

1 Introduction

Following the high intensity rainfall event of 17–20 August 2022 both shallow and deep-seated landslide ground displacement occurred within the Tahunanui Slump (TS) causing damage to land insured under the Earthquake Commission (EQC) Act.

Approximately forty-five (45) EQC claims were lodged for natural disaster damage resulting from the August 2022 event (the *event*).

1.1 Purpose of assessment report

This subsurface investigations, installation of monitoring instruments and geotechnical assessment were scoped primarily to:

1 Provide geotechnical data on which to allow an assessment of the depth and mechanisms controlling the various observed areas of deep and shallow ground movement observed within the TS following the *event* in order to support individual assessments of the extent of property damage and imminent risk under the EQC Act.

As discussed with EQC, these investigations also have the secondary purpose of contributing to the knowledge of the mechanisms controlling both deep and shallow movements within the TS to allow:

2 Publication of recent investigation data and monitoring results for the use of geotechnical practitioners when considering geotechnical risk in relation to site specific development within the TS.

3 Refinement of the engineering geological model of a portion of the TS with ground displacement and groundwater information available at the time of writing this report.

1.2 Scope of work

To achieve the above the following scope of work was undertaken.

- A desk-study review of available published geological information, and relevant existing subsurface investigation information held on T+T files and the New Zealand Geotechnical Database (NZGD).
- Review of recorded historic landslide movement (Section 2.4).
- Review of antecedent conditions prior to the *event* (Section 4.1).
- Subsurface investigations comprising of the following:
  - Six (6) cored machine boreholes to depths between 15 and 35 metres below ground level (m bgl).
  - One (1) wash-drilled machine borehole to 30 m bgl.
  - Three (3) test pits to 2 m bgl.
  - Two (2) hand augers to depths between 0.7 and 2.2 m bgl.
  - Twenty-two (22) dynamic cone penetrometer (Scala) tests to depths between 1.1 and 4.9 m bgl.
- Installation of monitoring instrumentation:
  - Four (4) inclinometers to depths between 30 and 35 m bgl.
  - One (1) Shape Accel Array (SAA) to a depth of 30 m bgl for 'live' ground deformation monitoring at 1-hourly increments.
  - Two (2) vibrating wire piezometers.
  - Four (4) nested vibrating wire piezometers.

  - Two (2) data-loggers.
- Monitoring comprising (Section 5):
  - Four (4) inclinometers monitoring rounds.
  - Monitoring of the Shape Accel Array (SAA) (November 2022 - April 2023).
  - Monitoring of the vibrating wire piezometers (November 2022 - April 2023).
- Development of a conceptual engineering geological model for the area investigated in the northern segment of the TS using the Leapfrog® modelling software (Section 6.1).
- Summarize inferred mechanisms of slope instability within land damage areas (Section 6.2).
- Provided recommendations for further work (Section 6.3).

The above scope of work was carried out as an extension to our existing agreement with EQC for provision of professional services. Approval to proceed with the work was received from Kate Tod of EQC on 12 September 2022.

2 Desk study

2.1 Site description

The TS is a large complex landslide covering an area of 30 hectares (ha) in the Port Hills above Tahunanui Beach, located within Nelson City. Residential development (totalling ~120 houses) is present across the majority of the TS, with the exception of steep slopes in its north and eastern extents.

Figure 2.1: Tahuananui Slump Core Overlay and Fringe Overlay (NRMP)[2].

The Nelson Resource Management Plan (NRMP) has defined the TS as an area of slope risk where specific building or development rules control development[1]. The Tahunanui Slump Risk Area (TSRA) is defined on planning maps and consists of a core area where the landslide has been considered to

[1] NCC, 2012. Nelson Resource Management Plan: Volume 2 Zones. Chapter 7 – Residential.

be active, surrounded by a fringe area which includes the headscarp and side-scarps of the landslide along with an area of variable width marginal to the scarps. The TSRA comprises the Tahunanui Slump Core Overlay (TSCO) and Fringe Overlay (TSFO) as shown below in Figure 2.1 (the area covered by the TSCO and TSFO is also shown on the figures attached in Appendix A.

2.2 Geomorphology

The main geomorphic features present within the TS are shown on Figure 1089612-F2 and Figure 2.2 and are discussed below.

Tahunanui Slump main scarp

The area comprises a 5 to 70 m high steeply inclined (35-55°) sparsely vegetated slope located along the upslope (south-east) margin of the TS. This feature decreases in height towards the north and is approximately 50-60 m in height in the southern part of the TS (south of [redacted] and 5-40 m in height in the northern part of the TS.

Terrace features

These semi contiguous areas are gently inclined to the northwest, or sub-horizontal and are located along Grenville Terrace, Moana Avenue, and Moncrieff Avenue. Commonly residential development has occurred in these areas due to their shallow ground angle.

Subsidiary scarp features

These are sub-arcuate moderately steep to steep slope segments consistent with degraded scarps, and separate the *terrace features* described above.

Toe zone

Downslope of the area of the landslide containing the terrace features and subsidiary scarps in the toe area of the TS, the ground surface is generally undulating and moderately steeply inclined, sloping at approximately 15° to the northwest. Within this area small flat areas are present locally, associated with residential development.

Northern Gully

The ground surface within Northern Gully is generally wet to saturated, hummocky, and inclined at between 18° and 22°. However, slopes on the south-eastern margin of the Northern Gully steepen to between 28 and 30° at a break in slope that trends at 055°. Historic shallow instability consistent with an earth slide-flow has been observed.

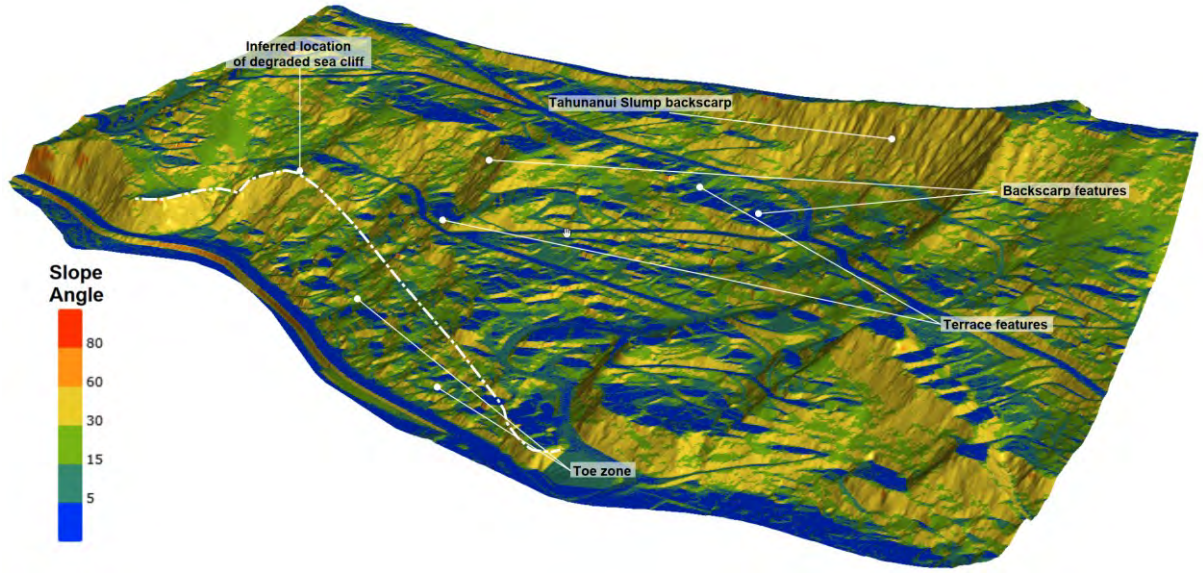

Figure 2.2 - Slope angle 3D model of the TS with main geomorphological features annotated.

2.3 Regional geology

A recently published geological map of the area[6] (Johnston et al, 2021) indicates that the TS comprises slope instability deposits of a Holocene to Late Quaternary age. The location of the TS (mapped as *ul*) is shown in the context of the regional geology on Figure 2.2 below.

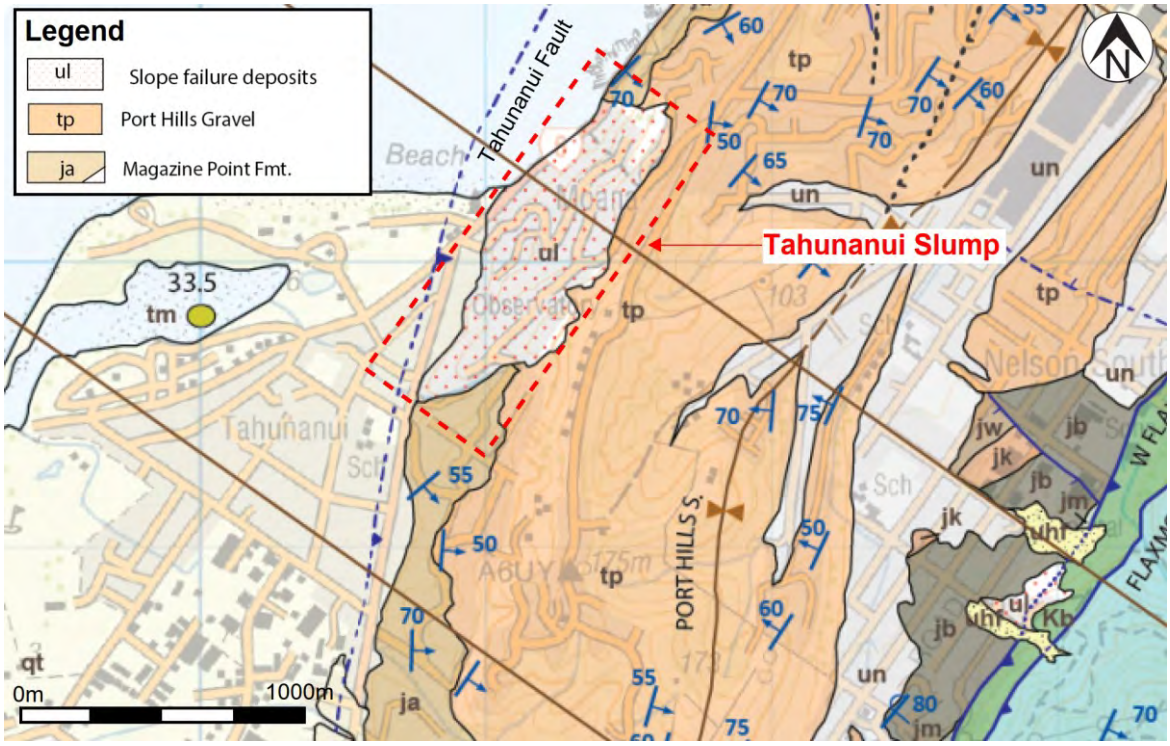

Figure 2.2: Geological setting (obtained from the Revised Geological Map of the Nelson-Richmond-urban area[3]).

The TS is located on the northwest limb of the Port Hills Syncline, with bedding of the Pliocene-aged Port Hills Gravel Formation (PHG) bedrock mapped to be dipping steeply (50–60°) to the east to southeast. PHG is mapped as a 500 m thick deposit consisting of a clay-bound gravel with local beds

of sandstone, siltstone, and mudstone present throughout the formation. The PHG unconformably overlies the Eocene to Oligocene-aged Magazine Point Formation (MB) which is mapped dipping very steeply (65–70°) to the east to southeast in the vicinity of the TS. MP consists of a sequence of well-bedded marine sandstone and mudstone and is exposed on the wave-cut platform to the north-east of the TS and to the north in the cliffs above Rocks Road.

The unconformable contact between the MP and the PHG is mapped dipping at approximately 40° southeast in the vicinity of the TS[2]. The contact is not observed across the TS area. Bedding within the MP exposed in the wave-cut platform to the west of the TS is folded around an axis that plunges to the east.

A splay of the active Waimea-Flaxmore Fault System, named the Tahunanui Fault, is inferred on the geological map to be located approximately 200–400 m offshore to the west of the TS. The Tahunanui Fault is inferred as a reverse fault, characterised by the upward and over-riding movement of the hanging wall (east) block relative to the footwall (west) block, due to regional compressional tectonic forces.

2.4 Historic Tahunanui Slump movements

The timing of initiation of the deep-seated TS landslide is not known. However, it likely occurred in the order of several thousand years ago. The mechanisms that resulted in the initial landslide are also not known.

Instability in response to excavations at the toe of the TS was first recorded across the base of the TS during construction of Rocks Road in 1893[3]. Land movement events have been reported in response to rainfall and seismic natural hazard events in 1929, 1962, and in 2011. As well as deep-seated displacement of the TS, areas of localized shallower instability within the main body of the TS have been recorded at the time of these natural disaster events.

The 'Northern Gully' area at northern end of the mapped extent of the TS (refer Figure 1089612-F1) is a well-known area of shallow earth slide-flow type instability. Episodes of increased displacement of the earth slide-flow have historically occurred in response to periods of high rainfall, as well as de-vegetation of the gully. The instability has in the recent past (in 2017 and 2022) generated slow moving debris flows that have inundated property above Rocks Road at the base of the gully.

A summary of these notable movement events is provided below in Table 2.1.

[2] Denton, P.C, Johnston, M.R, 1996. Housing Development on a Large, Active Landslip: *The 'Tahunanui Slump' Story, Nelson, New Zealand.*

[3] Denton, P.C, Johnston, M.R, 1996. Housing Development on a Large, Active Landslip: *The 'Tahunanui Slump' Story, Nelson, New Zealand.*

Table 2.1: Summary of notable historic movements

Date	Summary of movement
1893	• Landslide movement was triggered due to excavation along the toe of the slump during construction of Rocks Road. • Landslide movement resulted in bulges of the sea wall adjacent to the road edge, which are still visible today.
1929	• The Mw 7.3 Murchison Earthquake of 17 June 1929 resulted in severe (MM VIII) shaking intensity within Nelson. • The area was affected by heavy rainfall in the weeks that followed, with landslide movement triggered on the night of 13 July 1929. • Two houses were torn from their foundations and significant slumping was observed within Grenville Terrace. • It is understood that an area of 2 ha downslope of Grenville Terrace was involved in the movement.
1962	• Significant movement occurred on 1 June 1962 resulting in nine houses that were directly affected, including four of which were seriously damaged. This area of significant displacement was located south of the 1929 movement between Bisley Terrace and Rocks Road and covered an area of 1 ha. • Further minor movement was also noted throughout properties across Grenville Terrace area. • 1962 is the wettest year since records began in 1862. • Nelson City Council (NCC) carried out stormwater improvements within the TS following the movement to reduce surface water ingress into the underlying ground.
2011	• High intensity rainfall occurred on 13 and 14 December 2011, with rainfall accumulations totalling approximately 270 mm over a 48-hour period. • This significant rainfall event resulted in landslide movement of the Grenville Block, and displacement of the ground underlying at least 21 residential properties within the vicinity of Grenville Terrace, Moana Avenue, and Moncrieff Avenue. • A second, and smaller area of landslide movement also occurred between Bisley and Rocks Road affecting a further [redacted]. This landslide overlapped with land that was displaced during the 1962 event.

Historic annual rainfall records for Nelson are shown in Figure 2.2. Years where natural disaster events have been reported are highlighted on the figure.

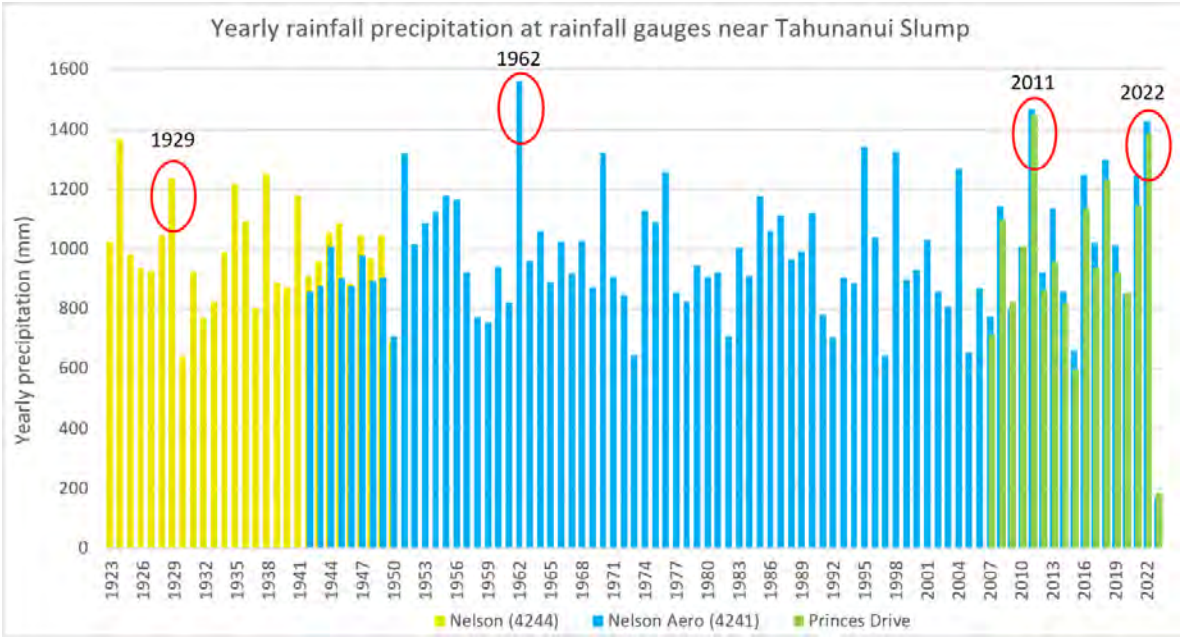

Figure 2.2: Historic rainfall records from weather stations near to the TS, with natural disaster events circled in red.

Monitoring discussed below in Section 2.5 below shows a pattern of ground movement indicating episodic movements or continuous extremely slow "creep" movements within portions of the TS, that account for cumulative displacement of land locally in the order of metres over time.

Episodic displacements of the TS have been recorded in inclinometers and in surface survey monitoring between these significant events in response to elevated groundwater levels.

Prior to 2011, the portion of the TS downslope of Moncrieff Ave and downslope of Grenville Terrace had not been monitored for ground movement. Surface observations and monitoring since 2011 has indicated that this area, and the Northern Gully, which have been a focus of the 2022 and 2023 subsurface investigations have experienced reactivated ground movement. Vector displacements recorded in the order of 10 mm have been recorded at the southern end of Grenville Terrace in the NCC cadastral survey, as compared with displacements generally in the order 2-5 mm at some locations surveyed within the southern part of TS[4]. We note that no surface monitoring is carried out in that portion of the southern part of the TS on the steep slope upslope of Moana Ave and Stansell Avenue and downslope of Princes Drive.

2.5 Historic investigations

Historic investigations[5] have been undertaken by T+T and others to investigate land for both residential and NCC developments across the TS. Both EQC and NCC have undertaken previous investigations of the TS following landslide movements, in July 1962 and December 2011.

Those investigations that have been reviewed during this investigation are summarised as follows:

- Three (3) machine boreholes undertaken by Falconer following the July 1962 landslide movement.
- Five (5) machine boreholes undertaken by T+T on behalf of EQC following the December 2011 landslide movement.

[4] Assessed based on NCC surface survey monitoring data.
[5] Historic investigations sourced from the New Zealand Geotechnical Database (NZGD) and Tonkin and Taylor Geotechnical Database (TTGD).

- Two (2) machine boreholes undertaken by T+T on Moncrieff Avenue in 2013 for NCC.
- Two (2) test pit investigations undertaken by T+T on Moncrieff Avenue in 2013 for NCC.
- An investigation trench undertaken by T+T along Days Track between Grenville Terrace and Moana Avenue in 2013 for NCC.
- Eleven (11) test pits undertaken by CGW at and , located downslope , in 2018.
- Two (2) machine boreholes undertaken by CGW downslope of in 2018.
- Ten (10) test pits undertaken by CGW at in 2020.
- The majority of historical investigations have not extended to or beyond the basal slide surface of the TS. The five boreholes drilled in 2012 for EQC did extend to what is described as in-situ Port Hills Gravel encountered at a depth of between 20 - 25 m bgl in the downslope portion of the TS and 41.5 metres in the upslope portion of the TS.
- The investigations available on the NZGD have not been appended to this report[6]. We have however, considered the above historic subsurface investigations as part of this assessment.

A brief summary of the main findings of these investigations is presented below:

- Borehole drilled in in 2012 showed 24 m of silty sandy Gravel consistent with PHG derived landslide deposits.
- Borehole , drilled in the toe area of the TS showed approximately 20 m of layered soils consistent with landslide deposits underlain by silty Gravel consistent with Port Hills Gravel Formation bedrock. Beneath this silty and sandy Gravel
- , drilled in the upper part of the TS of Days Track encountered approximately 41 m bgl of predominantly silty sandy Gravel consistent with PHG conglomerate derived landslide deposits.
- In at 41.5 m bgl the driller noted 2.5 m of artesian head for during drilling which dissipated over a 10-minute period.
- Borehole drilled on in the toe area of the TS showed approximately 15 m of layered landslide deposits underlain by a clean Gravel where the driller lost water circulation to 22 m bgl, underlain by a silty Gravel consistent with Port Hills Gravel Formation bedrock.

2.6 Historic monitoring

Historic monitoring carried out on behalf of NCC in the TS prior to and after the *event* includes monitoring of a surface survey network, groundwater and inclinometers installed in two boreholes.

2.6.1 Surface survey network

A cadastral survey of surface survey points in road carriageways has been carried out with repeat surveys at approximately five yearly intervals from 1924 to 2018, with a total of nine surveys having been undertaken to date. The latest survey data from a survey carried out following the *event* is attached in Appendix D.

The surface survey network comprises a total of approximately 40 survey points throughout the TS (some are now defunct, and others have only recently been installed).

[6] With the exception of boreholes BH01–BH04, which were drilled in 2012 on behalf of EQC and have not been published for EQC previously.

We note that as the NCC cadastral survey network was only recently (in 2018) extended to cover the Grenville Terrace area where much of the damage relating to the *event* has occurred. As no repeat survey of these new survey marks was undertaken prior to the *event*, no ground movement data is available from this survey in the Grenville Terrace prior to the *event*.

Ground surface monitoring (attached in Appendix D) was carried out on behalf of Civil Defence following the December 2011 natural disaster event in the Grenville Terrace to Rocks Road section of Days Track area following the December 2011 event up to January 2013.

Monitoring up to the 2018 monitoring round indicates the following:

- Observed historic ground displacements are generally higher in the area downslope and upslope of Grenville Terrace (~10 mm/yr) than in the southern part of the TS (2-5 mm/yr).
- Monitoring carried out in the Grenville Terrace to Rocks Road section of Days Track following the December 2011 event showed that ground displacements in the upper part of the track occurred for some weeks following the event. This displacement was not observed in the downslope part of the track below approximately 35 m RL.
- A final survey of the lower Days Track monitoring points in January 2013 did not show any movement outside of errors from the previous survey carried out in August 2012.
- Movement vectors at survey locations on and upslope of Moana Avenue are primarily vertical, whilst movement vectors in the central and lower part of the TS tend to be horizontal with a minor vertical component.

2.6.2 Inclinometer monitoring

Inclinometers were installed in two boreholes drilled on behalf of EQC in 2012 following the December 2011 Nelson storm in (located in Grenville Terrace) and (located in the toe area of the TS on).

A total of fourteen (14) rounds of inclinometer monitoring have been carried out on behalf of NCC in and prior to the *event*. The main findings of that monitoring are provided below:

- Approximately 80 mm of displacement between 24 and 25 m depth bgl between 31 January 2012 and the final measurement carried out on 15 August 2022 (2 days before the *event*).
- No measurable displacement is recorded in between ground level and 24 m bgl in that location.
- Displacement rates between inclinometer measurements vary from 0.015 mm/day and 0.85 mm/day.
- Although deep-seated movement appears to be episodic, the downslope displacement rate recorded at 24 – 25 m depth bgl in the inclinometer over the ten-year period from 2012-2022 equates to an average of 7.6 mm/yr.
- An attempt was made to read on 26th August 2022. The probe could not extend beyond 24 m and could not measure what displacement took place in the period 15 August 2022 and 26th August 2022. The probe did not identify any measurable displacement between 0 m and 24 m depth.

- Approximately 14 mm of displacement between 0 m and 11.5 m depth bgl between 19 March 2012 and 15 August 2022 (2 days before the *event*).
- Approximately 6 mm displacement between 0 m and 11.5 m depth bgl between 15 August 2022 to 12 April 2023.

- Of the total 20 mm displacement measured between 19 March 2012 and 12 April 2023, 12 mm has occurred at 10.5 m to 11.5 m and 8 mm has occurred between 0 and 10.5 m.
- Up to the *event*, displacement rates between inclinometer measurements vary from nil and 0.019 mm/day.
- Although movement appears to be episodic, the downslope displacement rate recorded at 10.5 – 11.5 m depth bgl in the inclinometer over the ten-year period from 2012 – 2022 equates to an average of 1.81 mm/yr.

2.6.3 Groundwater monitoring

Groundwater monitoring has been carried out on behalf of NCC at three locations since their installation in early 2012 (following the December 2011) event, up to the July 2015 event. Continuous groundwater monitoring was carried out in the lower standpipe of using a groundwater data logger, between 15 August 2022 and 30 March 2013.

The depth and screened geological unit for each piezometer location is attached in Table D.1 attached in Appendix D. The manual groundwater readings carried out between February 2012 to July 2015 are presented in Figure D.1.

The following is a summary of main findings of groundwater monitoring carried out prior to the *event*.

- Groundwater levels recorded in the upper standpipes are higher than the lower standpipes in
- During drilling artesian head in the order of 2.5 m above ground level was encountered at 41.5 m depth bgl. The driller reported that the artesian head dissipated over a period of 10 minutes.
- Perched groundwater levels have been recorded in the upper standpipe in
- The groundwater level recorded in shallower piezometers tend to have higher groundwater levels than those recorded in deeper ones and respond more rapidly to rainfall than the deeper groundwater tables.
- Groundwater levels measured in the upper standpipe in varied between 3.15 and 7.3 m bgl, with the screen installed from 3 to 8 m bgl within the conglomerate-derived landslide debris.
- Groundwater levels measured in the lower standpipe in varied between 5.24 and 7.12 m bgl, with the screen installed from 19.5 to 24 m bgl within the inferred basal slide surface of the TS.
- Groundwater levels measured in in the toe area of the TS varied between 8.35 to 13.4 m bgl.

3 Surface and subsurface conditions

Following the *event*, T+T carried out the surface subsurface investigations listed in Section 2.1 above on behalf of EQC. A summary of the main findings of these investigations is presented below.

3.1 Surface conditions

The surface features of the TS observed during our site walkover are summarized below:

- The surface morphology of the central and upper levels of the body of the TS is typified by gently inclined terraces separated by features consistent with active to degraded landslide scarps that form the upper and central parts of the TS and step down towards the north-west.
- The morphology of the toe area of the body of the TS varies from north to south. In the northern section (from [redacted] the slope is moderately steeply to steeply inclined up to sharp convex break in slope between approximately RL 40 to RL 47 m. South of [redacted] the toe area comprises an undulating moderately inclined irregular surface rising to approximately RL 40 m.
- The upslope margin of the TS comprises a 3 m to 8 m high inactive/dormant steeply inclined (approximately 38°) crown slope (headscarp) from about [redacted] The slope transitions to the south of Days Track over approximately 100 m into an active crown slope up to 50 m in height to RL 160 m.
- The north-eastern margin of the TS is defined by a north-west trending gully that is vegetated with scrub and appears to contain widespread active earth slide-flow.
- The south-western boundary is less clearly defined, but generally follows the northern flank of a spur that plunges to the west, downslope [redacted]
- The following exposures were noted during our assessment:
  - Highly weathered highly fractured Very Weak Mudstone consistent with Magazine Point Formation mudstone [redacted] on the axis of the Northern Gully at approximately 22 m RL.
  - Highly weathered tightly packed Silty Gravel consistent with PHG derived landslide deposits in the evacuated area at the base of the Northern Gully at approximately 30-40 m RL.
  - Soft to Firm wet Silty Clay consistent with earth slide-earth flow deposits in the Northern Gully at approximately 30- 50 m RL.
  - Sheared Extremely Weak Mudstone in excavations for services trenches at the northern end [redacted] at approximately 54 m RL.
  - Highly weathered sheared Extremely Weak Mudstone consistent with disturbed PHG exposed in the cut for the upslope side [redacted] approximately 55 m RL.
  - Highly weathered sheared Extremely Weak Mudstone consistent with disturbed PHG bedrock within the Northern Gully downslope [redacted] striking at 040-050° at approximately 63 m RL.
  - Highly weathered tightly packed silty Gravel consistent with disturbed PHG conglomerate in the shallow landslide directly downslope [redacted] in the North Gully at approximately at 65 m to 74 m RL.
  - Highly weathered tightly packed silty Gravel consistent with disturbed PHG conglomerate in the upslope cut in the main scarp of the shallow landslide that forms the downslope margin of the Days Track rotational slide (at approximately 82 to 83 m RL).

- Highly weathered moderately tightly packed silty Gravel consistent with disturbed PHG conglomerate in the upslope cut [redacted] (at approximately 93 m RL) as well as [redacted] (at approximately 92 m RL).

Physical indications of land damage observed during our geomorphic and land damage mapping are summarized in Section 4.2 below and are shown on Figure 1089612-F4.

3.2 Subsurface conditions

Subsurface investigation locations are shown on Figure 1089612-F1 in Appendix A. Investigation logs and an engineering geological terminology sheet are provided in Appendix B.

A general summary of ground conditions encountered during our subsurface investigations is provided below. Observations with respect to groundwater are summarized under each section.

3.2.1 Boreholes

A total of nine (9) No. machine boreholes were drilled as part of the 2011 and 2022 investigations to assess subsurface ground conditions within the TS and the depth to the basal surface of rupture in the area in the vicinity of Grenville Terrace. The location of these boreholes is shown below on Figure 3.1. A summary of the ground conditions encountered in each borehole is presented in Table B. 1 in Appendix B. Subsurface conditions encountered in the tests are summarized below.

- [redacted] drilled in the upper area of the TS encountered predominantly conglomerate consistent with landslide deposits derived from the PHG to depths between 20 and 40 m bgl.
- No layers > 0.5 m thick of material consistent with PHG derived mudstone or siltstone (bedrock or derived landslide deposits) were encountered in either [redacted]
- Conglomerate consistent with the PHG Fm bedrock was present from 23.4 m bgl and 40.2 m bgl in [redacted] respectively. [redacted] was terminated within the conglomerate-derived landslide debris.
- The core from [redacted] was generally retrieved intact and less disturbed than conglomerate-derived landslide debris encountered in boreholes in the lower portion of the TS, including [redacted]
- Very weak to Weak mudstone and sandstone consistent with PHG Fm bedrock was encountered from 23.9 to 34 m bgl (end of borehole) in [redacted] and from 17.5 to 30.5 m bgl in [redacted]
- In [redacted] drilled along the south-eastern margin of the Northern Gully, extremely weak mudstone / sandstone derived landslide debris was encountered to 3.45 m bgl. This was underlain by weathered extremely weak mudstone consistent with PHG Fm bedrock.
- in [redacted] drilled in the lower area of the TS at [redacted], Very Weak to Weak mudstone consistent with PHG Fm bedrock was encountered at 5.2 m bgl.

Figure 3.1: Location of 2011 and 2022 T+T machine boreholes undertaken across the Tahunanui Slump.

3.2.2 Test pits

Test pits were excavated at three locations to assess subsurface ground conditions, including the structure and continuity within the TS deposits in an area where historic and recent compression has been observed. Subsurface conditions encountered in the tests are summarized below.

- excavated along a 15 m length upslope of (to the south-east) in the Northern Gully encountered:
  - Downslope end of test pit – Soft to firm silty Clay up to 0.8 m thick, underlain by soft bluish grey, pervasively sheared siltstone to at least 1.6 m bgl downslope end of the test pit
  - Upslope end of test pit – Loosely packed clayey gravel up to 1.6 m thick, underlain by brownish grey, extremely weak siltstone with minor shearing to at least 2.6 m bgl.
  - Sheared siltstone strikes at approximately 035° and dipping upslope (south-east) between 20° and 40°.
  - Groundwater flows in the order of 2 to 4 L/m were encountered along the contact between the brownish grey siltstone and the underlying bluish grey pervasively sheared siltstone.
- excavated in the downslope (northern) part of encountered:
  - Low plasticity soft to firm clayey Silt to Clay to 2.5 m bgl, which was underlain by loosely packed clayey Gravel containing high plasticity clay to the base of the test pit at 3.5 m bgl.
  - Minor groundwater seepage at 2.5 m bgl, along the contact between the clay and underlying clayey gravel.

- excavated at in an area of ground compression noted in December 2011 exposed sheared mudstone consistent with disturbed PHG mudstone striking at approximately 050° and dipping at 30° to the south-east. No groundwater was noted in this test pit.

3.2.3 Hand augers

Subsurface conditions encountered in two hand auger holes are summarized below:

- drilled in Grenville Terrace adjacent to encountered firm to stiff Silt overlying inferred Gravel (Scala refusal) from 1.6 m bgl. Refusal was encountered at 2.2 m bgl.
- drilled in the North Gully downslope of – encountered stiff to very stiff gravelly silt, underlain by a firm sandy silt at 0.4 m bgl. Refusal was encountered on an inferred gravel at 0.71 m bgl.

3.2.4 Scala penetrometer tests

Scala penetrometer tests were carried out in the Northern Gully and the toe area of the Grenville Terrace instability to assist the inference of the depth of shallow landslide movement in these areas. Subsurface conditions encountered in the tests are summarized below.

Grenville Terrace instability

- In Scala penetrometer tests carried out between the notable increases in the relative Scala blow count were observed at between 2.0 and 4.9 m bgl in
- carried out on encountered refusal at 1.25 m due to a change in blow count from between 3-5 to >20. However, this may be due to encountering a gravel and is not necessarily representative of a change in ground conditions.

Northern Gully

- In the Northern Gully, notable increases in the Scala blow counts from approximately 1–6 blow per 50 mm to 6– >20 blows per 50 mm were observed between 1.5 and 1.6 m bgl in the upper portion of the slope and typically between 3.2 and 3.6 m bgl in the central portion of the slope at

4 August 2022 natural disaster event

4.1 Hydrological context

A storm event occurred from 17 to 20 August 2022, with rainfall accumulations totalling approximately 310 mm over an 80-hour period. The precipitation occurred in three waves over the four-day period.

Antecedent monthly rainfall accumulations through June and July exceeding the 95th percentile compared with historical data dating back to 1942, are presented in Figure 4.1.

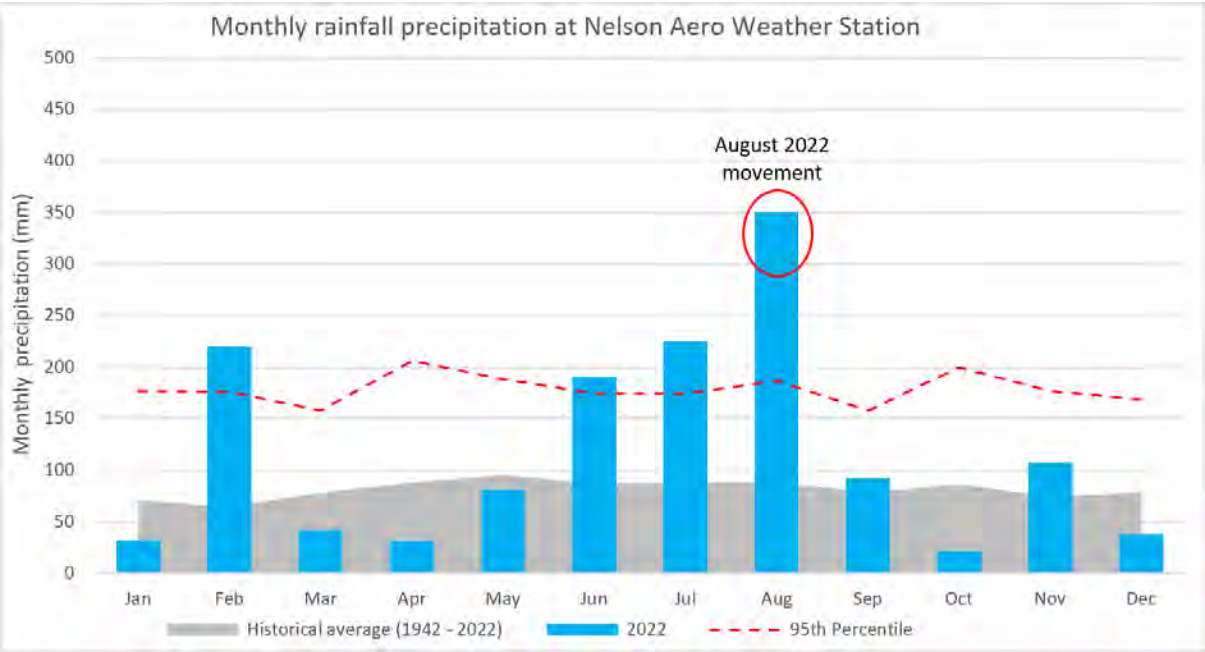

Figure 4.1: August rainfall accumulations compared with historical average and 95th percentile rainfall accumulations.

4.2 Observed land damage

The high rainfall that occurred in mid-August 2022 resulted in displacement of at the basal rupture surface within the TS during and following the *event*, as well as several areas of localized instability within the upper levels of the soils that comprise the TS (as described below and shown on Figure 4.2).

Figure 4.2: Areas of landslide movement observed within the Tahunanui Slump as a result of the event.

The inferred depth at which landslide movement has occurred, varies from less than 1 m to greater than 20 m. We have characterised land damage that we have observed to be either “shallow” being areas where there is widespread surface expression of land damage and “deep" where the surface expression of land damage limited in extent but is indicated by surface crack patterns supported borehole investigations.

The ground movement produced localized shallow landslides and landslide scarps typical of shallow instability, and linear tension cracks and compression features typical of deep-seated landslide movement, as well as causing localized damage to residential dwellings and structures and underground services.

T+T carried out land damage mapping within the TS following the] *event*, as well as carrying out individual assessments of land damage affecting properties subject to EQC natural disaster damage insurance claims. Geomorphic features indicative of ‘natural landslips” as defined in the Earthquake Commission Act 1993 that have been recorded by T+T following the *event* are shown on T+T Figure 1089612-F2 attached in Appendix A.

A factual summary of the observed characteristics of the different areas of shallow and deep instability observed to have occurred as a result of the *event* is provided in Table C.1 attached in Appendix C.

An interpretation of the extent and mechanisms controlling movement in the above areas is provided in Section 6.1.

4.2.1 Northern Gully earth slide-flow

This is a reactivated shallow earth slide-flow covering a 1.2 ha area vegetated in scrub and semi-mature trees in the Northern Gully that mobilized downslope in the order of 1 – 2 m during the event.

The earth slide-flow movement caused two successive earth flows to occur from the base of the gully, inundating Rocks Road; one during the *event* and one during a subsequent rain event (60 mm in 24 hours) in September 2022 inundating [redacted] with landslide debris. The earth slide-flow caused damage to residential property situated within the Northern Gully. Several areas of localised areas of shallow instability have occurred on the margins of the Northern Gully displaying arcuate scarps typical of shallow instability.

4.2.2 Rocks Road northern landslide

This is an area of shallow instability that has occurred on a steep slope inferred to be an abandoned sea-cliff upslope of [redacted].

A shallow debris flow of smaller extent and displacement occurred in the December 2011 event.

4.2.3 Tahunanui Slump main scarp instability

This instability comprises multiple shallow debris flows on a steep north-west facing slope (40-45°) between [redacted]

Multiple debris flows have resulted in approximately 6,000 m^2 of bare ground where debris has been evacuated from the upper slope and has inundated the lower part of the main scarp slope above Moana Avenue, as well as a section of the Moana Avenue carriageway, and [redacted]

Based on historical photography, it appears that the area of damaged ground resulting from the debris flows is similar in area to that damaged as a result of the June 1962 and December 2011 events.

4.2.4 Grenville Terrace instability

This approximately 9,000 m^2 area of instability downslope of [redacted] Grenville Terrace appears to be an earth slide. The instability extends from the carriageway of Grenville Terrace [redacted]

The Grenville Terrace earth slide instability shows a higher magnitude of displacement than the deep-seated TS movement. Up to 200 – 400 mm of downslope horizontal movement is inferred to have occurred based on the tension cracks and compression features that form the upslope and downslope margins of the Grenville Terrace instability. Tension cracks are widespread within this area.

The earth slide instability has caused racking damage to dwellings and other residential structures within the area, as well as widespread damage to underground services. Newer structures with deeper piles (>5 m bgl) show little structural damage.

The movement has occurred in the same general location as historically recorded movements in July 1929 and December 2011.

4.2.5 Days Track complex debris slide – debris flow

This is an approximately 5,000 m^2 area of gently inclined land adjoining Days Track downslope of the intersection of Moana Avenue and Moncrieff Avenue.

The upslope extent of land damage is defined by a 130 m wide length of broadly arcuate main scarp located approximately 20 m east of a sharp convex break in slope at about RL 81 m. The main scarps of two shallow debris flows inundating Days Track and private property on the steep slope upslope of Grenville Tce are located within the body of the rotational slide close to the convex break in slope. A marginal debris flow which has displaced the Days track upper level of steps extends between the main scarps of the two active debris flows.

This composite rotational debris slide-flow shows a greater level of horizontal and vertical displacement than background TS movement, with up to 250 mm horizontal displacement and vertical displacement within the rotational slide estimated along the central axis of the movement and reduced displacements at the lateral margins. Multiple transverse cracks occur within the body of the rotational slide.

Debris from the debris flows has travelled approximately 90 metres from the crown scarp at a travel angle of 24 degrees.

The rotational slide has resulted in structural damage and racking of dwellings and other structures as well as breakages and upslope rotation of pipe services.

4.2.6 Deep-seated Tahunanui Slump rock slide

Land damage resulting from deep-seated movement (as opposed to shallow and subsidiary movements of the TS described above) is mainly focussed in the Grenville Terrace area. In the southern parts of the TS [redacted]) land damage attributable to deep seated rock slide was not visibly detectable.

Ground surface indications of deep seated rock slide included linear tension cracks downslope of Moncrieff Avenue. A linear zone of compression in the carriageway of Grenville Terrace up to 50 m long was also observed. Vertical upwards movement of land upslope of this compression zone relative to downslope land was also observed. This movement caused an offset in the carriageway [redacted]

The tension cracks and compression occurred in areas where historic movements were noted in July 1962 and December 2011. An NCC survey mark[7] upslope of the compression feature at [redacted] Grenville Terrace showed horizontal movement of 47 mm over the four-year period 2018-2022. This survey mark is the only survey mark within the TS to show upward movement, moving upwards at 34° towards 277°.

Downslope deep-seated displacement in the Grenville Terrace area as a result of the *event* is estimated to be in the order of 50 mm based on a partially destroyed survey mark in the NCC survey network where only approximate horizontal displacement as a result of the *event* could be obtained.

Levels of property damage resulting from the deep-seated movement were lower than the level of property damage attributed to shallower depth landslides. Some localized breakages in underground services were observed in properties upslope of Grenville Terrace.

5 Post-August 2022 monitoring and instrumentation

This section summarises monitoring of ground movement and groundwater levels assessed in April 2023 based on data obtained following the *event* and up to 18-19 April 2023. It includes the following.

- Monitoring of instruments installed on behalf of EQC (Section 5.1).
- Monitoring of the NCC surface survey network carried out on behalf of Civil Defence Emergency Management (CDEM) (Section 5.2).
- Continuous-GPS monitoring stations installed by Geological and Nuclear Sciences (GNS) on behalf of NCC (Section 5.3).

Further groundwater and ground monitoring data post-dating 18-19 April 2023 that has become available prior to finalization of this report, is attached in Appendix E. However, no interpretation of the post 19 April 2023 data is provided within this report, however the factual data has been appended for completeness.

5.1 EQC instrumentation

Instrumentation has been installed in boreholes drilled as part of the EQC funded ground investigation, and additional monitoring undertaken of ground displacement and groundwater levels within the TS as described below.

Instrumentation consists of:

- A Shape Accel Array (SAA) to a depth of 30 m bgl, for 'live' ground deformation monitoring at 1-hourly increments.
- Four inclinometers to depths of between 30 and 35 m bgl.
- Eight vibrating wire piezometers and two (2) data-loggers in nested standpipe piezometers for 'live' groundwater monitoring.

5.1.1 Shape Accel Array

A Shape Accel Array (SAA) was installed on 25 November 2022 at the location of [redacted] to a depth of 30 m bgl, for 'live' ground deformation monitoring at 1-hourly increments. The purpose of this installation is to replace the now defunct inclinometer at [redacted] The manufacturer stated accuracy is +/- 1.5 mm across a 32 m long device.

[7] Survey mark 'BP4' from NCC cadastral survey network in TS.

Over the four months of monitoring to April 2023, a small magnitude slope displacement is indicated across a 2 m thick zone at approximately 20 – 22 m bgl with cumulative displacement across this zone in the order of 1.0 mm toward the northwest having occurred to date. Although only very small movements have been recorded across this zone (1.0 mm in four months) the ground deformation appears to be decreasing with time, as shown on Figure 4.2, with velocities at 22 m bgl decreasing from a rate of 3 mm/year in December 2022 to a rate of 1 mm/year in January and February 2023, and negligible movement registered throughout March 2023. There are no indications of ongoing shallower landslide movement above the basal sheared surface within the Shape Accel Array records to date.

The data received to date (18 April 2023) is not sufficient to enable meaningful conclusions to be drawn other than confirming the depth of the surface of rupture of the TS previously indicated by inclinometer reading in [redacted] and that the rate of movement post the event is similar to average rates of movement monitored during the years preceding the event .

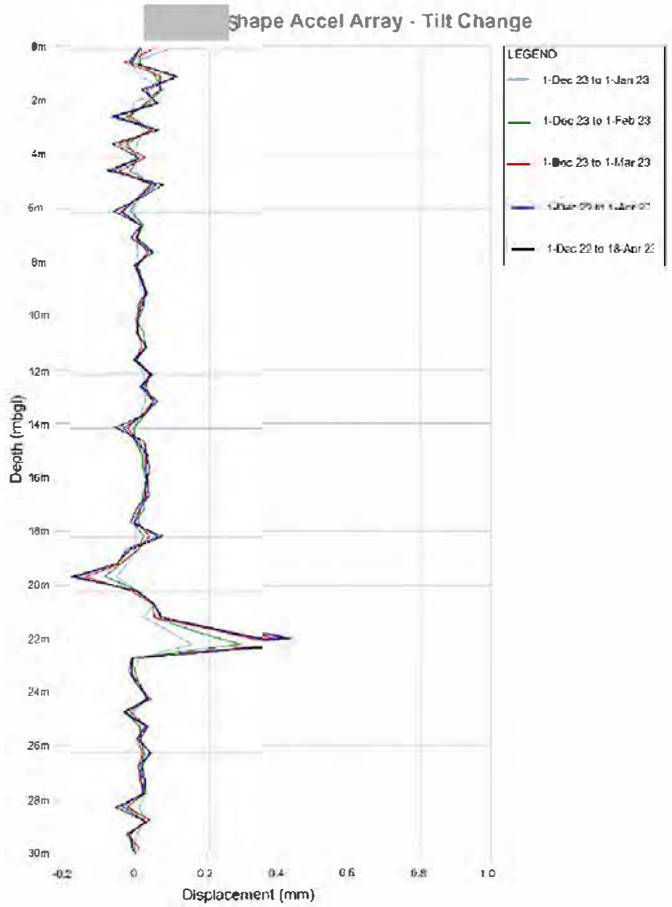

Figure 5.1: SAA tilt change plot indicating incremental displacement from December 2022 to April 2023

Available ShapeAccelArray ground movement monitoring data post-dating 19 April 2023 is attached in Appendix E.

5.1.2 Inclinometer monitoring

Since installation of four inclinometers in [redacted] in September and October 2022, three rounds of monitoring have been undertaken (November 2022, January 2023, and April 2023).

To date, there has been no clear displacement within the inclinometers up to the last monitoring round on 23 April 2023 that indicates downslope displacement of the TS.

The results of the inclinometer monitoring are presented in Appendix D.

5.1.3 Groundwater monitoring

Two single and four nested vibrating-wire (VW) piezometers, and two data loggers were installed across the TS in [redacted] to depths of up to 35 m bgl. The data recorded from the VW piezometers is uploaded to Geotechnics Solutions[8] (an online platform) where the telemetered data can be analysed in real time.

The piezometer tip depths were selected to target potential unconfined, confined, and potential perched piezometric levels. to develop a groundwater model to be developed for the TS. The depth and screened geological unit for each piezometer location is attached in Table D.1 attached in Appendix D. The groundwater monitoring to date is presented below in Figure 5.2.

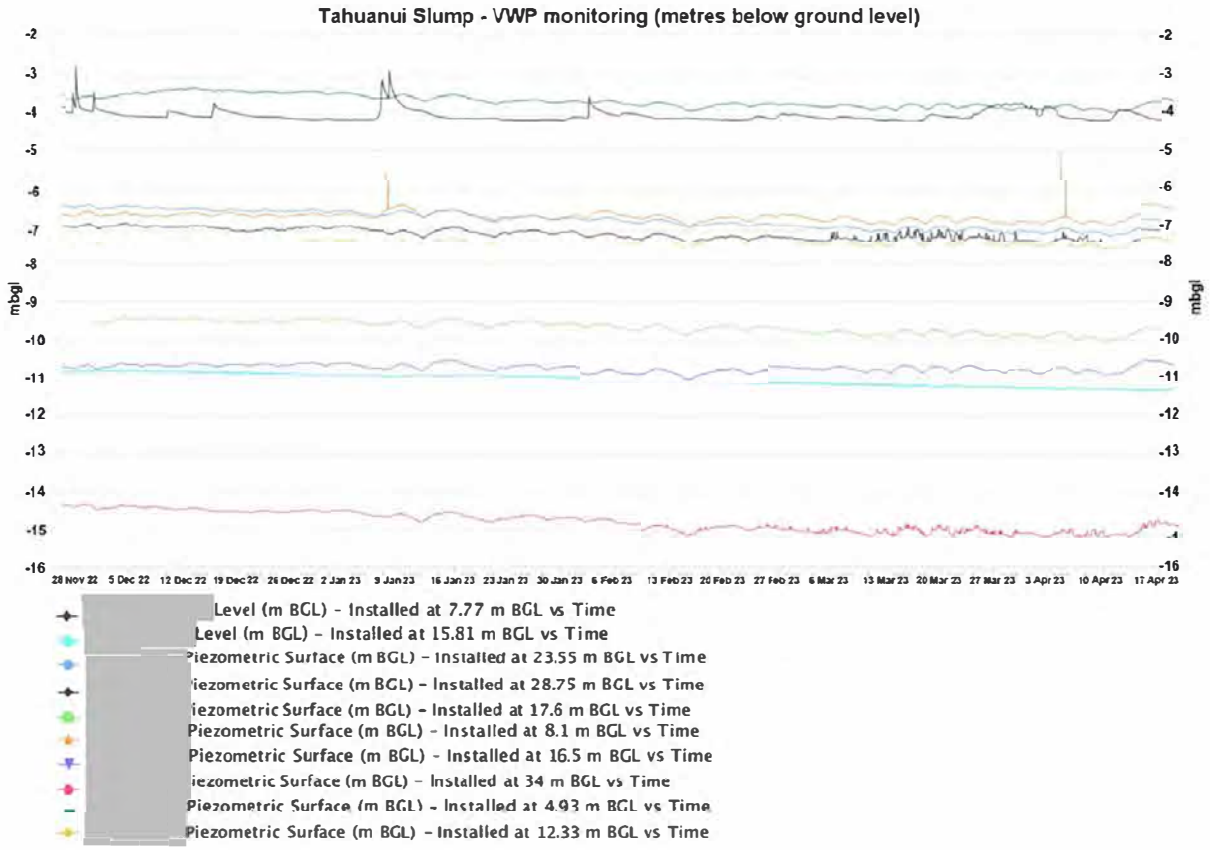

Figure 5.2: Times series graph of groundwater monitoring levels from 26 November 2022 to 19 April 2023.

Based on review of the five months of groundwater monitoring, from 26 November 2022 to 18 April 2023 the following observations were made:

- The piezometric level across all piezometers appears to have stabilised back to typical levels, that were present prior to the start of monitoring.
- In general, the piezometric response following rainfall appears relatively consistent across all piezometers. The groundwater rises almost immediately after rainfall and then takes two to

[8] www.geotechnicssolutions.com

three days to stabilise to normal levels after rainfall. The exception to this is , which appears to be more sensitive to rainfall compared with other installed piezometers. was installed in December 2011 and has been subjected to significant ground displacement, in particular during *the event*.

- It is too early to detect seasonal trends. A minimum of 12 months monitoring will be required.
- No intense or prolonged rainfall has occurred since monitoring commenced up until the time of preparation of this report (April 2023). Accordingly, groundwater fluctuations up until this time have been in the order of 0.2 – 0.5 m, except for in shallow where the piezometric fluctuation after rainfall is in the order of 0.5 – 1.2 m.

Available telemetered groundwater monitoring data post-dating 19 April 2023 is attached in Appendix E.

5.2 NCC surface survey network

Survey monitoring of the NCC surface survey network was undertaken on behalf of CDEM immediately following the *event* to monitor for ongoing ground displacements following the August 222 event.

This included a total of four (4) surveys of the NCC cadastral network containing approximately forty (40) survey points across the TS from 24 August to 15 September 2022. Local measurements of crack widths were also carried out to monitor for ongoing post *event* land movement. Table 5.1 below summarizes the results of this monitoring.

Table 5.1: Surface survey results

Area	Results
	• A survey point along Grenville Terrace within this landslide shows displacement from 2018-2022 of 171 mm (horizontal) and 100 mm (vertical). • In the four weeks following the event, and displacements were in the order of 5 mm (horizontal) and 5-10 mm (vertical) indicating movement had largely ceased.
	• No cadastral points exist within this area, and as such no data on the magnitude of movement is available from this survey. • In the four weeks following the event, horizontal and vertical displacements were in the order of 5-10 mm and 2–5 mm respectively indicating movement was ongoing but had decreased significantly.
	• In the Northern Gully at displacements recorded from 2018-2022 are 1908 mm horizontal and 385 mm vertical at a bearing of 330°. • In the four weeks following the event, horizontal and vertical displacements were in the order of 300-600 mm and 100-200 mm respectively, indicating that ongoing movement was still occurring within the Northern Gully at that time.
	• Monitoring in this area indicates that displacement in the order of 5 mm occurred along the upper portion of the track during the four weeks following the event. • No movement recorded on the lower portion of the track during this time period.
	• No clear displacements indicated during the four-week period following the event.
	• Away from survey points affected by shallower landslippage, displacements recorded from 2018-2022 ranged from 1 to 45 mm horizontal and +10 to -28 mm vertical displacement in the TS, and 13 to 77 mm horizontal and -7 to + 24 mm vertical displacement in the TS.

Area	Results
	• Monitoring point [redacted] in [redacted] Grenville Terrace was destroyed during the event, however horizontal displacements have been estimated based on the remaining part of the survey point. As a result, no vertical displacement information is available for this point. • Monitoring point [redacted] installed at [redacted] Grenville Terrace just upslope of the compression zone shows an increase in elevation of 24 mm in the four-year period 2018-2022.

5.3 GNS continuous-GPS monitoring

Following the *event*, Geological and Nuclear Sciences on behalf of EQC installed two (2) continuous GPS stations to record ground movement at the following locations:

Table 5.1: Continuous-GPS location table

GPS name	Location
[redacted]	Installed on the lawn downslope of the dwelling at [redacted] within Days Track rotational landslide.
[redacted]	Installed upslope of the dwelling at [redacted] – within the Grenville Terrace shallow landslide area.

Continuous GPS traces[9] attached in Appendix D show the following between August 2022 and 19 April 2023:

[redacted]

- NW movement in the order of 25 mm.
- Vertical displacement of in the order of 20 mm.

[redacted]

- NW movement in the order of 20 mm.
- Vertical displacement of in the order of 25 mm.

Discussions with s9(2)(a) [redacted] GNS indicate that the majority of movement indicated by the GPS installations may be attributable to drift, and that post-processing of this data is required to remove drift in the data and obtain accurate ground displacement information. As such this data is not discussed further in this report but has been included for completeness.

Available continuous-GPS monitoring data post-dating 19 April 2023 is attached in Appendix E.

6 Conclusions and recommendations

Recommendations and opinions in this report are based on available subsurface data from a desk-top study of existing geotechnical information, a subsurface investigation, and monitoring of groundwater levels and ground displacements. The nature and continuity of surface and sub-surface conditions away from observations and test locations that are shown on Figure 1089612-F1 are inferred and it must be appreciated that actual conditions may vary from the assumed model.

[9] www.geonet.org.nz.

6.1 Engineering Geological model

6.1.1 Geomorphological interpretation

An interpretation of geomorphological features within the TS is summarised below. Engineering geological cross sections are included in Appendix A (Cross-sections 1 to 3, Figures 10189612-F5 to F7).

6.1.1.1 Northern Gully

- The south-eastern margin of the North Gully aligns with the strike (040-050°) of mudstone beds where seepage was noted during our investigations The slope upslope of the mudstone bed is steeper than downslope. The emerging seepage indicates that the mudstone acts as an aquitard and that persistent seepage from this area has influenced slope forming processes in the gully.
- During investigations for replacement of the retaining wall supporting the northern end of Moncrieff Avenue carriageway near the lateral margin of the Northern Gully, sheared mudstone with groundwater seepage was also encountered along the trend of the strike of the mudstone encountered within the gully. This mudstone was observed at the northern end of the wall, where the ground is inclined more steeply than downslope portions of the gully
- This gully is well incised below the ridgeline to the north, and the central portion of the gully slope is hummocky indicating that that earth slide-flow instability has been occurring for some time.

6.1.1.2 Tahunanui Slump main scarp

- The more deflated topography present in the southern part of the TS, with and stronger preservation of terrace surfaces in the northern part of the TS suggests the southern part of the TS has been subject to more overall downslope movement than the northern part.
- The greater height of the main scarp in the south than in the north may also be due to more past movement in the southern part of the TS than in the northern part.

6.1.1.3 Terrace features

- The terraces are inferred to represent the relict surface of the north-west facing slope of the Tahunanui Hills prior to initiation of deep-seated instability.
- The terraces are generally separated by steep intervening slopes consistent with dormant and relict landslide scarps as described below.
- Terrace features are more prevalent in the northern part of the TS, likely due to the apparent lower levels of displacement in this area compared to the south.

6.1.1.4 Scarp features

- Subsidiary scarps present within the TS are likely to represent both:
  - i Subsidiary scarps associated with bedrock sliding at the basal surface of rupture of the TS inferred to separate the *terrace features* described above; or
  - ii Main scarps of shallower landslides i.e. where the surface of rupture is not at the base of the TS.
- To date insufficient geomorphic or ground movement data exists to conclusively determine which scarps correspond to i or ii above.

6.1.1.5 Toe zone

- The ground surface in this area does not display the terraced morphology of land upslope and is more typical of land affected by periodic shallow instability.
- [redacted] – both drilled within this zone - show layered landslide deposits to within 2 m of mean sea level, underlain by material interpreted as Port Hills Gravel Formation bedrock.
- Accordingly, the toe zone of the TS is inferred to be underlain by layered landslide deposits that have displaced beyond the toe of the original (pre landslide) slope and onto the (now buried) shore platform. This inference is supported by the presence of shell fragments encountered at sea-level in [redacted] drilled in April-May 2012.

6.1.1.6 Degraded sea-cliff feature

- The morphology of the land surface downslope and to the northwest of the inferred location of the degraded sea-cliff does not display the preserved terrace areas present above the inferred location of the degraded sea-cliff, having more of an undulating gully topography typical of areas affected by shallow instability.
- Our engineering geological model indicates that the surface of rupture of recent movement in the lower part of [redacted] is relatively shallow at approximately 5 m bgl.
- To the south of Grenville Terrace, the inferred location of the degraded sea-cliff lies just downslope of a gently inclined northwest facing terrace feature.
- Subsurface investigation data from [redacted] shows the toe area to comprise layered shallow landslide deposits suggesting that failure of the inferred sea-cliff feature early on in the genesis of the deep-seated TS rock slide may be responsible for local deposition of layered landslide deposits downslope of the surface of rupture.

6.1.2 Engineering Geological units

Table 6.1 below presents our inferred engineering geological stratigraphy within and underlying the TS.

Table 6.1: Inferred stratigraphy within and underlying the TS

Unit		Description	Extent
TS landslide deposits	Northern Gully earth slide-flow	Soft to Firm wet silty Clay with minor gravel.	Extends over an approximately 9,000 m^3 area in the Northern Gully.
	PHG Conglomerate-derived debris	Generally comprised of loose to dense clayey GRAVEL. The cementation between the clasts has generally been destroyed by instability. No shear fabric was observable within this unit.	Inferred TS landslide deposits recorded at up to 41.5 m thickness in [redacted] The majority of TS landslide debris encountered during our investigations is derived from PHG conglomerate.
	PHG Mudstone/ Siltstone derived debris	Generally comprising of a Soft to Hard pervasively sheared silty CLAY, or with minor Extremely Weak Siltstone.	Encountered generally in the toe area of the TS (Rocks Rd and Grenville Tce) Little evidence of mudstone/siltstone in the upper part of the TS.
PHG Fm	Conglomerate	Extremely Weak to strong Conglomerate comprising well-rounded pebbles, cobbles, and boulders.	Underlies the inferred basal shear zone TS.

Unit		Description	Extent
	Mudstone/ Siltstone	Extremely Weak to Weak bedded Mudstone, siltstone and fine sandstone and scattered lenses of coal and lignite encountered in subsurface investigations. Bedding strike recorded at 040-050° at ground surface in the Northern Gully upslope of	Mudstone and sandstone beds are present throughout the PHG Fm Encountered (interbedded with PHG conglomerate) immediately underlying the inferred basal surface of rupture in the toe area of the TS (Locally up to 16.4 m thick (
MP Fm	Sandstone/ Siltstone/ mudstone	Well-bedded and graded weak sandstone-siltstone-mudstone sequence; sandstone dominant in upper part and siltstone dominant in upper part of the sequence adjacent to the TS.	This unit was not encountered during our subsurface investigation but is exposed on the shore platform to the west of the toe of the TS. Inferred NOT to underlie the TS.

6.1.3 Three-dimensional (3D) engineering geological model

A three-dimensional (3D) ground model has been developed of the TS, using the software package 'Leapfrog' (produced by Seequent Limited). This involved interpretation of available ground investigation data, including 20 machine boreholes, 2 hand augers, 22 Scala, 30 test pits, general site observations, and LiDAR ground surface profiles undertaken prior to and after the *event*.

As is standard industry practise, it was necessary to include user generated points and lines to guide the geological surfaces and assist in model development. Where possible, these points and lines were used away from investigation data to keep the model as true to the raw data as possible.

An overview of the engineering geological model and an engineering geological cross section through the Grenville Terrace area are presented below in Figure 6.1 below. Note that this model does not show supplementary landslide features within the body of the main TS. Further cross sections generated by the 3D model (Cross-sections 1 to 3, Figures 10189612-F5 to F7) are included in Appendix A.

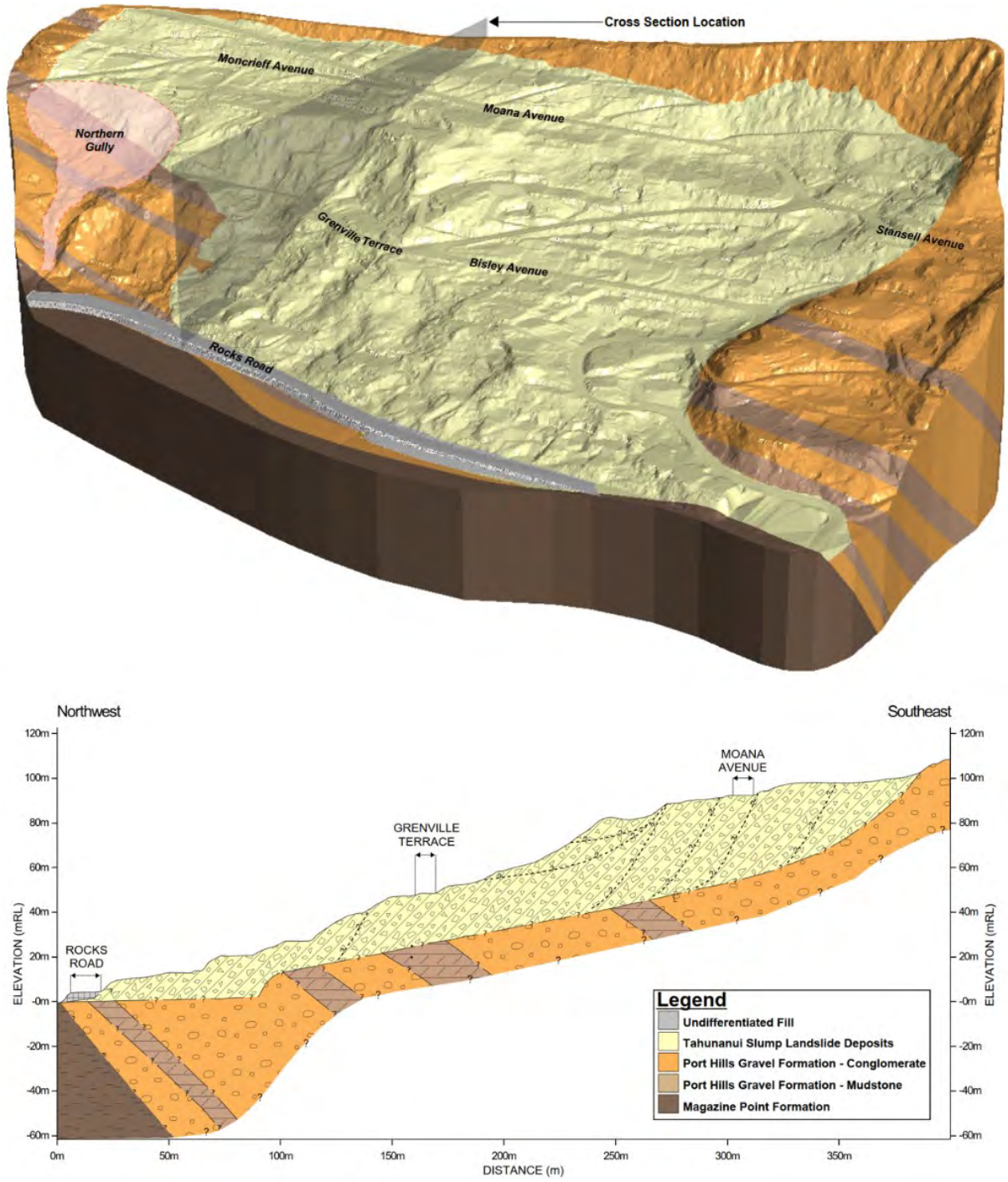

Figure 6.1: 3D Geological model and illustrative cross section of the Tahunanui Slump.

6.2 Inferred landslide mechanisms

Based on our assessment we infer the following with respect to the mechanisms controlling movement within each of the areas of land damage discussed in Section 4.2 above.

6.2.1 Rocks Road northern landslide

- Basal slide surface inferred to be 2 – 3 m depth bgl.
- Shallow landslide on abandoned degraded sea-cliff.
- No historic or recent evidence of deep-seated instability related to the TS in this area.

6.2.2 TS main scarp instability

- Area of shallow instability generally < 1 m depth.
- Ongoing weathering of exposed steep surface of PHG bedrock likely to produce shallow land slippage – particularly sensitive to rainfall events.

6.2.3 Northern Gully earth slide-flow

- Slide surface inferred to be 3–4 m depth bgl based on (and pattern of damage to structures at
- Field observations and NCC LiDAR data suggest that the area of earth slide-flow mobilized during the *event* is likely to be in the order of 12 ha.
- Since 2011 slow to rapid debris flows extending to the base of the gully and onto Rocks Road have periodically been activated in response to elevated rainfall.
- Locally high groundwater flows in sheared PHG mudstone striking at 050° at the south-east margin of the Northern Gully in indicates that the sheared mudstone that trends across the upper part of the gully may act as an aquitard locally, elevating piezometric levels, and saturating the near surface soils.
- Major damage to land and damage to structures located within the reactivated earth slide-flow.
- No recorded historic or recent evidence of deep-seated instability (within bedrock) downslope of the mudstone/siltstone beds exposed at ground surface in the southern, upslope part of the gully, indicating that deep-seated (rock slide) instability may not extend downslope of the RL 55 contour as shown on Cross section 3.
- Earth slide-flow soils were not encountered upslope of the break in slope trending at 055° in the south-eastern part of the Northern Gully.
- Earth slide-flow mobility has been greater in areas9(2)(a) has been removed in recent years.

6.2.4 Days Track complex debris slide – debris flow

- There is a low degree of certainty with respect to depth of movement and the location of the toe, if present. However, based on morphology (main scarp location) and observed main scarp offsets the landslide is inferred to be deep-seated, and in the order of 10 – 40 m depth bgl.
- This instability appears to be either:
  - An area of instability extending to the base of the deep-seated TS (30-40 m bgl) that is experiencing higher rates of displacement due to factors such as localized groundwater conditions or geology of underlying TS deposits; or
  - A rotational landslide with a shallower morphology (10-20 m bgl) with toe breakout on the slope upslope of Grenville Terrace.
- During both 2011 and 2022 events, the downslope part of slide has comprised a debris flow originating from the crest of the steep slope above Grenville Terrace and inundating the Grenville Terrace carriageway.
- Groundwater seepages have been observed on the steep slope downslope of the head of the landslide. As part of the Days Track construction works in 2017 a series of shallow subsoil drains were installed to intercept shallow groundwater.
- A mudstone layer in landslide debris (encountered in test pitting carried out on behalf of NCC in Days Track area following the December 2011 event) may play role as a source of seepage

or as an aquitard affecting piezometric levels during rainfall, that may have triggered the shallow landslide forming the downslope margin of the movement.

- It is likely that confined artesian pore water pressures occur beneath the basal surface of rupture in this area. While drilling [redacted] in April/May date 2012 artesian flows were encountered that were estimated by the driller to be at least 2.5 m above ground level, when drilling was at 41.5 m depth.
- Future movement likely initiated by elevated piezometric levels.
- The area affected also experienced similar but lower magnitude displacement/damage in December 2011 than the movement that occurred as a result of the *event*. The December 2011 event may have resulted in weakened ground and an increased vulnerability to rainfall triggering.

6.2.5 Grenville Terrace instability

- This is an area of earth slide instability of similar landslide deposits derived from the underlying TS deposits, rather than a single discrete landslide.
- Slide surface inferred to be 2–4 m depth bgl and slide surface inferred to be undulating causing break up of soil mass.
- Movement likely to be driven by elevated groundwater levels in slide mass.

6.2.6 Deep-seated Tahunanui Slump rock slide

- A complex and composite rotational-translational rock slide-debris slide. The basal surface of rupture beneath the central body of the landslide, based on borehole information is inferred to be 20–41 m depth bgl.
- Based on geological model the basal surface of rupture is generally inclined to the west at 10 to 14 degrees but may be stepped and or wavey reflecting underlying lithology and pre-initiation geomorphology.
- There is no evidence that the toe of the landslide extends below the current sea level.
- There is evidence, notably in the northern section that at the time of initiation, the toe of the landslide broke out above the base of the pre-existing sea cliff.
- Historic movement episodes have occurred in response to both elevated groundwater levels and seismic shaking.
- Movement rates vary widely from 2-5 mm/yr in the less active southern part of the TS, to 10 mm/yr in the Grenville Terrace area, although these are average rates over time, and it is more likely that the TS experiences long periods with little movement occurring and short intervals where more substantial movement takes place.
- Results from the inclinometer in [redacted] indicate that that the toe deformation can be distributed over a zone in the order of 1 m thick above basal surface of rupture.
- Localised areas of observed compression, upslope (south-east) uplift of ground relative to the downslope land over several metres in width and extending over approximately 100 m along and downslope of northern end of Grenville Terrace shown on Figure 1089612-F2 is inferred to indicate the toe zone of the deep-seated TS rock slide.
- Historic cracks in Days Track adjacent to [redacted] and compression of pavement upslope of [redacted] also indicate a concentrated zone of stress. We infer that this zone aligns with mapped mudstone observed at [redacted], in services trenches at the northern end of Grenville Terrace, and mudstone observed in [redacted] and surface exposures upslope of the dwelling at [redacted].

- Our assessment found no obvious historic or recent surface indications of deep-seated instability downslope of the areas of compression mapped shown on Figure 108962-F2 - although we note that subtle landslide toe compression can occur over several metres and be difficult observe away from pavement or other brittle surfaces.

We infer that between the compression zone indicates the toe breakout of the TS (deep-seated rock slide) and that the mudstone structure and effect of the mudstone on groundwater have contributed to the initiation and ongoing movement of the TS in this area (including the earth slide-flow in the Northern Gully).

In areas within the deep-seated TS that are remote from the main scarp, subsidiary scarps and the toe compression and breakout zones, the level of land damage experienced due to deep-seated displacement as a result of natural disaster events is generally less severe than in areas subject to shallow landslides.

Based on our investigation we consider the active deep-seated instability associated with the TS does not extend to the full area defined as the TSRA in the NRMP. We have not found any evidence that Rocks Road has been recently affected by underlying deep-seated movement of the TS. Our assessment indicates that landslide movement may terminate or attenuate downslope of the compression zone in northern Grenville Terrace, and the break in slope in the Northern Gully where mudstone beds were encountered in and in exposures at ground surface within the gully.

Ground movement attributed to the TS has been indicated by the inclinometer in To the south of the deep-seated TS breaks out upslope of Rocks Road but is inferred to be located over a diffuse zone 10 to 40 m upslope of the road. We consider that at the time of initiation of the TS there is likely to have been a sea-cliff present within this zone.

It is likely that to the south of at the initiation of the TS the toe of the surface of rupture was located variably at the toe and at higher elevations within a pre-existing sea cliff and the foot of the landslide has extended over a pre-existing beach platform. All remnants of the sea cliff are now removed or are covered by debris that forms the deflated topography evident upslope of Rocks Road to the south of .

We note that in the southern area, where the main scarp of the TS is up to 50 m high there is likely to have been several tens of metres of movement over time, with removal of toe deposits through coastal erosion (prior to construction of Rocks Road) contributing to ongoing deep-seated movement.

6.3 Likelihood of future instability

This section assesses potential future landslide likelihood arising from rainfall events similar to those that have caused land damage in the past. We have not specifically analysed slopes to assess seismic triggering potential, but note that in general slopes of marginal stability will be subject to displacement as a result of large earthquake events.

6.3.1 Northern Gully earth slide-flow

In its current state and in the near future the earth slide-flow in the Northern Gully is more likely to be triggered by more frequent and less intense rainfall events than in recent years. This is due to the fact that the gully now contains a broken-up mass of saturated plastic soils containing tension cracks and ponds of water (particularly in the lower part of the gully) allowing easier ingress of surface water into the slide mass. Accordingly, there is an elevated likelihood of slow to rapid debris flows causing inundation at the base of the gully upslope of Rocks Road.

With time (and assuming no ongoing high frequency events triggering further movement of the earth slide-flow) the stability of the gully is likely to return to pre-*event* levels as pore-water

pressures return to normal levels, tension cracks heal, and areas of ponded water are reduced. Regardless, without construction of slope stability mitigation measures, it is likely that the earth slide-flow in the Northern Gully will remain episodically active, generating debris flows from the base of the gully.

Instability within the gully is likely to remain sensitive to vegetation removal, surface water ponding and shallow perched groundwater levels.

6.3.2 Rocks Road northern landslide

This instability comprises an earth slide that has occurred on a steeply inclined slope upslope of the dwellings along Rocks Road. The main scarp has left an over-steepened slope in the order of 3 m in height on the steep slope, increasing the risk of shallow earth slide instability upslope of the landslide.

6.3.3 Tahunanui Slump main scarp instability

The main scarp of the TS is likely to be subject to ongoing shallow instability during high intensity rainfall events as exposed bedrock weathers. This will involve future periodic regression of the main scarp with resulting inundation of downslope land.

6.3.4 Days Track complex debris slide – debris flow

There is a low degree of certainty with respect to the mechanisms controlling movement of this area of instability. As such, it is difficult to predict the future level of activity.

However, the nature of recent movement indicates a progressive weakening of the ground though cumulative displacements by episodic triggering events. One future landslide scenario that may be possible is the inundation of multiple (up to 10) properties downslope and land evacuation around the crown.

6.3.5 Grenville Terrace instability

Episodic downslope displacement of the shallow landslide deposits in this area has been recorded on several occasions in the past (1929 and 2011).

Due to the disruptive nature of the downslope movement, and differential movement within the slide mass, it is likely that multiple tension cracks are present within the landslide that will in the near future allow greater infiltration of surface water into the slide mass. Similarly, any underground services damaged as a result of the *event* that are not adequately repaired will increase the risk of instability in this area.

This means that this area will currently have a greater sensitivity to rainfall induced movement than prior to the *event*.

6.3.6 Deep-seated Tahunanui Slump rock slide

South

In the southern part of the TS (south of Grenville Terrace and) where the age of deep-seated land slippage appears older the topography is more deflated, and protection of the toe of the slope by Rocks Road is preventing further removal of mass at the toe of the slope, it is likely that deep-seated instability in this part of the TS will decrease with time.

North

In the northern part of the TS (north of Grenville Terrace and) deep-seated displacements are:

- Anticipated to be of a similar level in the future to levels experienced under historic seismic and rainfall natural disaster events.
- Not anticipated downslope of the zone of compression in the northern part of Grenville Terrace.
- Not anticipated within the Northern Gully downslope of the break in slope in the southern part of the gully (as discussed in Section 6.1.5).
- Anticipated in the Days Track landslide area, and the upper part of the Grenville Terrace Landslide area upslope of the location of the inferred degraded sea-cliff.

Seismic or rainfall triggered natural disaster events are likely to result of greater levels of displacement and property damage in the northern part of the TS than the south.

As has been the case with the *event*, we anticipate that the greater deep-seated displacements anticipated in the northern part of the TS are likely to trigger shallower (and more damaging) land movement.

We expect that triggering events causing extensive land damage may occur at intervals in the order of 10 to 50 years.

6.4 Potential remediation/mitigation options

Conceptually there are a range of remediation/mitigation options that can be considered for each of the areas discussed in Section 4.2 that are in addition to potential works outlined in respect of individual land damage claim settlements. Some options are presented in Table 6.2 below.

Any consideration of landslide remedial and or mitigation measures over and above those identified elsewhere as part of individual land damage claim assessments, will need to be supported by careful risk-based analysis which is beyond the scope of this assessment.

Table 6.2: Potential remediation/mitigation options

Damage area	Potential remedial measures
Northern Gully earth slide-flow	• Due to the extent of earth slide-flow movement in the Northern Gully (1.2 ha) it is unlikely that this instability can be addressed through construction of hard engineered structures. • Subsoil drainage and improved control of stormwater flows entering the gully from upslope are likely to reduce the activity of the earth slide-flow within the Northern Gully. • Reduced groundwater levels within the Northern Gully are likely to reduce the incidence of slow-moving debris flows that have recently and historically inundated insured property on Rocks Road. • Construction of a deflection barrier is likely to be a viable option to protect insured property [redacted] from further debris flows, however design of such a structure would need careful consideration of debris flow volumes and velocities.
Rocks Road northern landslide	• This appears to be a shallow landslide that has occurred on a steep slope inferred to be an abandoned sea-cliff. Hard engineering solution exists to mitigate against future potential damage to property as a result of future movement of this landslide and can be implemented on a property-by-property basis to protect land and housing assets. • Solutions should consider restoring support to ground immediately upslope of the landslide.
Tahunanui Slump main	• Due to the steepness of the Tahunanui main scarp, it is likely that shallow instability will continue to be generated during future natural disaster events. Hard engineering solutions such as anchored shotcrete slope protection are available to protect the main

Damage area	Potential remedial measures
scarp shallow instability	scarp from land slippage. However, protection of the entire main scarp area is unlikely to be economic. • Planting of vegetation will locally reduce the frequency and downslope effects of this instability. • Mitigation to reduce the consequence to downslope properties include rock catch fences. Historically debris flows initiating on the main scarp have individually not had sufficient volume or velocity to cause catastrophic damage and therefore design loads are likely to be feasible to design for. Such structures would require a commitment to ongoing maintenance although this is likely to be a lower cost than debris clear up.
Grenville Terrace instability	• Stabilization of this entire area of shallow instability is unlikely to be feasible, as it is inferred to comprise an area of coalescing landslide deposits rather than a discrete landslide. • However, due to the limited depth of movement, hard engineering solutions exist that may be implemented on a property-by-property basis to locally mitigate against future potential damage to residential property as a result of future movement of the Grenville Terrace instability.
Days Track complex debris slide – debris flow	• As the mechanism controlling the movement of the Days Track rotational failure is not well understood, it is unclear whether hard engineering solutions existing to improve the stability of the landslide. Further work is required to assess the feasibility of risk mitigation. • Improved stormwater collection and installation of subsoil drainage is likely to reduce anticipated displacements during future natural disaster events, but this will require a further period of groundwater monitoring and potentially the installation of test drains.
Deep-seated Tahunanui Slump rock slide	• Due to the depth and complexity of landslide movement, stabilization of the deep-seated TS utilizing hard engineering solutions such as retaining walls or earthworks such as shear keys is unlikely to be either economic or feasible. • Subsoil drainage carried out across the slump is an option to reduce future displacement of the deep-seated landslide. • Further stability modelling, review of ground water trends and correlation of movement from ground monitoring with groundwater is required to establish the relative degree of benefit of subsoil drainage under future natural hazard scenarios.

6.5 Further work

The following areas of further work are recommended to improve the understanding of geotechnical risk within the TS:

- Ongoing monitoring of ground movement and groundwater monitoring data from instruments installed on behalf of EQC. EQC may wish to commence discussions with stakeholders within the TS including NCC and Waka Kotahi with respect to transfer of responsibility for ongoing monitoring of these instruments.
- Following confirmation of deep-seated movement depths in inclinometers, and groundwater trends and correlations, further slope stability modelling should be carried out in the northern part of the TS. This modelling should utilize the real-time groundwater and ground displacement data from instrumentation installed as part of this investigation.
- We recommend that at least one full year of monitoring data should be gathered before initial conclusions can be drawn with respect to the relationship between groundwater and ground movement.
- Further investigations and installation of ground movement and groundwater monitoring instrumentation in the southern part of the TS where existing ground investigation information is sparse, and the mechanisms controlling instability are less well understood than in the northern part of the TS.
- Once sufficient real-time ground movement and groundwater data has been obtained, future likely natural hazard events may be modelled. This will allow stakeholders to assess the implications of future predicted displacements of the TS as well as the localized damage areas on property and public infrastructure, including roads and underground piped services.
- Further geotechnical assessment should be carried out to establish the downslope extent of deep-seated instability in the Grenville Terrace area and Days Track area. Amendment of the extent of deep-seated instability has significant implications for affected property owners, geotechnical practitioners, insurers, and NCC.

7 Applicability

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

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

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s9(2)(a)

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Authorized on behalf of T+T by:

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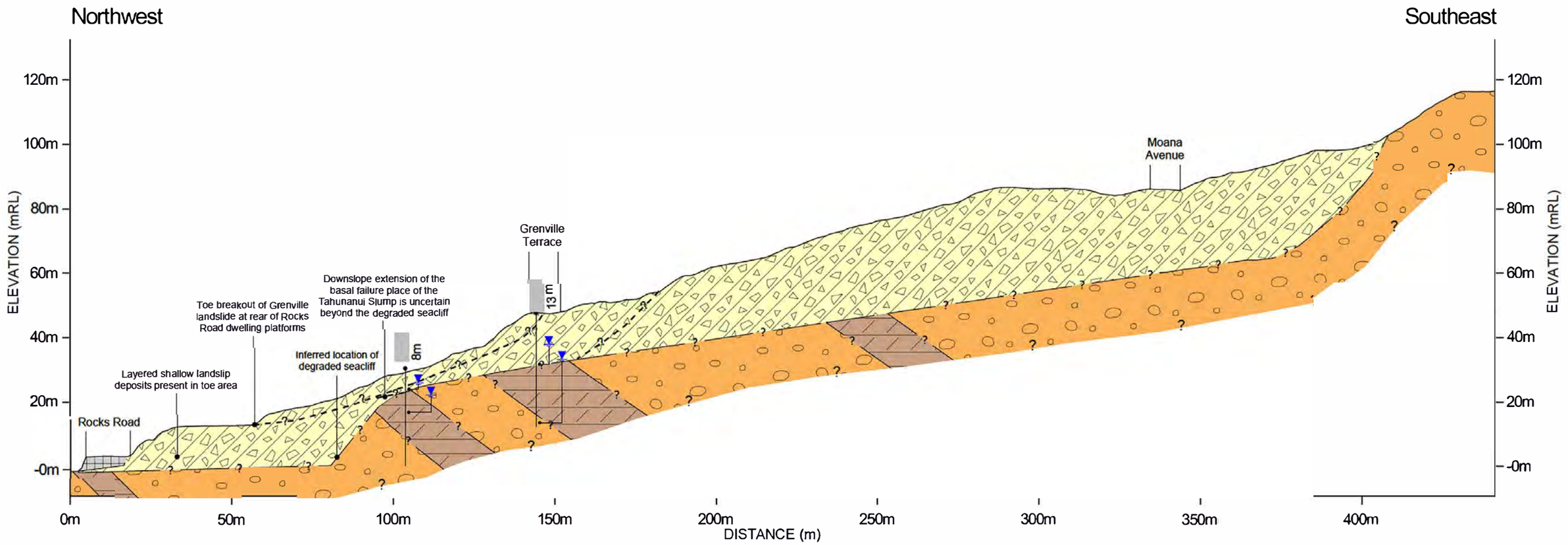
Appendix A T+T figures

- **Figure 1089612-F1 – Site investigation location plan.**
- **Figure 1089612-F2 – Geomorphology plan.**
- **Figure 1089612-F3 – 2022 Land damage mapping.**
- **Figure 1089612-F4 – 2022 Land damage areas.**
- **Figure 1089612-F5 – Geological cross-section 1.**
- **Figure 1089612-F6 – Geological cross-section 2.**
- **Figure 1089612-F7 – Geological cross-section 3.**

The following four pages have been withheld in their entirety.



Cross-section 1

Scale: 1:1,250

Vertical exaggeration: 1x

0m 50m

Location

West: 1621282, 5430414

East: 1621566, 5430077

Legend

- Undifferentiated fill
- Tahunanui Slump Landslide Deposits
- Port Hills Gravel Formation - Conglomerate
- Port Hills Gravel Formation - Mudstone
- Magazine Point Formation

ORIGINAL IN COLOUR

Tonkin+Taylor

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NOTES
1. EXISTING GROUND PROFILE BASED ON 2021 NELSON LIDAR
2. VERTICAL DATUM: NZVD2016
3. THE DEPTH OF GEOLOGICAL UNITS PRESENTED IN THIS CONCEPTUAL GEOLOGICAL MODEL IS BASED ON INFORMATION OBTAINED FROM RECENT INVESTIGATIONS AND HISTORICAL INVESTIGATIONS UNDERTAKEN AT POINT LOCATIONS. THE NATURE AND CONTINUITY OF THE GEOLOGY AWAY FROM BOREHOLE LOCATIONS MAY VARY FROM THOSE ASSUMED IN THIS DRAWING.

REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE

DESIGNED s9(2)(a)
DRAWN
DESIGN CHECKED
DRAWING CHECKED

NOT FOR CONSTRUCTION

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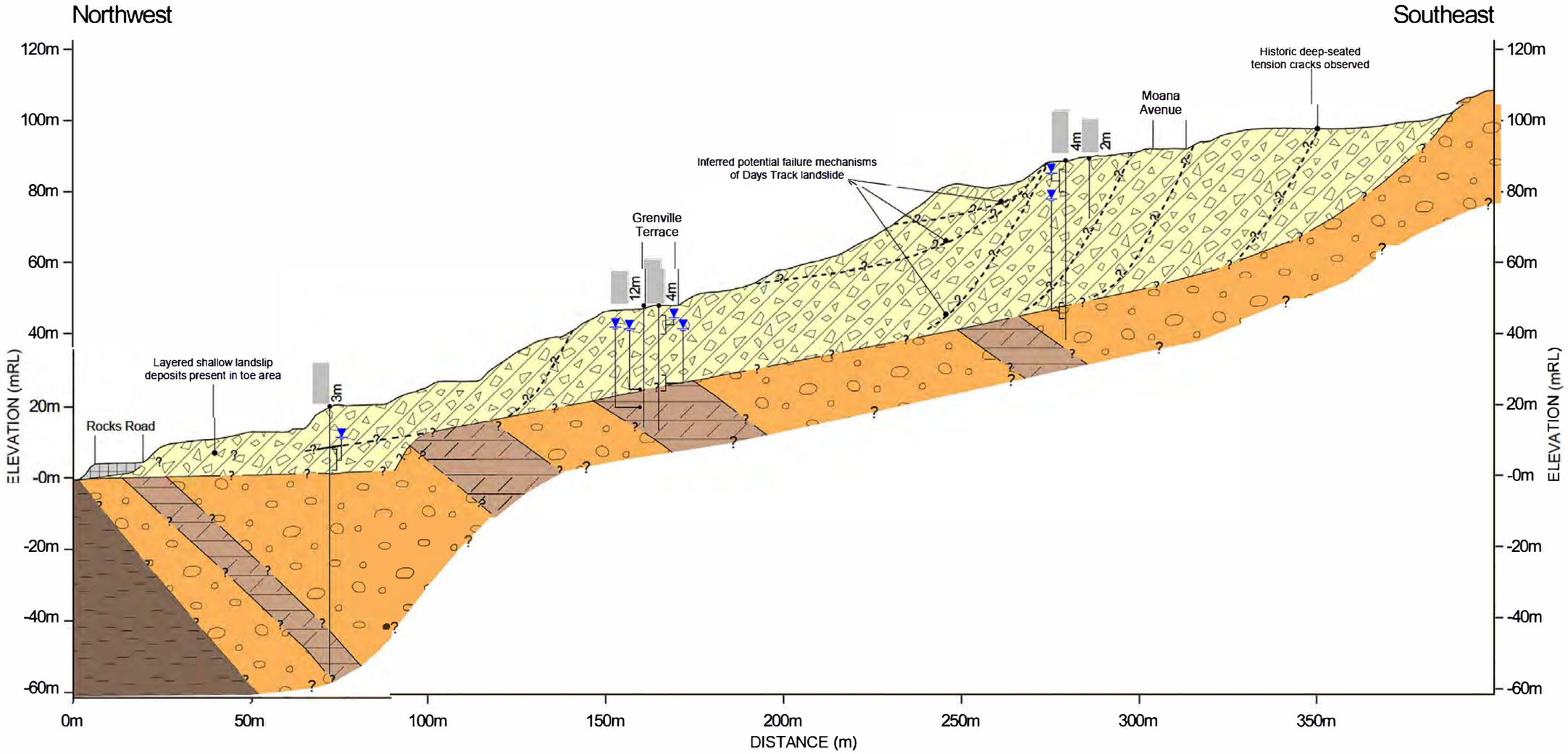
CLIENT **EARTHQUAKE COMMISSION**

PROJECT **TAHUNANUI SLUMP GEOTECHNICAL ASSESSMENT**

TITLE AUGUST 2022 NATURAL DISASTER EVENT GEOLOGICAL CROSS-SECTION 3

SCALE (A3) 1:1.250 FIG NO. 1089612-F5 REV 1



Cross-section 2

Scale: 1:1,250

Vertical exaggeration: 1x

0m 50m

Location

West: 1621288, 5430418

East: 1621552, 5430057

ORIGINAL IN COLOUR

Legend

- Undifferentiated fill
- Tahunanui Slump landslide deposits
- Port Hills Gravel Formation - Conglomerate
- Port Hills Gravel Formation - Mudstone
- Magazine Point Formation

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NOTES
1. EXISTING GROUND PROFILE BASED ON 2021 NELSON LIDAR
2. VERTICAL DATUM: NZVD2016
3. THE DEPTH OF GEOLOGICAL UNITS PRESENTED IN THIS CONCEPTUAL GEOLOGICAL MODEL IS BASED ON INFORMATION OBTAINED FROM RECENT INVESTIGATIONS AND HISTORICAL INVESTIGATIONS UNDERTAKEN AT POINT LOCATIONS. THE NATURE AND CONTINUITY OF THE GEOLOGY AWAY FROM BOREHOLE LOCATIONS MAY VARY FROM THOSE ASSUMED IN THIS DRAWING.

REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE

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DESIGN CHECKED APR.23
DRAWING CHECKED APR.23

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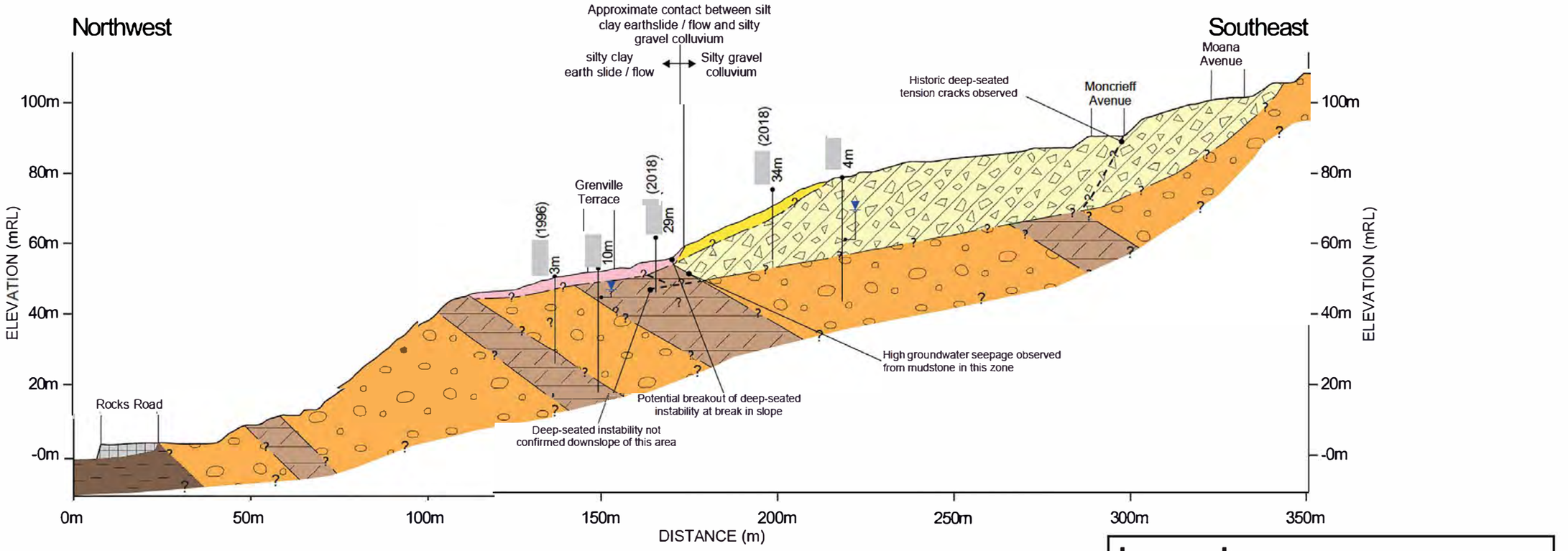
CLIENT **EARTHQUAKE COMMISSION**

PROJECT **TAHUNANUI SLUMP GEOTECHNICAL ASSESSMENT**

TITLE AUGUST 2022 NATURAL DISASTER EVENT GEOLOGICAL CROSS SECTION 2

SCALE (A3) 1:1.250 FIG NO. 1089612-F6 REV 1



Cross-section 3

Legend

- Undifferentiated fill
- Earth slide / flow deposits - Silty clay
- Colluvium Deposits - Silty gravel
- Tahunanui Slump landslide deposits
- Port Hills Gravel Formation - Conglomerate
- Port Hills Gravel Formation - Mudstone
- Magazine Point Formation

Scale: 1:1,250

Vertical exaggeration: 1x

0m 50m

Location

Northwest: 1621411, 5430545

Southeast: 1621710, 5430363

ORIGINAL IN COLOUR

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NOTES
1. EXISTING GROUND PROFILE BASED ON 2021 NELSON LIDAR
2. VERTICAL DATUM: NZVD2016
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CLIENT EARTHQUAKE COMMISSION
PROJECT TAHUNANUI SLUMP GEOTECHNICAL ASSESSMENT
TITLE AUGUST 2022 NATURAL DISASTER EVENT CROSS SECTION 3
SCALE (A3) 1:1.250 FIG NO. 1089612-F7 REV 1

Appendix B Site investigation results

- **Table B.1 – Borehole summary table.**
- **Borehole logs – [redacted] to [redacted] (December 2011 to May 2012).**
- **Borehole logs - [redacted] to [redacted] (September-October 2022).**
- **Test pit logs - [redacted] to [redacted] (November 2022).**
- **Hand auger logs - HA01 to HA02 (October 2022).**
- **Scala logs - SC01 to SC22 (November - December 2022).**
- **Moncrieff wall investigations – [redacted] and [redacted] (2013).**
- **Engineering geology terminology sheet.**

B.1: 2022 borehole summary table

BH	Location	Summary description
		• Conglomerate-derived debris was present from the ground surface to a depth of 21.4 m bgl, where a 2.5 m thick pervasively sheared mudstone-derived debris layer was encountered (The base of this layer is the basal slip surface of the TS, as confirmed by previous monitoring of an adjacent and now defunct inclinometer in • Very thick beds (>2 m) of alternating mudstone and sandstone of the Port Hills Gravel Formation are present from 23.9 m bgl until the base of the hole at 34 m bgl.
		• Extremely Weak conglomerate-derived debris encountered from the ground surface. • Grades into intact conglomerate at ~9 m bgl showing little indications of significant deformation due to landslide displacement. • Widely spaced, moderately thin shear zones were logged within the conglomerate from 18.8 to 23.4 m bgl. • Conglomerate consistent with PHG Fm bedrock was present from 23.4 m bgl to the base of the hole at 35 m bgl.
		• Mudstone-derived debris encountered to a depth of 3.5 m bgl, underlain by weathered mudstone soil consistent with PHG Fm bedrock. • Slightly to unweathered mudstone and sandstone consistent with Port Hills Gravel Formation bedrock present from 9.75 m bgl. • Conglomerate consistent with PHG Fm bedrock is encountered at a depth of 13.75 m bgl and is present until the base of the hole at 35 m bgl, • A localised very thick (2.5 m) mudstone bed present at 21.45 m bgl.
		• Conglomerate-derived debris was encountered from the ground surface to a depth of 15.1 m bgl, • Below this a 2.4 m thick layer of pervasively sheared mudstone-derived debris was encountered (the base of this layer is inferred to be the basal slip surface of the TS). • Mudstone consistent with PHG Fm bedrock is present from 17.5 to 30.5 m bgl, separated by a 4 m thick sandstone bed from 18.8 to 22.8 m bgl. • Conglomerate consistent with PHG Fm bedrock was encountered to the base of the hole at 35 m bgl.
		• The drill rig encountered unexpected and unmanageable ground conditions while drilling through the conglomerate-derived debris at this location. • After drilling for four days, the hole was abandoned at a depth of 16.7 m bgl in soils consistent with PHG conglomerate derived TS landslide debris.
		• Mudstone-derived debris was encountered from the surface at this location, with pervasive shearing present from 2.1 to the base of the mudstone-derived debris at 5.2 m bgl (the base of this layer is inferred to be the basal slip surface of the TS). • Mudstone consistent with Port Hills Gravel Formation was present from 5.2 m bgl before transitioning to a sandstone at 19.65 m bgl. • Conglomerate was encountered from 21.3 m bgl to the base of the hole at 30 m bgl.

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DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 1 OF 4

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 19/12/11
	DATUM: NZMG49	HOLE FINISHED: 17/1/11
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...):
FILL	30mm ASPHALT 0.03-1.3m: Fine to medium GRAVEL, grey, loose
	Inferred contact?
TAHUNANUI SLUMP MATERIAL	1.3m: Silty GRAVEL, brownish grey, medium dense, moist Drilling disturbance, core loss
	2m: Gravelly SILT, with minor clay to silty GRAVEL, brown/grey, firm to stiff/medium dense, moist Drill disturbance, core loss
	3.2m: Silty GRAVEL and GRAVEL, with some cobbles, brown and grey, loose to medium dense?, moist?, core loss
	4.2m: SILT, with minor gravel, brown, stiff, moist
	5m: Clayey SILT, with minor to some gravel, light grey mottled orange, firm, moist
	5.8-6m: Silty GRAVEL/gravelly SILT, with minor clay, orange brown, firm to stiff/medium dense, moist
	6m: Silty GRAVEL, grey, medium dense, moist 6.6-10.2m: GRAVEL, silty GRAVEL and gravelly SILT, light grey, dense, dry
	NOTES: Gravel layers likely to have had fines washed out in drilling process. * Inferred in-situ - silty GRAVEL/gravelly SILT. * Core dry as not wrapped, also desiccated, effects density. * Sub-angular to sub-rounded gravels.

ROCK WEATHERING: UW SW MW HW

ROCK STRENGTH: R4 R3 R2 R1 R0

PT LOAD / UCS TEST (MPa)

CORE LOSS /LIFT (%): 0 10 50 100

METHOD, CORE & CASING: HQ3 HQ

TEST SYMBOL

DEPTH (m): 1 2 3 4 5 6 7 8 9 10

GRAPHIC LOG

DEFECT LOG

FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH

RQD (%)

WATER

DRILL WATER LOSS (%): 25 50 75

CORE BOX

RL (m): 60 59 58 57 56 55 54 53 52 51

Box 1

Box 2

T+T DATATEMPLATE.GDT 2mm

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 2 OF 4

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 19/12/11
	DATUM: NZMG49	HOLE FINISHED: 17/1/11
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
TAHUNANUI SLUMP MATERIAL	10.2-11m: SILT, grey, very stiff (desiccated), dry 10.9m: Coal fragment 11m: SILT, with minor gravel to gravelly SILT, grey, stiff to very stiff, dry 11.5-13m: Silty GRAVEL/gravelly SILT, stiff to very stiff, grey, medium dense? 13m: Silty GRAVEL/gravelly SILT, with minor sand, grey green, stiff/medium dense?, dry to wet? 14-14.5m: Minor cobbles 15.2m: Darker grey green, possibly due to saturation 16.5m: Cobbles 17m: Gravally SILT, with minor sand, grey green, stiff?, moist to wet 17.6m: Gravelly SILT/silty GRAVEL, minor cobbles, grey green, stiff/medium dense? dry to moist (core) GRAVEL layers in core, inferred that fines washed out during the drilling process. Minor sand in some layers. Clasts predominantly sub-rounded, minor sub-angular.	UW SW MW HW	R4 R3 R2 R1 R0		3 10 30 100	HQ3 HQ		11 12 13 14 15 16 17 18 19 20		50 10 6 1	10.3m: Core broke along a 50° plane. 10.5-10.8m: Sheared zone. NB: Difficult to log as not wrapped dry, desiccated. NB: Core boxes fell over, disturbed and dry/desiccated, therefore difficult to assess any defects.				25 50 75	Box 2 49 48 Box 3 47 46 45 44 Box 4 43 42 41 Box 5

T+T DATATEMPLATE.GDT 2mm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 3 OF 4

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO ORDINATES

DIRECTION:

ANGLE FROM HORIZ.: -90.00°

DRILL TYPE: Rotary
DATUM: NZMG49
R.L. GROUND: 60.40 m
R.L. COLLAR: 60.40 m

HOLE STARTED: 19/12/11
HOLE FINISHED: 17/1/11
DRILLED BY: CW Drilling Ltd
LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE		ROCK DEFECTS
GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS
TAHUNANUI SLUMP MATERIAL	Gravelly SILT/silty GRAVEL, minor cobbles, grey green, as above at 17.6m	NB: Box 6 with slide zone was dropped before logged. Slide zone difficult to log as dried, desiccated.
SLIDE ZONE	23.2m: SILT, with minor clay to clayey SILT, brown, firm to stiff, dry (core) Disturbed zone with sheares and slickensided surfaces, no dip, chaotic texture	Slide zone - Sheared zone and slickensided surfaces. Shear zone 40°, planar, slickensided, tight, clean.
PORT HILLS FORMATION SILTSTONE	24.1m: UW, grey, very thinly bedded SILTSTONE, extremely to very weak, cemented, carbonaceous material 24.9-26.1m: Silty SANDSTONE to sandy SILTSTONE 26.1m: SILTSTONE, transitional grading to fine SANDSTONE 27.2m: UW, grey, fine SANDSTONE, extremely weak, cemented to partially cemented, massive 27.6m: Laminated SILTSTONE, as at 24.1m 28.1m: Fine to medium SANDSTONE, as at 27.2m 29.1m: MUDSTONE/SILTSTONE, very weak	Bedding 25°, planar, smooth, tight, clean. Bedding 20°, planar, smooth, tight, clean. Bedding 25°, planar, smooth, tight, clean. Joint 35°, planar, smooth, tight, clean. Joint 40°, planar, smooth, tight, clean.

Column headings: ROCK WEATHERING (UW SW MW HW); ROCK STRENGTH (R4 R3 R2 R1 R0); PT LOAD / UCS TEST (MPa); CORE LOSS / LIFT (%) (0 10 30 50 100); METHOD, CORE & CASING; TEST SYMBOL; DEPTH (m); GRAPHIC LOG; DEFECT LOG; FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1); DATE / DEPTH; RQD (%); WATER; DRILL WATER LOSS (%) (25 50 75); CORE BOX; RL (m)

Method: HQ3, HQ, HQ, HQ, HQ, HQ3, HQ3, HQ, HQ3, HQ, HQ, HQ3, HQ3, HQ3, HQ3, HQ3

Depth (m): 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

RQD (%): 100, 100, 100, 96

Core box: Box 5, Box 6, Box 7, Box 8, Box 9

RL (m): 40, 39, 38, 37, 36, 35, 34, 33, 32, 31

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Hole Location:

SHEET 4 OF 4

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO ORDINATES [redacted]

DIRECTION:

ANGLE FROM HORIZ.: -90.00°

DRILL TYPE: Rotary | HOLE STARTED: 19/12/11

DATUM: NZMG49 | HOLE FINISHED: 17/1/11

R.L. GROUND: 60.40 m | DRILLED BY: CW Drilling Ltd

R.L. COLLAR: 60.40 m | LOGGED BY: s9(2)(a) | CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc.);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
PORT HILLS FORMATION SILTSTONE	MUDSTONE/SILTSTONE, with carbonaceous content, very weak, laminated					HQ3		31				Difficult to log as dry, desiccated.		96		
	31m: Laminations becoming faint					HQ3		32						100		
	Laminations becomes undulating					HQ3		33						100		Box 9
						HQ3		34				Polishing possibly due to carbonaceous content.		100		
						HQ3		35				Shear zone, with polished surfaces ~30°.		100		Box 10
	END OF BOREHOLE AT 35m.							36								
								37								
								38								
								39								

T+T DATATEMPLATE.GDT amm

ROCKLG 870981A.GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 1 OF 7

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 17/1/12
	DATUM: NZMG49	HOLE FINISHED: 27/1/12
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW, SW, MW, HW)	ROCK STRENGTH (R4, R3, R2, R1, R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3, 10, 30, 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50, 10, 6, 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25, 50, 75)	CORE BOX RL (m)
								1 2 3 4 5 6 7 8 9 10								60 59 58 57 56 55 54 53 52 51

T+T DATATEMPLATE.GDT amm

ROCKLG 870981A.GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 2 OF 7

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 17/1/12
	DATUM: NZMG49	HOLE FINISHED: 27/1/12
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW, SW, MW, HW)	ROCK STRENGTH (R4, R3, R2, R1, R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3, 10, 30, 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50, 10, 6, 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25, 50, 75)	CORE BOX RL (m)
								11								50
								12								49
								13								48
								14								47
								15								46
								16								45
								17								44
								18								43
								19								42
								20								41

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Hole Location: [redacted]

SHEET 3 OF 7

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO ORDINATES [redacted]

DRILL TYPE: Rotary | HOLE STARTED: 17/1/12

DATUM: NZMG49 | HOLE FINISHED: 27/1/12

DIRECTION: | R.L. GROUND: 60.40 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 60.40 m | LOGGED BY: s9(2)(a) | CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc.);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 6 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
	Start of [redacted] at 21.0m.					HQ3										40
SLIDING ZONE HUNUANUI SLUMP MATERIAL	21m: Silty GRAVEL/gravelly SILT, with minor to some sand, grey green, stiff-medium dense, moist					HQ3		21								
	23.2m: SILT, with minor clay/clayey SILT, brown, firm, moist, sheared Disturbed zone					HQ3		22								39
	23.5m: UW, grey MUDSTONE/SILTSTONE, very weak, faint very thin bedding, cemented, carbonaceous material - flecks. Can break along bedding planes					HQ3		23				23.2-23.5m: Shear zone with polished, slickensided surface, some ~20° bedding angle.				38
	24.6m: SILTSTONE, with carbonaceous flecks					HQ3		24				Joint 50°, planar, smooth, tight, clean, steeper and slightly oblique to bedding (20° oblique). 24.1m: Drillers fines filled at end of core run, not a defect, disked.				37
PORT HILLS FORMATION SILTSTONE	25m: Silty, fine SANDSTONE, with fine SILTSTONE beds, beds becoming coarser with depth					HQ3		25				2x Bedding 20°, planar, rough, tight, clean - drill induced?		96		Box 1 36
	27.1m: Fine SANDSTONE, extremely weak					HQ3		26						100		35
	28.5m: UW, grey MUDSTONE, very weak, faint very thin bedding, cemented, with fine carbonaceous beds					HQ3		27				Joint 60°, slightly curved, rough, tight, open, 5mm silt.		100		Box 2 34
						HQ3		28				Joint 40°, planar, smooth, tight, clean. Bedding 25°, slightly curved/stepped, slickensided, tight, clean, slickensided along dip. Bedding 20°, planar, smooth, tight, clean.		100		33
						HQ3		29						87		32
						HQ3		30				Bedding 20°, planar, slickensided, tight, clean,				Box 3 31

T+T DATATEMPLATE.GDT 2/11/12

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 4 OF 7

PROJECT: Grenville Block | LOCATION: Rocks Road, Nelson | JOB No: 870981

CO ORDINATES | DRILL TYPE: Rotary | HOLE STARTED: 17/1/12

DATUM: NZMG49 | HOLE FINISHED: 27/1/12

DIRECTION: | R.L. GROUND: 60.40 m | DRILLED BY: CW Drilling Ltd

ANGLE FROM HORIZ.: -90.00° | R.L. COLLAR: 60.40 m | LOGGED BY: s9(2)(a) | CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc..);	ROCK WEATHERING (UW SW UW MW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 6 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
PORT HILLS FORMATION	30.2m: Carbonaceous fragment 30.5m: SILTSTONE, with carbonaceous fragments, very weak, approaching weak strength 31.15m: Carbonaceous fragments, weak strength 34.3-34.8m: Colour change to brown, increase in carbonaceous content 35m: Change to grey 36m: UW, light grey SILTSTONE, weak, massive (possible very faint bedding), cemented, carbonaceous material 38m: UW, light grey, sandy SILTSTONE/silty SANDSTONE, cemented, faint bedding 38.2-38.3m: Coarse SANDSTONE bed 38.5m: SW, greyish green, interbedded sandy GRAVEL and coarse SAND, very weak, cemented; Gravel is sub-angular to sub-rounded, some gravelly beds partially cemented, extremely weak					HQ3		31 32 33 34 35 36 37 38 39 40			slickenside perpendicular to dip along strike. 2x Joints 10°, planar, slickensided, tight, clean. Joint 35°, planar, smooth, tight, clean, slightly steeper than bedding. Bedding 20°, planar, rough, tight, clean. 35.3-35.5m: Highly fractured zone. 5 x Joints 40-55°, slightly curved, smooth, some slickensides, tight, clean. Joint 50°, planar, rough, tight, clean.		87 100 100 100 66 100 100			3 30 29 28 Box 4 27 26 25 Box 5 24 23 Box 6 22 21 Box 7

T+T DATATEMPLATE.GDT 2mm

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 17/1/12
	DATUM: NZMG49	HOLE FINISHED: 27/1/12
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS FORMATION GRAVEL	40m: Becoming extremely weak, minor cobbles					HQ3		41								
	41m: SW, greyish green, sandy GRAVEL, with minor silt, extremely weak, uncemented, massive; gravel is sub-angular to sub-rounded					HQ3		42								
						HQ3		43								
						HQ3		44								
	44.5m: SW, greyish green, fine to medium sandy, silty, fine to coarse GRAVEL, with minor cobbles and boulders, extremely weak, massive, uncemented, bedding to 300mm; clasts sub-angular to sub-rounded, coarse soil strength? NB: Clasts vary from strong, competent rock to crushable weathered rock					HQ3		45				NB: Exposed faces of cobbles and boulders are polished.				
						HQ3		46								
						HQ3		47								
	47.4m: SW, greyish green, fine to coarse GRAVEL/COBBLE, mass with minor to some sand/silt matrix, rare boulders, extremely weak, uncemented, massive; clasts are sub-angular to minor sub-rounded; sand is fine to coarse					HQ3		48				NB: At 47.4m change to a more cobble and boulder predominant mass, less sand and silt matrix.				
						HQ3		49								
	44.5m: SW, greyish green, fine to medium sandy, silty, fine to coarse GRAVEL, with minor cobbles and boulders, as at 44.5m					HQ		50								

Box 7 | Box 8 | Box 9 | Box 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Hole Location: [redacted]

SHEET 6 OF 7

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES [redacted]	DRILL TYPE: Rotary	HOLE STARTED: 17/1/12
	DATUM: NZMG49	HOLE FINISHED: 27/1/12
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc. .);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS /LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS FORMATION GRAVEL	50m: SW, greyish green, fine to medium sandy, silty, fine to coarse GRAVEL, with minor cobbles and boulders, as above	UW SW MW HW	R4 R3 R2 R1 R0		0 10 30 100	HQ3		50 51 52 53 54 55 56 57 58 59 60			50 10 6 1	NB: Polished surfaces on cobbles and boulders.				10 9 8 7 6 5 4 3 2 1
	51.5m: SW, greyish green, silty GRAVEL, with minor sand, minor cobbles, rare boulders, extremely weak, uncemented, massive														25 50 75	Box 11 Box 12 Box 13 Box 14
	52.7m: GRAVEL, with minor silt to silty GRAVEL (matrix percentage varies), rare sand, clasts becoming predominantly sub-angular (very dense soil strength?)															
	NB: Density of unit increasing with depth. Extremely weak rock strength.															
	58.5m: Fresh, greyish green GRAVEL, with minor to some silt, minor cobbles, rare boulders, sand, extremely weak (difficult to break core by hand), uncemented, massive; clasts sub-angular, minor sub-rounded															

T+T DATA TEMPLATE.GDT 2mm

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Hole Location:

SHEET 7 OF 7

PROJECT: Grenville Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 17/1/12
	DATUM: NZMG49	HOLE FINISHED: 27/1/12
DIRECTION:	R.L. GROUND: 60.40 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90.00°	R.L. COLLAR: 60.40 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...):	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS /LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 6 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
PORT HILLS FORMATION GRAVEL	60m: Fresh, greyish green GRAVEL, with minor to some silt, minor cobbles, rare boulders, sand, as above					HQ3		61								Box 14
	62m: Core easily broken by hand (dense soil strength?)					HQ3		62								
	SW, greyish green, silty GRAVEL, with minor sand and cobbles, rare boulders, extremely weak, cemented, massive					HQ3		63								Box 15
								64								Box 16
	END OF BOREHOLE AT 65m.							66								
								67								
								68								
								69								

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

ROCKLG 870981A.GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on:

SHEET 1 OF 8

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES | DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 32 00 m | LOGGED BY: s9(2)(a) | CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 0 3 00)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 0 5)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
TOPSOIL AND FILL	Bag Samp e -3m: SILT, w th m nor to some grave , ght brown, st ff, d y, non-p ast c [TOPSOIL and FILL?]															
FILL	Bag Samp e 3-4 5m: SILT, w th some c ay, m nor organ cs and grave , brown, mo st to wet, ow p ast c ty [FILL]															
	4 7m Start of HQ Cor ng: Grave y SILT, w th some c ay, m nor sand, ght brown and brown, d y to wet, non-p ast c w th ow p ast c ty zones [FILL]					CO C TR CS		4								
TAHUNANUI SLUMP - PORT HILLS FMN DERIVED	Contact ~6m to GRAVEL w th some s t, m nor c ay, green sh b ue, med um dense, dry, non-p ast c [TAHUNANUI SLUMP]					Q3 BOR G		6								
	6 7-7 7m Bag Samp e: SILT, w th some sand and grave , m nor c ay, green b ue, mo st, ow p ast c ty					Q3		7								
	7 7-7 8m: S ty CLAY, w th some grave , brown grey, f rm, wet, moderate p ast c ty 7 8m: Carbonaceous fragmented coa measures w th m nor s t/c ay matr x, dark brown sh grey, extreme y weak, moderate y weathered, mo st, mPa coa fragment, f rm so matr x					Q3		8								
	8 2-9 4m: Grave y, c ayey SILT (w th h gher c ay content n zones), f rm, mo st to wet, moderate p ast c ty					Q3		9				8 2-9 4m: Sheared surfaces H stor c shears and part a y hea ed, remou ded shears M cro-fractures 2-4mm, fragmented shears (s d ng surface)	6 02 20 2 7 02 20 2 20 02 20 2				Box Box 2
	9 4-9 9m: Grave y SILT to s ty GRAVEL, brown grey, oose, saturated, non-p ast c					Q3		0								

T T DATATEMPLATE GDT 2mm

Log Scale 1 50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]

SHEET 2 OF 8

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES [redacted]

DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 32 00 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT

ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);

ROCK WEATHERING | ROCK STRENGTH | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm)

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX RL (m)

TAHUNANUI SLUMP - PORT HILLS FMN DERIVED

9 9m: Grave y, c ayey SILT, as at 8 2m

0 4- 0 6m: S ty CLAY, grey, f rm, mo st, ow to moderate p ast c ty

0 6- 0 7m: Grave y, c ayey SILT, green grey, f rm, mo st to wet, ow p ast c ty

0 9- 4m: Sandy, s ty GRAVEL, w th m nor c ay, ght grey, oose, saturated, non-p ast c; grave s sub-angu ar to angu ar

6- 9m: S ty, c ayey GRAVEL, w th m nor sand, grey sh green, oose, saturated, non-p ast c; grave s are angu ar to sub-angu ar

9- 3 4m: Grave y, c ayey SILT, w th m nor sand to c ayey, s ty GRAVEL, grey sh greem, f rm, wet to saturated, ow p ast c ty

3 5- 3 6m: F ne SAND, w th m nor grave , s t, grey, dense, d y, non-p ast c

3 6- 4 8m: SILT, SAND and GRAVEL compos t, grey, carbonaceous f ecks, med um dense, mo st, non-p ast c; grave s sub-rounded, po shed, random grad ng and c ast or entat on

4 6m: 5cm coa fragment

4 8- 5 3m: Sandy, s ty GRAVEL, b ue grey, oose, saturated (Dr ng d sturbance?)

5 3- 5 9m: S ty GRAVEL, w th m nor c ay, sand, grey w th green/b ue t nges, saturated, ow to moderate p ast c ty (Dr d sturbance?)

5 9- 7 5m: S ty, sandy GRAVEL, b ue-grey, oose (fr ab e and eas y crushed by hand); grave c asts from f ne po shed, sub-rounded to arge angu ar sandstone, wet/saturated zone

7 5m: Sandy, s ty, f ne to coarse GRAVEL, w th m nor to rare c ay, green sh grey, oose to med um dense, wet, non-p ast c; grave s predom nant y angu ar, m nor sub-rounded, beds of predom nant y sub-rounded grave s, can c ush some c asts by hand, mudstone c asts c ushab e n core

8 2m: W th m nor bou ders and cobb es

0 4- 0 6m: Sheared zone, m cro-fractures -3mm, fragmented shears (s d ng su face?)

3 6m: Shear zone

3 5- 4 8m: Chaot c grad ng or entat on, s ump ng and sheared zones

5 9- 7 3m: Random sheared sect ons

7 3- 7 5m: Shear ng m cro-fractures

20 02 20 2

2 02 20 2

Box 2 | Box 3 | Box 4 | Box

T T DATA TEMPLATE GDT amm

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]

SHEET 3 OF 8

PROJECT: Grenv e B ock	LOCATION: Rocks Road, Ne son	JOB No: 870981
CO ORDINATES [redacted]	DRILL TYPE: Rotary	HOLE STARTED: 16/2/12
	DATUM: NZMG49	HOLE FINISHED: 2/3/12
DIRECTION:	R.L. GROUND: 32 00 m	DRILLED BY: CW Dr ng Ltd
ANGLE FROM HORIZ.: -90 00°	R.L. COLLAR: 32 00 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT	DESCRIPTION OF CORE	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	ROCK DEFECTS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	UW SW MW HW	R4 R3 R2 R1 R0		3 0 3 00						50 0 5	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS				25 50 75	
PORT HILLS GRAVEL FORMATION	Grave becom ng predom nant y sub-rounded at 20m (a grave s to 20m depth are uncemented)					Q3											
	20 5-22 7m: Core d sturbed by dr ng					Q3		2									Box 6
	2 m: W th m nor to some bou ders and cobb es					Q											
	22 7-23 m: Sandstone bou der, fractured n core					Q3		22									
	23 -23 5m: Sandy, s ty GRAVEL, w th some cobb es/bou ders, oose to med um dense, wet					Q3		23									
	23 5-23 7m: On y m nor f nes, poss b y washed out dur ng dr ng process, dr ng d sturbance					Q3											
	23 7m: Sandy, s ty, f ne to coarse GRAVEL, green sh grey, oose to med um dense, wet, non-p ast c, c asts are sub-rounded to sub-angu ar, sandstone and s tstone, some c asts can be crushed by hand; sand s f ne					Q3		24									
	25 7-25 9m: Core dr d sturbed					Q3		2									Box 7
	25 9-26 m: No f nes, washed out?					Q3							22 02 20 2				
	26 8-27 m: GRAVEL, w th m nor s t, sand, cobb es, poss b e dr d sturbance wash ng out f nes					Q3		26									
	27 -27 5m: C ayey SILT, s ght y p ast c matr x					Q3		27					23 02 20 2				Box 8
	27 2m: Sandy, f ne to coarse GRAVEL/grave y f ne to coarse SAND, green sh grey, dense, mo st, non-p ast c, c asts are sub-rounded [Weathered Gran te?]					Q3		28									
	28 -28 4m: Sandy GRAVEL [Weathered Gran te?]					Q3											
	29 2m: Becom ng med um dense, wet, m nor s t content					Q3		29									
	29 6-30 m: Dr ng d sturbance					Q3							24 02 20 2				Box 9
	29 6m: Becom ng oose to med um dense,					Q3		30									

T T DATA TEMPLATE GDT amm

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on:

SHEET 4 OF 8

PROJECT: Grenv e B ock	LOCATION: Rocks Road, Ne son	JOB No: 870981
CO ORDINATES	DRILL TYPE: Rotary	HOLE STARTED: 16/2/12
	DATUM: NZMG49	HOLE FINISHED: 2/3/12
DIRECTION:	R.L. GROUND: 32 00 m	DRILLED BY: CW Dr ng Ltd
ANGLE FROM HORIZ.: -90 00°	R.L. COLLAR: 32 00 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS GRAVEL FORMATION	wet 30m: Sandy GRAVEL/grave y SAND, as above 3 m: F ne to coarse GRAVEL, w th m nor s t, f ne sand, cobb es, green sh grey, ow to med um dense, wet, non-p ast c, c asts are sub-rounded 3 8-32m: Core dr d sturbance 32 2m: Some sand/s t 33 m: GRAVEL, w th rare to some s t/sand matr x, med um dense to dense, wet, grave s moderate y weathered, cobb es to 50mm? d a , d ff cu t to measure n core 34 2-34 9m: Sandy, s ty GRAVEL, med um dense, wet, dr ng d sturbance 34 9-35m: GRAVEL, w th rare to some s t/sand matr x, as at 33 m 35m: Rare f nes, GRAVEL, dense 35 9-37 m: BOULDER (poss b y from 35 5m and fractured dur ng dr ng), f ne sandstone bou der w th carbonaceous f ecks 37 m: Sandy f ne to coarse GRAVEL/grave y coarse SAND, green sh grey, dense, mo st to wet, sub-rounded c asts, dens ty ncreases w th overburden [Weathered Gran te?] 38 6-39 3m: GRAVEL, w th m nor sand, dense, wet 39 3-40 7m: Sandy GRAVEL, dense, dr ng d sturbance [Weathered Gran te?]					Q3		3 32 33 34 3 36 37 38 39 40				35 m: Grave c ast has a 75° d pp ng po shed su face	24 02 20 2 28 02 20 27 02 20 2				Box 9 Box 0 Box Box 2 Box 3

T T DATATEMPLATE GDT amm

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on:

SHEET 5 OF 8

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES

DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 32 00 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING | ROCK STRENGTH | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX RL (m)

PORT HILLS GRAVEL FORMATION

40-40 7m: Sandy GRAVEL, dense, dr ng d sturbance [Weathered Gran te?] Uncemented to 40 7m

40 7m: SW GRAVEL CONGLOMERATE, green sh grey, extreme y to very weak rock mass, cemented to part a y cemented, unknown cement agent (overburden?)
So descr pt on: F ne to coarse GRAVEL, w th m nor coarse sand

40 9-4 6m: Dr nduced fractur ng

42 3-43 8m: Dr nduced fractur ng, h gh y fractured, weaker zone, angu ar rock fragment
So descr pt on: GRAVEL, w th some sand

43 8-49 m: SW GRAVEL CONGLOMERATE, green sh grey, extreme y weak poss b e ow range very weak rock strength, cemented w th pa t a y cemented beds, m nor dr ng nduced broken zones, sub-rounded to sub-angu ar c asts
44 7-45 3 and 46 -46 3m: Weaker bends, assoc ated w th mudstone c asts, mudstone can be c ushed by hand, strength poss b y as ow as dense so strength?

47 5-47 6m: Weaker bed
47 7-48m: Weaker bed

49 m: SW GRAVEL CONGLOMERATE, w th m nor s t and sand n matr x, extreme y weak, cemented to part a y cemented, c asts are

Box 3 | Box 4 | Box | Box 6 | Box 7

T T DATATEMPLATE GDT amm

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on:

SHEET 6 OF 8

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES

DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION:

R.L. GROUND: 32 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 32 00 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS GRAVEL FORMATION	sub-angu ar to sub-rounded, c asts predom nant y sandstone, s tstone w th m nor mudstone, gran te; grave s f ne to coarse, m nor cobb es and bou ders; gran te/mudstone c asts are weathered, can be crushed by hand 50m: SW GRAVEL CONGLOMERATE, w th m nor s t and sand matr x, as above 5 4m: M nor to some med um to coarse sand matr x, very dense, grave strength? 53-54 5m: SANDSTONE and SILTSTONE BOULDERS, x3? 53 9m: Carbonaceous f eck From 54 5m: F ne to coarse GRAVEL, w th some coarse sand, m nor s t, c asts are sub-angu ar, predom nant y gran te-weathered/c ushab e, med um dense to dense so (extreme y weak rock n-s tu), mo st, gran te c asts weathered to res dua so strength					Q3 COR G Q3 Q3 Q3 Q3 Q3 Q3		1 2 3 4 5 6 7 8 9 60				5 4-53m: Dr nduced fractur ng, poss b y assoc ated w th h gher sand content n matr x 54 5-6 3m: Dr nduced fractur ng, h gher sand content	29 02 20 2 03 20 2				8 Box 7 9 2 22 Box 8 23 24 2 Box 9 26 27 Box 20

T T DATATEMPLATE GDT amm

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on:

SHEET 7 OF 8

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES

DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION:

R.L. GROUND: 32 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 32 00 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS GRAVEL FORMATION	F ne to coarse GRAVEL, w th some coarse sand, m nor s t, as above 6 4m: UW Gran te BOULDER Interna Port H s Grave Contact from grave to nterbedded coa and mudstone/s tstone 62 4m: SW, brown sh b ack COAL, extreme y weak, cemented NB: Numerous ha r ne fractures n core Gradua trans t on to SILTSTONE 64m: SW ght grey SILTSTONE, very weak, cemented NB: Core ntact but can break a ong ha r ne jo nt/bedd ng defects and poss b e stress re ef re ated defects, pa t a y rehea ed/cemented? Carbonaceous, coa f ecks n s tstone 65 m: SW, b ack sh brown MUDSTONE, w th coa /cabonaceous content, extreme y weak, cemented 65 -65 8m: Very st ff so strength 65 7m: Becomes very weak Trans t on to coa 67 2m: SW, brown sh b ack COAL, very weak, cemented 67 8m: Trans t on to b ack sh brown, sandy SILTSTONE/s ty SANDSTONE, w th coa , carbonaceous beds/content, ve y weak, cemented, w th extreme y weak bands, pa t a y cemented bands 68 7-69 3m: SW, b ack COAL, very weak, cemented, w th sandstone nc us ons 69 3m: SW, ght grey SILTSTONE, ve y weak, cemented, 60° strat graph c contact	UW SW MW HW	R4 R3 R2 R1 R0		3 0 3 00	Q3 Q3 COR G Q3		6 62 63 64 6 66 67 68 69 70				62 4-62 5m: Dr ng nduced fractur ng 62 55m: Core s ckens ded when broken, Jo nt 25° Bedd ng 50°, p anar, smooth, t ght, c ean 62 9m: Dr nduced fractures Bedd ng 50°, s ght y cu ved, smooth, t ght, c ean Jo nt 70°, s ght y curved, rough, t ght, c ean Bedd ng 45°, p anar, rough, t ght, c ean Jo nt 5°, s ght y curved, rough, t ght, c ean Bedd ng 48°, p anar, smooth, t ght, c ean Jo nt 75° Bedd ng 40°, stepped, rough, t ght, c ean Jo nt/Bedd ng 60°, p anar, smooth, t ght, c ean 65 m: Shear zone, very st ff so strength 65 2-65 4m: Shear zone w th po shed s ght y cu ved bedd ng surface NB: Shear zones n mudstone rehea ed and hard to break open Bedd ng 40°, s ght y cu ved, smooth (po shed, no s ckens ded movement), t ght poss b y open?, 3mm c ay gouge? Shear zone Bedd ng 40°, s ght y cu ved, smooth, t ght, c ean 65 7-66 5m: Can break a ong ha r ne jo nts - mu t p e or ent t ons, very t ght, jo nts, coa enses Jo nt 40°, stepped, rough, t ght, c ean 66 5-67m: Can break a ong 5x 20-25° Jo nts, stepped, rough, very t ght, c ean 2x Jo nts 30°, p anar, rough, t ght, c ean Jo nt/bedd ng 40°, s ght y curved, rough, t ght, c ean Bedd ng 45°, s ght y cu ved, rough, t ght, c ean 68 2 and 68 5m: Coa fragments Jo nt 0°, a ong coa ense, stepped, s ckens ded, t ght, c ean Bedd ng 45° on coa seam, s ght y cu ved, s ckens ded, t ght, c ean NB: S ckens ded movement ob que to jo nt, bedd ng Bedd ng 40°, s ght y cu ved, rough, t ght, c ean Jo nt 20°, s ght y curved, s ckens ded, t ght,	03 20 2 2 03 20 2	0 35 0 90 100 0 100 93 90 85		25 50 75	Box 20 Box 2 Box 22 Box 23 Box 24

T DATATEMPLATE GDT 4mm

Log Scale 1 50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on:

SHEET 8 OF 8

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES

DRILL TYPE: Rotary | HOLE STARTED: 16/2/12

DATUM: NZMG49 | HOLE FINISHED: 2/3/12

DIRECTION: | R.L. GROUND: 32 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 32 00 m | LOGGED BY: s9(2)(a) | CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS GRAVEL FORMATION	69 8m: SW, b ack COAL, ve y weak, cemented SW, b ack COAL, as above 70 5m: Trans t ona contact COAL - SW, brown w th b ack f ecks s ty SANDSTONE, w th coa nc us ons, very weak, cemented 7 6m: Weak 72 2m: SW, brown, sandy SILTSTONE, very weak, cemented, w th coa nc us ons	UW SW MW HW	R4 R3 R2 R1 R0		3 0 3 00	Q3 Q3		7 72 73 74			50 0 s	c ean; s ckens de 40° ob que to p ane of jo nt and bedd ng 60°, strat graph ca contact Jo nt 5°, p anar, s ckens ded, t ght, c ean (ob que to strat graph ca contact and bedd ng) 69 3-69 8m: Ve y narrow coa beds (coa bedd ng 45°-73° on Port H s), bedd ng 45° ????) Jo nt 20°, p anar, smooth, t ght, c ean 70 m: Dr nduced fractur ng d sturbance Jo nt 60°, s ght y curved, stepped, t ght, c ean 2x Jo nts 65°, s ght y cu ved, smooth, t ght, c ean Intersect ng jo nt 50°, s ght y rough, t ght, c ean Bedd ng 55°?, coa bedd ng seam? Jo nt 45°, p anar, s ckens ded, t ght, c ean, coa bed 50mm, s ckens de 50° ob que to jo nt p ane Jo nt 45°, p anar, stepped, t ght, c ean (coa) Jo nt/Bedd ng 50°, s ght y curved, smooth, t ght, c ean (coa) Jo nt/Bedd ng 50°, p anar, s ckens ded/smooth, ve y t ght, c ean Jo nt 25°, s ght y curved, smooth, t ght, c ean Jo nt/Bedd ng 50°, p anar, smooth, t ght, c ean	2 03 20 2	85 86 98 100		25 50 75	Box 24 Box 2 39 40 42 43 44 46 47
	END OF BOREHOLE AT 74.6m.							7 76 77 78 79								

T T DATATEMPLATE GDT amm

Log Scale 1:50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]
SHEET 1 OF 6

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES [redacted]
DIRECTION:
ANGLE FROM HORIZ.: -90 00°

DRILL TYPE: Rotary
DATUM: NZMG49
R.L. GROUND: 0 60 m
R.L. COLLAR: 0 60 m

HOLE STARTED: 12/4/12
HOLE FINISHED: 17/5/12
DRILLED BY: CW Dr ng Ltd
LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT

ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);

ROCK WEATHERING: UW SW MW HW
ROCK STRENGTH: R4 R3 R2 R1 R0
PT LOAD / UCS TEST (MPa)
CORE LOSS / LIFT (%)
METHOD, CORE & CASING
TEST SYMBOL
DEPTH (m)
GRAPHIC LOG
DEFECT LOG
FRACTURE LOG spacing of natural fractures (cm)

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH
RQD (%)
WATER
DRILL WATER LOSS (%)
CORE BOX RL (m)

TAHUNANUI SLUMP MATERIAL

Sta t of [redacted] at 2m

2-2 2m: (Samp e dr -d sturbed) Grave y SILT - S ty GRAVEL, w th m nor cobb es, orange brown, f rm?, wet

2-2 2m: Dr d sturbance - can't og defects

2 2-2 7m: S ty GRAVEL, w th m nor sand, orange brown, oose, wet

2 7-3 2m: (Samp e dr -d sturbed) GRAVEL, w th m nor s t matr x, rare cobb es, orange brown, oose, wet

2 7-5 7m: Dr d sturbance - can't og defects

3 2-5 7m: (Core samp e dr -d sturbed) GRAVEL, w th m nor cobb es, m nor s t, rare sand matr x (f nes poss b y washed out dur ng dr ng), tan brown w th orange sta n ng, oose, saturated

5 7-6 6m: S ty GRAVEL, w th m nor cobb es, tan brown w th orange sta n ng, oose, wet/saturated

6 6-6 75m: GRAVEL (f nes poss b y washed out)

6 75-6 95m: S ty GRAVEL - Grave y SILT, green brown, oose/f rm, wet, s d ng surface? contact?

NB: See contact * recent to h stor c Tahunanu S ump mater a at 6m n [redacted] (Poss b e s d ng su face at 6 75-6 95m n [redacted]

6 95- 0m: S ty GRAVEL, w th m nor f ne sand, b ue/green-grey, med um dense, wet
NB: Dr d sturbance 8-9 8m, f nes poss b y washed out dur ng dr ng process? Poss b e Tahuranu S ump - Port H s Grave der ved?

3 04 20 2
6 04 20 2

T T DATATEMPLATE GDT amm

Log Scale 1 50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]
SHEET 2 OF 6

PROJECT: Grenv e B ock	LOCATION: Rocks Road, Ne son	JOB No: 870981
CO ORDINATES [redacted]	DRILL TYPE: Rotary	HOLE STARTED: 12/4/12
	DATUM: NZMG49	HOLE FINISHED: 17/5/12
DIRECTION:	R.L. GROUND: 0 60 m	DRILLED BY: CW Dr ng Ltd
ANGLE FROM HORIZ.: -90 00°	R.L. COLLAR: 0 60 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT

ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);

ROCK WEATHERING: UW SW MW HW

ROCK STRENGTH: R4 R3 R2 R1 R0

PT LOAD / UCS TEST (MPa)

CORE LOSS / LIFT (%): 3 0 3 00

METHOD, CORE & CASING

TEST SYMBOL

DEPTH (m)

GRAPHIC LOG

DEFECT LOG

FRACTURE LOG spacing of natural fractures (cm): 50 0 5

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH

RQD (%)

WATER

DRILL WATER LOSS (%): 25 50 75

CORE BOX RL (m)

TAHUNANUI SLUMP MATERIAL

NB: Core oss shown at bottom of run
0- 3m: (Dr ng d sturbance) S ty GRAVEL, w th m nor to some cobb es, m nor sand, b ue/green-grey, med um dense, wet

Increas ng dens ty w th depth, more competent from 3m

3- 2 m: As above, dense

2 m: S ty GRAVEL - GRAVEL w th m nor s t, green grey, ve y dense, wet; grave s f ne to med um
NB: C asts f ne from 2 m

3 5- 6 3m: (Dr ng d sturbed, poss b y a ooser zone or cobb es catch ng?)
S ty GRAVEL - GRAVEL, w th m nor s t, m nor cobb es, rare sand, med um dense?, wet; grave s f ne to coarse, cobb es to 50mm; c asts becom ng coarser 3 5- 6 3m

6 3- 6 7m: S ty GRAVEL, w th rare sand, b ue/grey, med um dense, wet, d sturbed; f ne to med um grave , rounded to angu ar broken h gh y po shed SW-HW grave s, chaot c texture

7 2m: As above, w th a most a f nes washed out - GRAVEL

7 75- 7 8m: F nes recovered as per 6 3- 6 7m
7 8- 7 9m: F nes washed out by dr ng
8 - 8 2m: S ty, grave y, f ne to coarse SAND, oose, wet; grave s f ne to coarse
8 2- 8 6m: As 6 3- 6 7m, f nes washed out 8 2- 8 25m
8 6- 8 7m: F nes washed out by dr ng process

9 2- 9 8m: Recovered as s ty, f ne to med um, rounded to angu ar GRAVEL, oose (concentr x)
NB: Core oss shown at bottom of run

0- 3m: Dr ng d sturbance

3 5- 6 3m: Dr ng d sturbance

6 04 20 2
7 04 20 2
8 04 20 2
9 04 20 2
23 04 20 2
24 04 20 2
0 20 2

Box 3
Box 4

T DATATEMPLATE GDT 4mm

Log Scale 1 50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]
SHEET 3 OF 6

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES [redacted]

DRILL TYPE: Rotary | HOLE STARTED: 12/4/12
DATUM: NZMG49 | HOLE FINISHED: 17/5/12
DIRECTION: | R.L. GROUND: 0 60 m | DRILLED BY: CW Dr ng Ltd
ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 0 60 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG (spacing of natural fractures, cm) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX RL (m)

TAHUNANUI SLUMP MATERIAL

9 8-20 2m: S ty GRAVEL, oose to med um dense, wet to mo st, chaot c texture; grave s f ne to med um MW-CW po shed, rounded to sub-angu ar grave

NB: Core oss shown at top of run

20 6m: Now wet

20 9-2 2m: F nes washed out

22 8-24 3m: Recovered as sandy, grave y SILT, oose/f rm, mo st (concentr x)

24 3m: S ty, f ne to coarse RAVEL, rare sand, med um dense, wet; grave s are occas ona y cobb e-s zed, SW-HW, sub-angu ar to rounded h gh y po shed and common y shattered w th a chaot c texture

25 4-26 5m: Dense and we cemented

26 9m: SW, grey MUDSTONE, carbonaceous, extreme y weak, h gh y sheared w th s ckens des para e and ob que to d p, conta ns rare to some rounded, f ne to med um po shed grave c asts, jo nts rehea ed but part eas y, core recovered as ntact core fu un ength

27 2-27 4m: More grave y

28 2-28 4m: SW, b ack COAL, extreme y weak/ve y dense, h gh y sheared w th s ckens d ng para e and ob que to jo nt d p

28 4m: S ty GRAVEL, green grey, very dense/extreme y weak, d y; po shed grave s as at 26 9m, chaot c texture

28 7-29 m: Recovered as oose sandy GRAVEL (concentr x)

29 m: S ty, f ne to coarse RAVEL, rare sand, med um dense, wet; grave s are

NB: Core oss shown at top of un

24 9-25m: F nes washed out by dr ng

25 8-25 9m: F nes washed out by dr ng

Sets:
Jo nt ~40°-50°, s ckens ded, wavy, t ght, c ean (poss b y bedd ng)
2 Jo nt 60°, stepped, p anar, t ght
3 Jo nt 90°, wavy, smooth, t ght

28 m: Jo nt ~40°, wavy, s ckens ded, c ean (poss b y bedd ng)

29 4-29 7m: F nes washed out by dr ng

Box 6 | Box 8

T T DATA TEMPLATE GDT amm

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Hole Location: [redacted]
SHEET 4 OF 6

PROJECT: Grenview Block	LOCATION: Rocks Road, Nelson	JOB No: 870981
CO ORDINATES [redacted]	DRILL TYPE: Rotary	HOLE STARTED: 12/4/12
	DATUM: NZMG49	HOLE FINISHED: 17/5/12
DIRECTION:	R.L. GROUND: 0 60 m	DRILLED BY: CW Drilling Ltd
ANGLE FROM HORIZ.: -90 00°	R.L. COLLAR: 0 60 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT

ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);

ROCK WEATHERING

ROCK STRENGTH

PT LOAD / UCS TEST (MPa)

CORE LOSS / LIFT (%)

METHOD, CORE & CASING

TEST SYMBOL

DEPTH (m)

GRAPHIC LOG

DEFECT LOG

FRACTURE LOG spacing of natural fractures (cm)

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH

RQD (%)

WATER

DRILL WATER LOSS (%)

CORE BOX RL (m)

TAHUNANUI SLUMP MATERIAL

occas ona y cobb e-s zed, SW-HW, sub-angu ar to rounded, h gh y po shed S ty GRAVEL, as above, SW-HW c asts

32 7-32 9m: F nes washed out by dr ng

33 2m: SW, b ue/grey SILTSTONE, st ff, dry/mo st, h gh y sheared w th po shed shear su faces
33 5-33 7m: No shear ng, hard/extreme y weak

33 25-33 5m: H gh y sheared zone 40-60°, po shed su faces
Jo nt 35°, p anar, undu at ng, t ght, c ean
Jo nt 90°, p anar, undu at ng, t ght, c ean

34 2m: S ty, f ne to coarse RAVEL, w th rare coarse sand, b ue/grey, oose to med um dense, wet, d sturbed; grave s rounded to sub-angu ar, SW-HW grave s wh ch are common y sheared to so strength, su faces of grave s are po shed, occas ona cobb es throughout

35 -35 3m: F nes washed out by dr ng

36 2-36 4m: F nes washed out by dr ng

36 8-37m: F nes washed out by dr ng

38-38 m: Dense, dry

39 8m: Dr ng d sturbed Ev dence of

T DATATEMPLATE GDT 4mm

Log Scale 1 50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]
SHEET 5 OF 6

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES [redacted]
DIRECTION:
ANGLE FROM HORIZ.: -90 00°

DRILL TYPE: Rotary | HOLE STARTED: 12/4/12
DATUM: NZMG49 | HOLE FINISHED: 17/5/12
R.L. GROUND: 0 60 m | DRILLED BY: CW Dr ng Ltd
R.L. COLLAR: 0 60 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX RL (m)

PORT HILLS GRAVEL

39 8m: SW, b ack/grey, sandy MUDSTONE, carbonaceous, ve y st ff, dry, pa t a y remou ded by dr ng, nc us ons of coa , poss b y baked by dr ng

40 2m: Grave y, s ty, f ne to coarse SAND, med um dense to dense, mo st to wet, mass ve; grave s ma n y f ne to med um, occas ona y coarse

40 6m: SW, b ack COAL, hard, h gh y sheared w th po sh ng on jo nt su faces w th f ne to coarse sand

40 7m: S ty GRAVEL, w th sand, as above, med um dense to 4 0m

4 -4 m: Med um dense

43m: S ty GRAVEL, trace coarse sand, dense, mo st, ght y cemented, st eas y broken by hand; grave s ess weathered than above, st po shed and fractured

49 4-49 7m: Ev dence of sandstone c asts wear ng softer s tstone c asts, ke y through tecton c deformat on, e f ex ? s p around grave c asts

shear ng, but no d p apparent as core has been spun n barre and baked Poss b y base of T S)

40 6-40 7m: Shear zone d ps at 60°

4 2-42 4m: F nes washed out by dr ng

4 5m: Dr er reports 2 5 m of artes an head for 0 m nutes wh e dr ng

6 0 20 2

7 0 20 2

Box 2 | Box 3 | Box 4

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: [redacted]
SHEET 6 OF 6

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES [redacted]

DRILL TYPE: Rotary | HOLE STARTED: 12/4/12
DATUM: NZMG49 | HOLE FINISHED: 17/5/12
DIRECTION: | R.L. GROUND: 0 60 m | DRILLED BY: CW Dr ng Ltd
ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 0 60 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PHG	50m: S ty GRAVEL, as above					Q3		1					20 2			Box
	END OF BOREHOLE AT 50.3m.												7			

Log Scale 1 50

ROCKLG 870981A GPJ 1/11/12

T T DATATEMPLATE GDT amm

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: Above Rocks Road
SHEET 1 OF 4

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES [redacted]
DIRECTION:
ANGLE FROM HORIZ.: -90 00°

DRILL TYPE: Rotary | HOLE STARTED: 18/4/12
DATUM: NZMG49 | HOLE FINISHED: 9/5/12
R.L. GROUND: 29 00 m | DRILLED BY: CW Dr ng Ltd
R.L. COLLAR: 29 00 m | LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS
T/S	TOPSOIL AND ROOTS	
COLLUVIUM	0 2m: SILT, w th some grave and sand, red brown w th grey mott e, f rm to st ff, mo st, dr ng d sturbance, core oss	NB: Core oss and dr d sturbance n upper 5m
	5- 8m: Sandy SILT, brown, f rm, mo st	
	8-2m: SILT, w th m nor c ay, brown, f rm, mo st	
TAHUNANUI SLUMP MATERIAL	2m: SILT, w th m nor sand and grave , ght brown w th grey green and orange mott e, st ff, mo st	
	3m: M nor ron sta n ng and m cro shear ng	3-3 5m: M cro-shear ng
	3 4m: S ty SAND, grey brown, med um dense, mo st (SILT nc us ons - shear ng?)	
	3 5-4 2m: SILT, w th some grave , m nor c ay and sand?, brown, soft to f rm?, mo st to wet (Core h gh y d sturbed by dr ng and h gh percentage core oss)	3 5-4 2m: Poss b e shear ng? Core d sturbed
	4 2-5 2m: SILT, w th m nor to some c ay, grave /cobb es, m nor to rare sand?, orange brown and ght grey, f rm?, mo st (H ght percentage core oss)	
	5 2-6 m: SILT, w th m nor to some sand and grave , grey brown, f rm?, mo st to wet	5 2-6m: M cro-shear ng (shear zone)
	6 -7m: SILT, w th some sand and grave , m nor c ay, b ue to grey, f rm?, mo st to wet (Core d sturbance from dr ng)	6-7m: Poss b e shear ng, but no ev dence due to dr nduced core d sturbance
	7m: SILT, w th m nor c ay, grave and cobb es, green sh grey w th green nc us ons, f rm?, mo st to wet, rare organ c f brous nc us ons, s ght organ c odour Geo og ca y younger s ump mater a - secondary s ump, more recent y mob sed?	7 5-8m: M cro-shear ng w th n so
	8-9 5m: SILT, w th some c ay, m nor grave , cobb es, saturated, f brous organ c nc us ons (H gh eve of dr ng d sturbance, d sturbed core)	8-9 5m: Dr ng d sturbance, shear ng unknown
	9 5m: SILT, w th some grave , m nor c ay, green grey, soft to f rm?, mo st to wet, grave c asts so strength (EW rock)	9 5m: No shear ng, angu ar grave c asts g ve shear ng appearance when sp tt ng core NB: Core oss shown at bottom of un

Hole open to 6m depth (18/4-8:00am)

Box
Box 2
Box 3

T T DATATEMPLATE GDT amm

Log Scale 1 50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on: Above Rocks Road

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES

DRILL TYPE: Rotary | HOLE STARTED: 18/4/12

DATUM: NZMG49 | HOLE FINISHED: 9/5/12

DIRECTION: | R.L. GROUND: 29 00 m | DRILLED BY: CW Dr ng Ltd

ANGLE FROM HORIZ.: -90 00° | R.L. COLLAR: 29 00 m | LOGGED BY: s9(2)(a) | CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
TAHUNANUI SLUMP MATERIAL - PORT HILLS GRAVEL DERIVED	0 5- m: Fresh branch/bark mater a , ev dence of more recent s ump act v ty, secondary s ump? Core dr ng d sturbed - 5m: SILT, w th some c ay and grave , grey green, f rm?, mo st to wet, ow p ast c ty 5- 2m: Dr d sturbance 5- 2 5m: As above, w th m nor fresh wood fragments, organ c odour, dr ng d sturbance 2 5- 3m: D sturbed samp e 3- 3 5m: SILT, w th some grave m nor c ay, becom ng grave y SILT, grey green, f rm?, mo st to wet 3 5- 8 m: GRAVEL, w th m nor cobb es and bou ders, rare s t, grey, unknown strength, mo sture?, water oss (D sturbed samp e - f nes f any washed out dur ng the dr ng process?) 8 -20m: S ty, f ne to coarse GRAVEL to f ne to coarse GRAVEL w th m nor s t, m nor cobb es and bou ders, grey green, oose to med um dense?, mo st to wet?; bou ders to 50mm, c asts are sub-angu ar, rare sub-rounded, c asts vary from h gh y weathered c ushab e, so strength to fresh, rock strength	UW SW MW HW	R4 R3 R2 R1 R0		3 0 3 00	Q3		2 3 4 6 7 8 9 20		-50 0 5	5- 2 5m: Dr d sturbance 3 5- 8 m: Dr wash out? Grave on y, no f nes 3 5- 8 m: Dr ers recorded water oss and a r oss from compressed a r No water return NB: Core oss shown at bottom of un				-25 -50 -75	9 8 7 6 4 3 2 0 Box 3 Box 4 Box

Log Scale 1 50

T T DATATEMPLATE GDT amm

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No:
Ho e Locat on: Above Rocks Road
SHEET 3 OF 4

PROJECT: Grenv e B ock | LOCATION: Rocks Road, Ne son | JOB No: 870981

CO ORDINATES

DIRECTION:

ANGLE FROM HORIZ.: -90 00°

DRILL TYPE: Rotary
DATUM: NZMG49
R.L. GROUND: 29 00 m
R.L. COLLAR: 29 00 m

HOLE STARTED: 18/4/12
HOLE FINISHED: 9/5/12
DRILLED BY: CW Dr ng Ltd
LOGGED BY: s9(2)(a)
CHECKED: s9(2)(a)

DESCRIPTION OF CORE

GEOLOGICAL UNIT | ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); | ROCK WEATHERING (UW SW MW HW) | ROCK STRENGTH (R4 R3 R2 R1 R0) | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG

ROCK DEFECTS

DEFECT LOG | FRACTURE LOG (spacing of natural fractures (mm)) | SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | CORE BOX | RL (m)

TAHUNANUI SLUMP MATERIAL

20-20 m: SILT, w th some grave , grey green, f rm, mo st to wet

20 -22 m: F ne to coarse GRAVEL, w th m nor to some s t, m nor cobb es, oose to med um dense, mo st to wet?; c asts are sub-angu ar, rare sub-rounded, c asts vary from h gh y weathered c ushab e, so strength to fresh, rock strength

2 6-22 m: Trans t ona ??
Change to coarser gra ned, more compact grave at 22 m, but can st c ush up core

PORT HILLS FORMATION GRAVEL

22 m: SW-MW GRAVEL/COBBLES, w th m nor s t matr x, m nor bou ders, grey green, extreme y weak (med um dense to ve y dense so ?), mo st to wet, mass ve, uncemented; c asts sub-angu ar, can break un t apart eas y, rare sub-rounded

23 5-23 8m: F ner GRAVEL, w th h gher percentage of weathered c asts, can be c ushed by hand (GRAVEL, w th some s t, m nor sand)

24 4-25 7m: GRAVEL, w th m nor s t, grey green, extreme y weak (med um dense to dense so ?), mo st, mass ve, uncemented; h gh percentage (50-70%) of c asts weathered, crushab e

25 7m: Becom ng more competent (dense to ve y dense so ?), c asts stronger, ncreas ng dens ty w th depth

27 2m: GRAVEL, w th m nor cobb es and s t, rare sand, grey green, extreme y weak (ve y dense so ?) to extreme y weak rock strength, mo st, mass ve, uncemented, some part a y cemented; c asts sub-angu ar

Method: Q3 (throughout)

Depth (m): 2, 22, 23, 24, 2, 26, 27, 28, 29, 30

Rock defects:

20-20 m: Shear ng? Or Grave fragment mpr nt (potent a s ump basa contact?)

NB: No obv ous s d ng p ane at 22 m, but changes to coarser gra ned, more competent grave

NB: C asts strength/weather ng ncons stent, va y from HW to fresh, extreme y weak to strong

NB: See core before/after photos

Water: Hole open 16.5-24.5m (27/4-8:00am)

Core box: Box, Box 6, Box 7, Box 8

RL (m): 9, 8, 7, 6, 4, 3, 2, 0

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: [redacted]
Ho e Locat on: Above Rocks Road
SHEET 4 OF 4

PROJECT: Grenv e B ock	LOCATION: Rocks Road, Ne son	JOB No: 870981
CO ORDINATES [redacted]	DRILL TYPE: Rotary	HOLE STARTED: 18/4/12
	DATUM: NZMG49	HOLE FINISHED: 9/5/12
DIRECTION:	R.L. GROUND: 29 00 m	DRILLED BY: CW Dr ng Ltd
ANGLE FROM HORIZ.: -90 00°	R.L. COLLAR: 29 00 m	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
PORT HILLS FORMATION GRAVEL	30-30 35m: GRAVEL, w th some s t, extreme y weak (med um dense to dense so ?) 30 35-30 4m: S ty GRAVEL 30 4-3 m: Poss b e core oss due to h gher s t content?	UW SW MW HW	R4 R3 R2 R1 R0		3 0 3 00	Q3		3			50 0 5	C asts va y from HW to fresh, extreme y weak to strong				25 50 75	Box 9
	33 3m: GRAVEL, w th m nor s t, cobb es, grey green, extreme y weak (very dense so) to extreme y weak rock strength?, mo st, mass ve, pa t a y cemented					Q3		32 33 34									Box 0
	Increased dens ty w th depth, bands of pa t a y cemented and uncemented					Q3		3 36 37									Box
	END OF BOREHOLE AT 40m. Inc nometer nsta ed to 38 0m depth					Q3		38 39									Box 2

T T DATATEMPLATE GDT amm

Log Scale 1:50

BOGYLG 870981A.GPJ 1/11/12

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 1 OF 7

PROJECT: Tahunanui Slump	CO-ORDINATES: (NZTM2000)	R.L. GROUND: 48.34m	DRILLED BY: s9(2)(a)
JOB No.: 1089612.0000		R.L. COLLAR:	LOGGED BY:
LOCATION: Tahunanui, Nelson	DIRECTION:	DATUM: NZVD2016	CHECKED:
	ANGLE FROM HORIZ.: -90°	SURVEY: Handheld GPS	START DATE: 19/09/2022
			FINISH DATE: 22/09/2022
			CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*0.00m:* NO RECOVERY. Hydro-vac excavation to clear services.			HVAC	0		48	0.5										
	1.50m: NO RECOVERY.							1.0										
	1.60m: Sandy fine to coarse GRAVEL, some silt; orangish brown. Tightly packed, dry. Gravel, sub-rounded to angular, mudstone, iron stained reddish brown.			SNC	87		47	1.5										
	1.75m: Gravelly fine to coarse SAND, some silt; orangish brown. Tightly packed, dry. Gravel, fine to medium, sub-rounded to sub-angular, mudstone, iron stained reddish brown.							2.0										
	2.25m: NO RECOVERY.																	
	2.35m: Gravelly fine to coarse SAND, some silt; orangish brown. Tightly packed, dry. Gravel, fine to medium, sub-rounded to sub-angular, mudstone, iron stained reddish brown.			SNC	87		46	2.5										
	3.00m: NO RECOVERY.							3.0										
	3.15m: Silty fine to coarse SAND, some gravel, minor clay; orangish brown. Tightly packed, moist. Gravel, fine to medium, sub-rounded to sub-angular, fine sandstone, iron stained reddish brown.			SNC	90		45	3.5										
	3.85 - 3.87m: Lense of clayey SILT; greenish grey and cream. Firm, moist, medium plasticity.																	
	3.87m: Gravelly fine to coarse SAND, some silt; orangish brown. Tightly packed, moist. Gravel, fine to coarse, rounded to angular, fine sandstone, iron stained reddish brown.							4.0										
	4.40m: Silty fine to coarse SAND, some gravel; grey. Tightly packed, moist. Gravel, fine to medium, sub-rounded to sub-angular.						44	4.5										
	4.50m: NO RECOVERY.																	

44mm PWT

Box 1, 0.00-4.30m

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: [redacted]

SHEET: 2 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 19/09/2022

FINISH DATE: 22/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.34m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*5.00m:* Gravelly S LT, some sand, trace clay; greyish brown. Stiff, moist, low plasticity. Gravel, fine to coarse, rounded to sub-rounded; sand, fine to medium.			SNC	69		43	5.5										
	5.50m: Gravelly fine to coarse SAND, some silt; greyish brown. Tightly packed, moist. Gravel, fine to coarse, rounded to sub-angular, sandstone and greywacke, grey with iron staining (reddish brown).														29/10/2022: VWP01			
	6.10m: Clayey SILT; grey. Finn, moist, high plasticity.							6.0										
	6.12m: Gravelly S LT, some sand; bluish grey, specked white. Tightly packed, moisL Gravel, fine to coarse, sub-rounded to sub-angular, greywacke, sandstone, and mudstone; sand, fine to medium.			SNC	100		42	6.5					*6.12 - 21.40m:* Weathered rock fabric completely destroyed by sonic drilling process.		29/10/2022: VWP02			
								7.0					*6.90 - 7.60m:* Baking of core during drilling process.					Box 2, 4.30-7.20m
				SNC	100		41	7.5					7.39 - 7.44m: BZ, UN, R, VN					
	8.30m: NO RECOVERY.							8.0										
	8.60m: Gravelly S LT, some sand; reddish purple and bluish grey, specked white. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, greywacke, sandstone, and mudstone; sand, fine to medium.			SNC	63		40	8.5										
	9.10m: NO RECOVERY.							9.0										
	9.40m: Sandy fine to coarse GRAVEL, trace silt; bluish grey, specked white. Tightly packed, moist. Gravel, sub-rounded to angular, sandstone, greywacke.; sand, fine to coarse.						39	9.5										
	9.70m: Gravelly fine to coarse SAND, trace silt; reddish brown and bluish grey, specked white. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to angular, sandstone, greywacke.															4mm PVT		Box 3, 7.20-10.00m

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 3 OF 7

PROJECT: Tahunanui Slump	CO-ORDINATES: [redacted] (NZTM2000)
JOB No.: 1089612.0000	DIRECTION:
LOCATION: Tahunanui, Nelson	ANGLE FROM HORIZ.: -90°
R.L. GROUND: 48.34m	DRILLED BY: s9(2)(a)
R.L. COLLAR:	LOGGED BY: [redacted]
DATUM: NZVD2016	CHECKED: [redacted]
SURVEY: Handheld GPS	START DATE: 19/09/2022
	FINISH DATE: 22/09/2022
	CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*10.00m:* Gravelly fine to coarse SAND, trace silt; reddish brown and bluish grey, specked white. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to angular, fine sandstone.			SNC	73		38	10										
	10.40m: Clayey SILT, some gravel; brownish grey, specked white. Very stiff, dry, medium plasticity. Gravel, fine to medium, rounded to sub-rounded. Silt, carbonaceous.																	
	10.50m: NO RECOVERY.																	
	10.85m: Clayey SILT, some gravel; brownish grey, specked white. Very stiff, dry, medium plasticity. Gravel, fine to medium, rounded to sub-rounded. Silt, carbonaceous. *11.10m:* Grades to very soft, wet.							11										
	11.25m: Silty fine to coarse SAND, some gravel; bluish grey, specked white. Tightly packed, wet. Gravel, fine to coarse, sub-rounded to sub-angular, fine sandstone. *11.70 - 12.20m:* Moist.			SNC	78		37	11										
	12.20m: Gravelly fine to coarse SAND, some silt, minor cobbles; bluish grey. Tightly packed, moist. Gravel, fine to coarse, rounded to sub-angular, sandstone and greywacke.			SNC	100		36	12										
	13.02m: NO RECOVERY. Drill bit caught on cobble and pushed it down the whole run.			SNC	9		35	13										
	13.70m: NO RECOVERY.																	
	13.85m: Gravelly fine to coarse SAND, some silt, trace cobbles; bluish grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, fine sandstone and granite; cobbles, rounded.			SNC	81		34	14										
	14.50m: NO RECOVERY.																	
	14.60m: Gravelly fine to coarse SAND, some silt, trace cobbles; bluish grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, fine sandstone and granite; cobbles, rounded.																	

Box 4, 10.00-13.70m

44mm PVT

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: [redacted]

SHEET: 4 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.34m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY: [redacted]
CHECKED:
START DATE: 19/09/2022
FINISH DATE: 22/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No.
Tahunanui Slump Landslip Deposits	15.35m: Gravelly fine to coarse SAND; grey. Tightly packed, moist. Gravel, fine to medium, sub-rounded to sub-angular, greywacke and sandstone.			SNC	88		33	15.5										
	15.50m: Gravelly fine to coarse SAND, some silt; grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, granite, sandstone, and greywacke..																	
	15.95 - 16.30m: Wet.							16.0										
	16.40 - 16.80m: Trace cobbles. Cobbles, sub-rounded to sub-angular, granite, 60-80mm.						32	16.5										Box 5, 13.70-18.40m
	16.70m: NO RECOVERY.			SNC	100													
	16.80m: Gravelly fine to coarse SAND, some silt; grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, granite.							17.0										
							31	17.5										
								18.0										
	18.30m: NO RECOVERY.			SNC	94		30	18.5										
	18.40m: Gravelly fine to coarse SAND, some silt, trace cobbles; grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, granite; cobbles, rounded to sub-rounded, granite.																	
	18.40 - 18.90m: Light greenish grey.																	Box 6, 18.40-18.90m
	19.25 - 19.90m: Trace cobbles. Cobbles, rounded to sub-angular, granite and fine grained sandstone, 60-70mm.						29	19.0										
	19.60m: NO RECOVERY.			SNC	93			19.5										
																44mm PVT		

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:44:25 am - Produced with CoreGS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

SHEET: 5 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 19/09/2022

FINISH DATE: 22/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.34m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*20.00m:* Gravely fine to coarse SAND, some silt; grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular, granite.			SNC	79		28	20										
	20.60 - 21.30m: Light grey and bluish grey.			SNC	100		27	21										
	21.40m: S LT, some clay, minor sand. Stiff, moist, low plasticity. Sand, fine. Pervasively sheared (Completely weathered mudstone).			SNC	100		26	22				0						Box 7, 18.90-21.50m
	23.80m: Silty CLAY. Firm, moist, high plasticity. Pervasively sheared. (Completely weathered mudstone).			SNC	100		25	23				0	*23.80 - 23.90m:* Inferred basal slip surface					Box 8, 21.50-23.90m
Port Hills Gravel Formation	*23.90m:* Silty CLAY; light brownish grey. Very stiff, moist, high plasticity. (Highly weathered mudstone).						24	24										
	24.40m: NO RECOVERY.											73						
	24.80m: Moderately weathered, greyish brown, MUDSTONE. Very weak.															44mm PWT		

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:44:25 am - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 6 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.34m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY: [redacted]
CHECKED:
START DATE: 19/09/2022
FINISH DATE: 22/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*25.00m*: Moderately weathered, greyish brown, MUDSTONE. Very weak. Interbedded with: Highly weathered, light brownish grey, SANDSTONE. Fine grained. Bedding inclined between 20 - 25 .																	
	25.40m: Slightly weathered, grey, SANDSTONE. Weak, fine grained.			SNC	73			25				73						
	25.75 - 25.90m: Recovered as gravels.																	
	25.90m: NO RECOVERY.							26										
	26.35m: Slightly weathered, grey, SANDSTONE. Weak, fine to coarse grained.			SNC	70			26				70						
	27.50m: Unweathered, grey, SILTSTONE. Weak.			PQTT	100			27				100						
	28.25m: Unweathered, grey, SANDSTONE. Weak, fine to medium grained.							28										
	28.35m: Unweathered, grey, MUDSTONE. Weak. Bedding is inclined between 15 - 20 .			PQTT	100							100	*28.40 - 28.60m*: Shear zone inclined at approximately 15°. Extremely weak (finn).					
	29.00m: Unweathered, light grey with brown laminations, SILTSTONE. Weak. Bedding is inclined between 20 and 25 .. 10 to 20mm thick. Interbedded with: Unweathered, dark grey, MUDSTONE. Weak. Carbonaceous layers (1-2mm) interbedded. 10 to 20mm thick.							29					28.84m: J, 15° dip, ST, R, N					
	29.30 - 30.17m: Trace carbonaceous material.											100						

144mm PWT

Box 9, 23.90-27.10m

Box 10, 27.10-29.40m

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 7 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 19/09/2022

FINISH DATE: 22/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.34m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	30.17m: Unweathered, grey, SANDSTONE. Weak, fine grained. Trace carbonaceous material.			PQTT	100		18	30				100	30.17m: B, 20° dip, UN, SM, N 30.33m: B, 20° dip, PL, SM, T					
	30.60 - 30.80m: Light grey.							30.5										
	30.80m: Unweathered, light grey, SANDSTONE. Weak. 15 to 70 mm thick. Interbedded with: Unweathered, dark grey, MUDSTONE. Weak. Trace carbonaceous material. 10mm thick.							31					30.74m: B, 20° dip, UN, SM, T					
	31.10m: Unweathered, light grey, SANDSTONE. Weak. Trace carbonaceous material.			PQTT	100		17	31.5				100	31.52m: B, 20° dip, UN, SM, T 31.55m: B, 20° dip, PL, SM, T 31.57m: B, 25° dip, UN, SM, T					
	31.66 - 31.70m: Unweathered, dark grey, MUDSTONE. Moderately strong. 31.74 - 31.76m: Unweathered, dark grey, MUDSTONE. Moderately strong.												31.75m: B, 25° dip, UN, SM, T					
	32.00 - 32.05m: Unweathered, dark grey, MUDSTONE. Moderately strong. 32.14 - 32.20m: Unweathered, dark grey, MUDSTONE. Moderately strong.						16	32										
	32.55m: Unweathered, grey streaked light and dark grey, SILTSTONE. Weak. Trace carbonaceous material. Bedding inclined at 25 .			PQTT	100			32.5				100						
	32.65 - 33.25m: Unweathered, grey, SANDSTONE. Strong, fine grained.																	
	33.08 - 33.10m: Unweathered, grey, MUDSTONE. Very weak.							33					33.08m: B, 25° dip, UN, SM, T 33.10m: B, 25° dip, UN, R, N					
	33.25m: Unweathered, brownish grey, MUDSTONE. Extremely weak. Recovered as: S LT, some clay. Hard, moist.						15						33.22m: B, 25° dip, ST, SM, N					
	33.50m: Unweathered, bluish grey, SILTSTONE. Weak.							33.5					33.45m: B, 25° dip, UN, R, N					
	33.65m: Unweathered, grey, SANDSTONE. Weak, fine grained. Trace carbonaceous material. 33.82 - 33.85m: Unweathered, bluish grey, SILTSTONE. Strong. 33.88 - 33.92m: Unweathered, greyish brown, MUDSTONE. Strong.			PQTT	100							100							
	33.95m: Unweathered, grey streaked light and dark grey, SILTSTONE. Weak. Layers of carbonaceous material (dark grey, 1-2mm thick).							34										
	34m: END OF BOREHOLE						14	34.5										

Box 11, 29.40-32.35m

Box 12, 32.35-34.00m

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed approximately 1.5m offset from this location. VWP01 and VWP02 have been installed at 23.55 and 28.75mbgl respectively. 2. A shape accel array has been installed at this location to 30mbgl

Hole Depth 34m

Scale 1:25

Rev.: A

- 19/4/2023 12:44:25 am - Produced with CoreGS by GeRoc

General Log

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No. [redacted]

SHEET: 1 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 19/09/2022
R.L.: 48.34m	DRILL METHOD: SNC	HOLE FINISHED: 22/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: AMHO CHECKED:

0.00-4.30m

4.30-7.20m

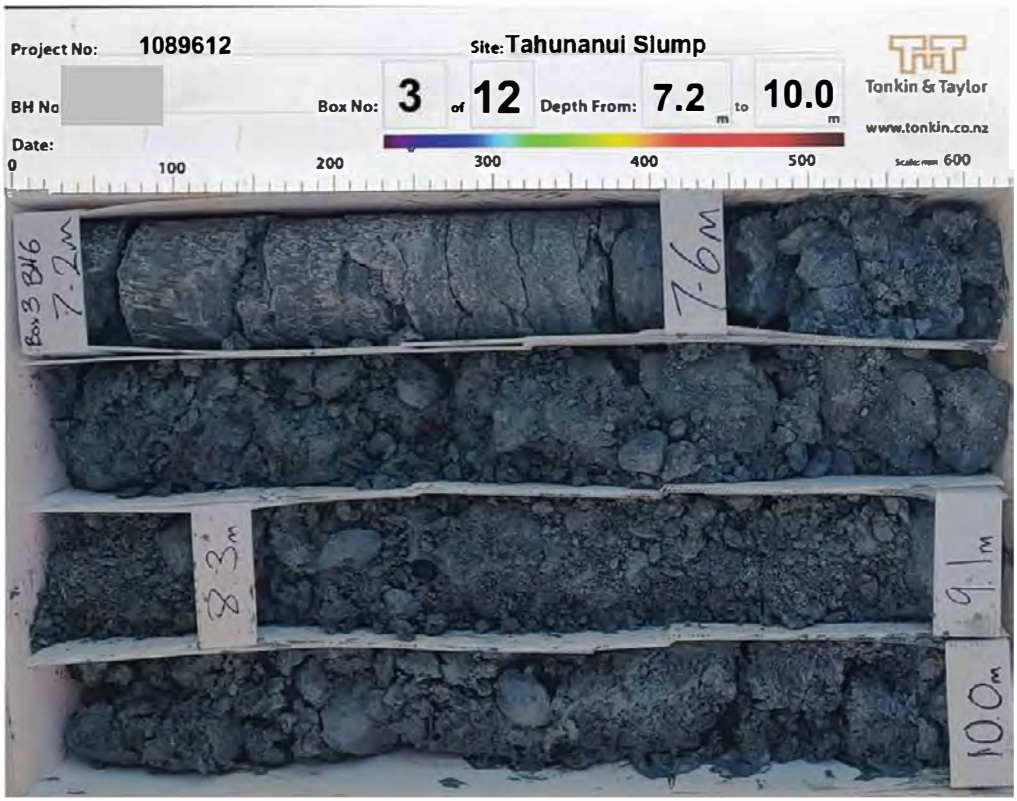
Tonkin+Taylor

CORE PHOTOS

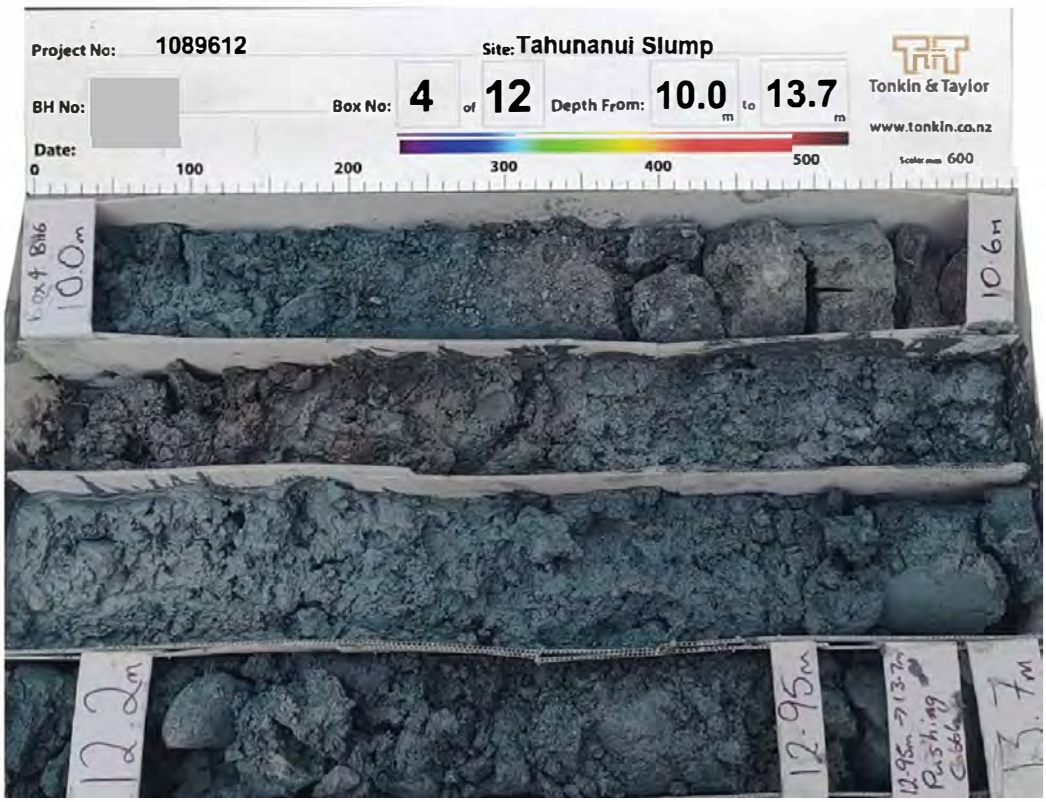
BOREHOLE No.: [redacted]

SHEET: 2 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 19/09/2022
R.L.: 48.34m	DRILL METHOD: SNC	HOLE FINISHED: 22/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a



7.20-10.00m



10.00-13.70m

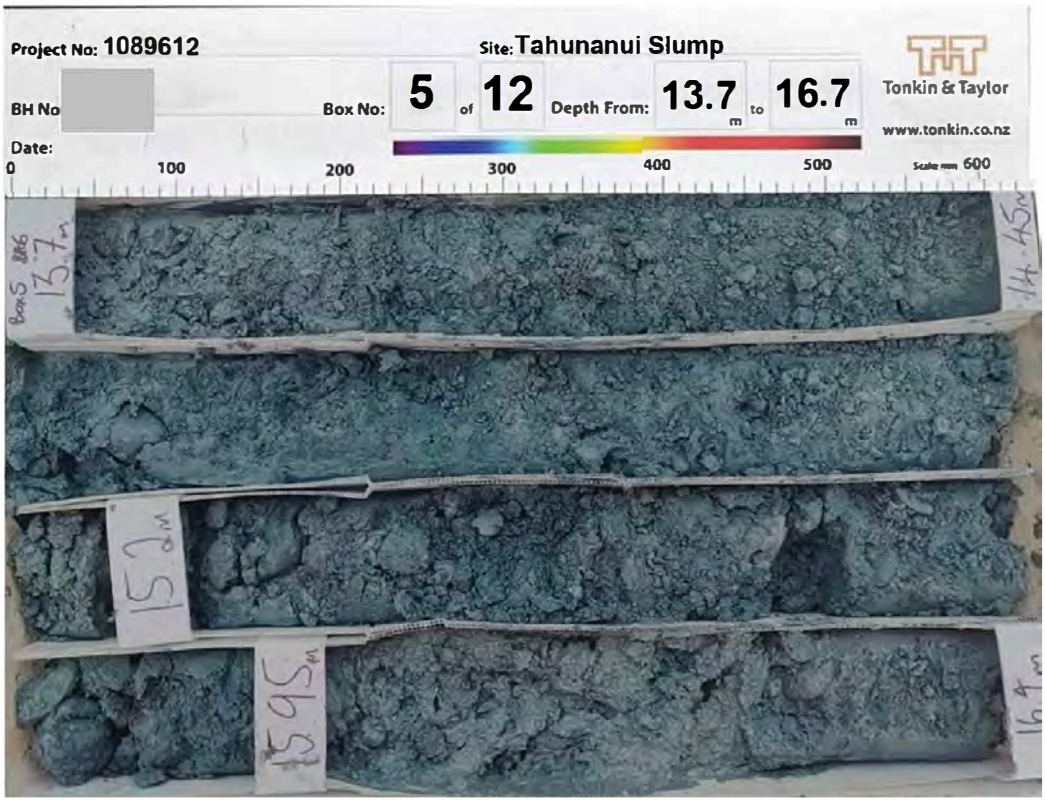
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 3 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 19/09/2022
R.L.: 48.34m	DRILL METHOD: SNC	HOLE FINISHED: 22/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



13.70-16.40m

16.40-18.90m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No [redacted]

SHEET: 4 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 19/09/2022
R.L.: 48.34m	DRILL METHOD: SNC	HOLE FINISHED: 22/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

18.90-21.50m

21.50-23.90m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No. [redacted]

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 19/09/2022
R.L.: 48.34m	DRILL METHOD: SNC	HOLE FINISHED: 22/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

23.90-27.10m

27.10-29.40m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No. [redacted]

SHEET: 6 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 19/09/2022
R.L.: 48.34m	DRILL METHOD: SNC	HOLE FINISHED: 22/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

29.40-32.35m

32.35-34.00m

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 1 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 19/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*0.00m:* TOPSOIL; dark brown. Soft, moist, low plasticity.			PQTT	100		79	0.5	TS									
	0.50m: S LT, some rootlets; greyish brown with greyish brown streaks and orange brown mottles. Firm, moist, non-plastic.																	
	0.83m: CLAY, some silt, minor gravel, trace rootlets; light grey with orange brown mottles. Stiff, moist, high plasticity. Gravel, fine, angular, highly weathered.			PQTT	100		78	1.0										
	1.05m: Very stiff.							1.5										
	1.65m: gravel, fine to medium.			PQTT	100		77	2.0										
	2.80m: Gravelly CLAY; orange brown with grey streaks. Stiff, moist, high plasticity. Gravel, fine - coarse, sub-angular - sub-rounded, granite and siltstone. (Completely weathered conglomerate).			PQTT	100			2.5								140mm PVT		
	3.35 - 3.55m: 200mm thick lense of sandy SILT; orange brown with light grey steaks.			PQTT	100		76	3.0										
	3.60m: very stiff.			PQTT	100			3.5					*3.80 - 4.00m:* Core disturbed by drilling process.					
	4.50 - 4.85m: some cobbles, subrounded to rounded, greywacke.			PQTT	100		75	4.0					*4.20 - 4.50m:* Core disturbed by drilling process.					
	4.80m: Clayey fine to coarse GRAVEL, minor cobbles. Tightly packed, dry, well graded. Gravel, rounded to sub-rounded,			PQTT	100			4.5										

Box 1, 0.00-2.40m

Box 2, 2.40-4.70m

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 2 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY: [redacted]
CHECKED:
START DATE: 19/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*5.00m:* Clayey fine to coarse GRAVEL, minor cobbles. Tightly packed, dry, well graded. Gravel, rounded to sub-rounded, greywacke; cobbles, up to 150mm, rounded to sub-rounded, greywacke. (Moderately weathered conglomerate).			PQTT	100		74	5.5				100	5.10 - 5.20m: BF, 55° dip, PL, SL, T, CN					
				PQTT	100		73	6.0				100						
	7.00m: Cobbly fine to coarse GRAVEL, minor clay. Tightly packed, dry, well graded. Gravel, rounded to sub-rounded, greywacke; cobbles, up to 120mm, rounded to sub-rounded, greywacke. (Moderately weathered conglomerate).			PQTT	100		72	6.5 7.0				100						
	8.60m: clasts, granite and greywacke.			PQTT	100		71	7.5 8.0 8.5				100						
	9.20m: Slightly weathered, orange brown and grey, CONGLOMERATE. Very weak. Clasts, 2 - 110mm, subrounded to rounded, greywacke, mudstone, and granite.						70	9.0 9.5				100	9.66 - 9.72m: J, 45° dip, PL, SL, T, CN		25/10/2022: VWP01		Box 3, 4.70-6.92m Box 4, 6.92-9.20m	

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:45:10 am - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 3 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED: [redacted]

START DATE: 19/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*10.00m:* Slightly weathered, orange brown and grey, CONGLOMERATE. Very weak. Clasts, 2 - 110mm, subrounded to rounded, greywacke, mudstone, and granite.			PQTT	100		69	10				100						
	10.70m: Unweathered, bluish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite.			PQTT	100		68	11				UN						
	12.70 - 13.30m: brownish grey.			PQTT	100		67	12				40	11.60 - 11.80m: BF, 65° dip, ST, SL, T, CN 11.76 - 11.92m: BF, 60° dip, UN, SL, T, CN 11.97 - 12.09m: BF, 55° dip, PL, SL, T, CN 12.10 - 12.18m: J, 50° dip, PL, SM, T, CN 12.10 - 12.26m: BF, 65° dip, PL, SL, T, CN 12.20 - 12.30m: J, 60° dip, PL, SL, T, CN					Box 5, 9.20-11.50m
	13.40m: clasts, 2 - 120mm.			PQTT	100		66	13				UN						Box 6, 11.50-13.90m
							65	14				UN						

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35 mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:45:10 am - Produced with CoreGS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: [redacted]

SHEET: 4 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 19/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000) [redacted]

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m) / Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*15.00m:* Unweathered, bluish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite. *15.30 - 15.75m:* Potential crush zone. Extremely weak. *18.00 - 18.10m:* 120mm granite cobble. *18.18 - 18.26m:* 110mm granite cobble. *18.60 - 21.20m:* Extremely weak. *18.80 - 19.05m:* Potential shear zone.			PQTT PQTT PQTT PQTT PQTT PQTT PQTT	100 100 100 100 100 100 100		64 15 5 16 0 63 16 5 17 0 62 17 5 18 0 61 18 5 19 0 60 19 5				100 100 100 100 0 71 100					Box 7, 13.80-16.25m Box 8, 16.25-18.30m

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 5 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY: [redacted]
CHECKED:
START DATE: 19/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	R.L. (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*20.00m*: Unweathered, bluish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite. *20.00 - 20.35m*: Potential shear zone. *20.95 - 21.05m*: 110mm sandstone cobble. *21.00 - 21.20m*: Potential shear zone. *21.25 - 21.34m*: 110mm sandstone cobble. *21.80 - 21.93m*: 130mm greywacke cobble. *22.50 - 22.60m*: 150mm sandstone cobble. *22.60 - 22.80m*: Potential shear zone. Extremely weak.			PQTT	100		59	20				0					Box 9, 19.30-20.15m
				PQTT	100			20.5				76						
				PQTT	100		58	21										
								21.5				100						
				PQTT	100		57	22				100						Box 10, 20.35-22.50m
				PQTT	60			22.5				0						
	22.80m: NO RECOVERY.							23				0						
	23.00m: Unweathered, bluish grey, CONGLOMERATE. Extremely weak, iron stained banded. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite. Potential shear zone.			PQTT	100		56											
Port Hills Gravel Formation	*23.40m*: Unweathered, bluish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite. *23.70 - 23.79m*: 110mm sandstone cobble. *24.95 - 25.30m*: Extremely weak.			PQTT	100		55	23.5				100						
								24										
								24.5				100						Box 11, 22.50-24.95m

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: [redacted]

SHEET: 6 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 19/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m) / Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*25.00m*: Unweathered, bluish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite.			PQTT	100		54 / 25				100						
	25.60 - 25.75m: 150mm granite cobble.			PQTT	100		53 / 26				100						
	26.12 - 26.22m: 120mm sandstone cobble.																
	26.75 - 26.80m: 100mm sandstone cobble.			PQTT	100		52 / 27				100						
	27.78 - 28.00m: 220mm granite boulder.																
	28.00 - 28.20m: 200mm greywacke boulder.			PQTT	100		51 / 28				100						
	29.20 - 29.40m: 200mm greywacke boulder.						50 / 29				100	29.40 - 29.50m: BF, 60° dip, PL, SM, T, CN					Box 13, 27.20-29.60m
	29.86 - 29.96m: 130mm mudstone cobble.																

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:45:10 am - Produced with Core-GS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: [redacted]

SHEET: 7 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 19/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.26m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*30.00m*: Unweathered, bluish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite. *30.00 - 30.13m*: 140mm greywacke cobble. *31.06 - 31.16m*: 120mm greywacke cobble. *32.95 - 33.06m*: 130mm greywacke cobble. *33.35 - 33.50m*: 160mm greywacke cobble. *34.42 - 34.49m*: 120mm greywacke cobble. *34.49 - 34.56m*: 110mm greywacke cobble.			PQTT PQTT PQTT PQTT	100 100 100 100		49 48 47 46 45	30 31 32 33 34				100 100 100 100	29.90 - 30.00m: BF, 55° dip, PL, SM, T, CN 32.60 - 32.72m: BF, 60° dip, PL, SM, T, CN					Box 14, 29.60-31.90m Box 15, 31.90-34.10m Box 16, 34.10-35.00m

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 17.6 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:45:10 am - Produced with Core-GS by GeRoc

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 1 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

0.00-2.40m

2.40-4.70m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 2 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

4.70-6.92m

6.92-9.20m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 3 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a

9.20-11.50m

11.50-13.90m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 4 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

13.90-16.25m

16.25-18.30m

Tonkin+Taylor

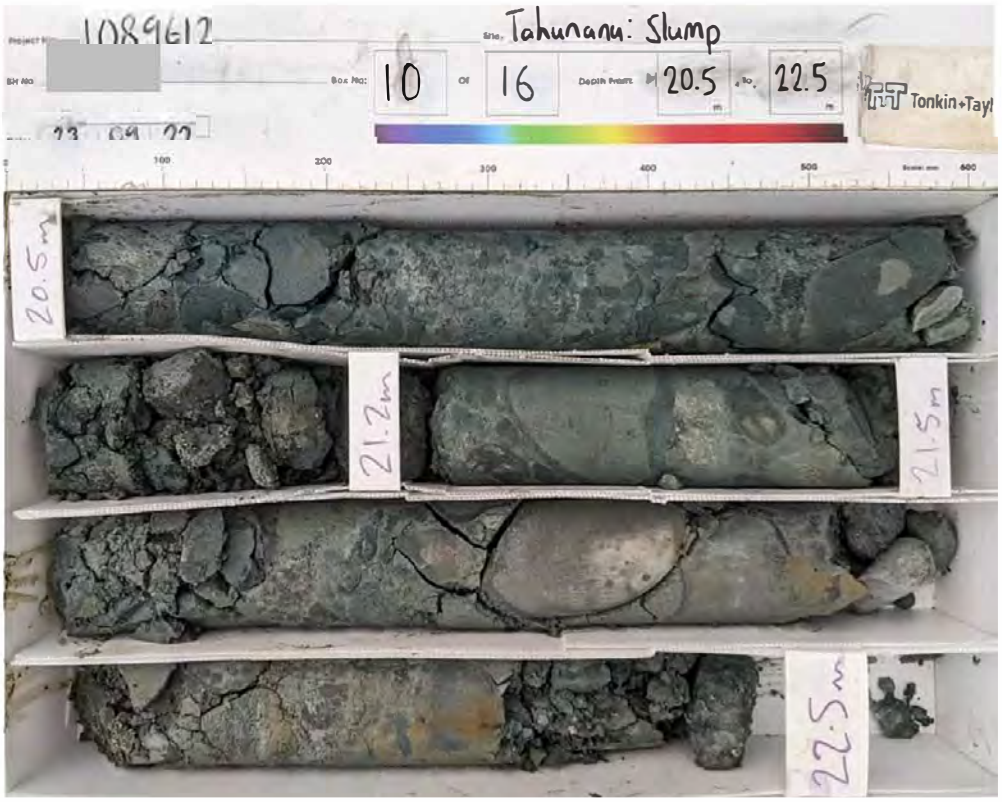
CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 5 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

18.30-20.35m



20.35-22.50m

Tonkin+Taylor

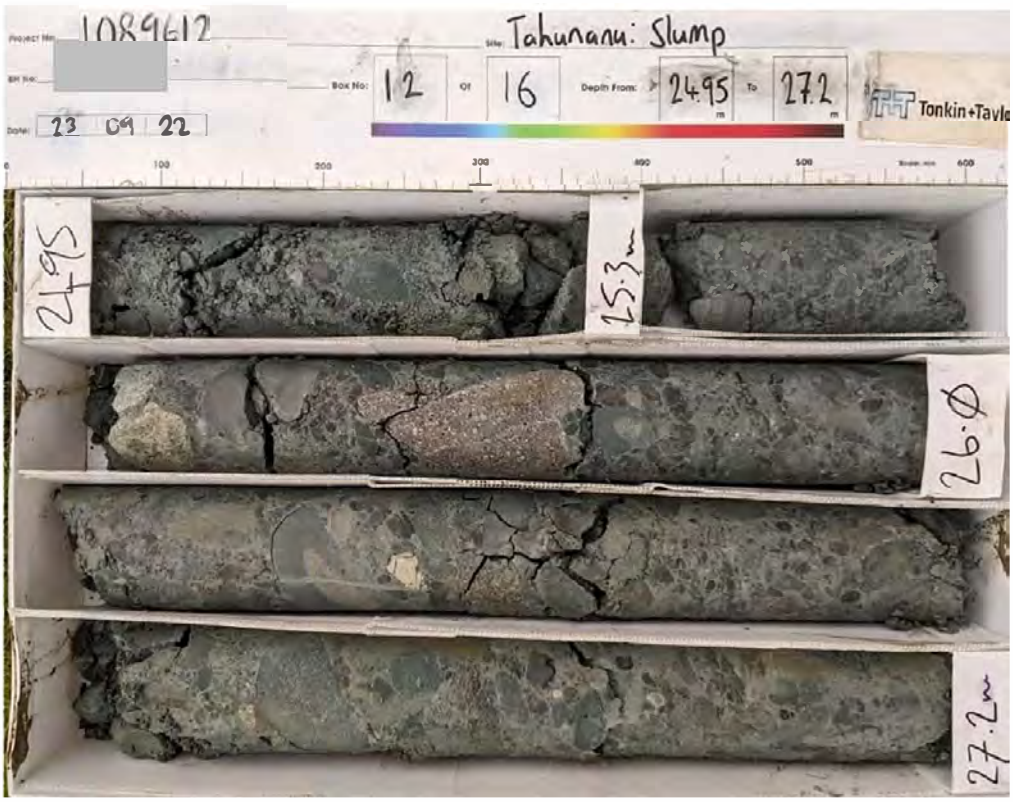
CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 6 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

22.50-24.95m



24.95-27.20m

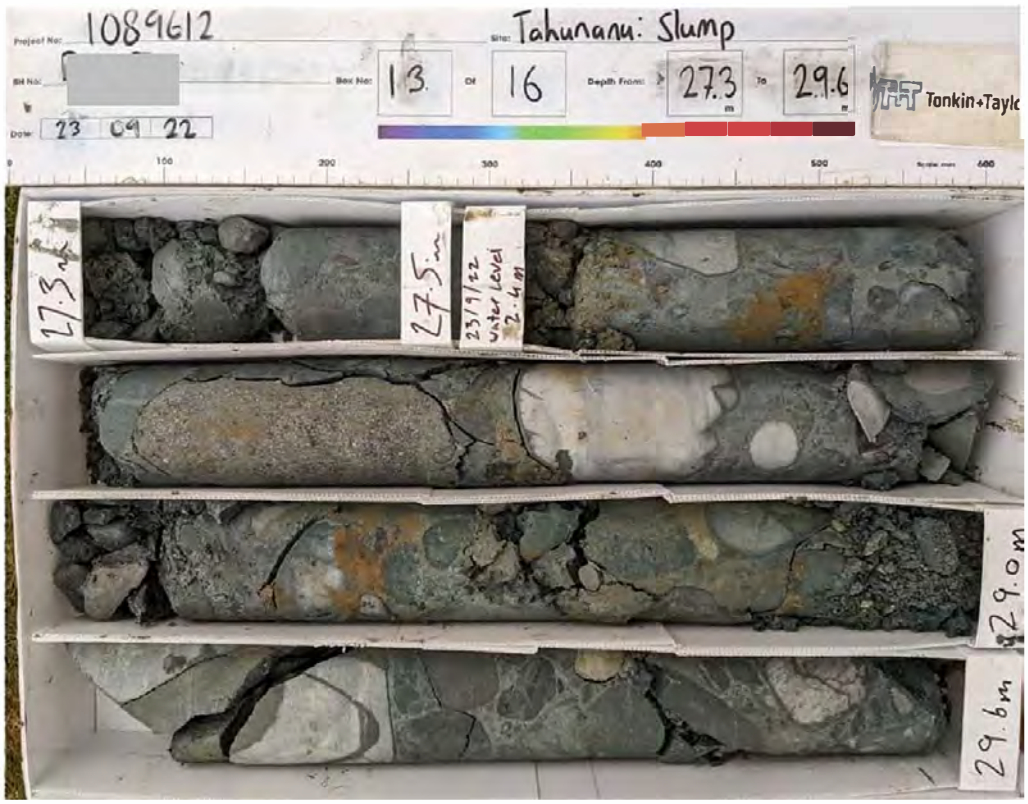
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 7 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED s9(2)(a)



27.20-29.60m

29.60-31.90m

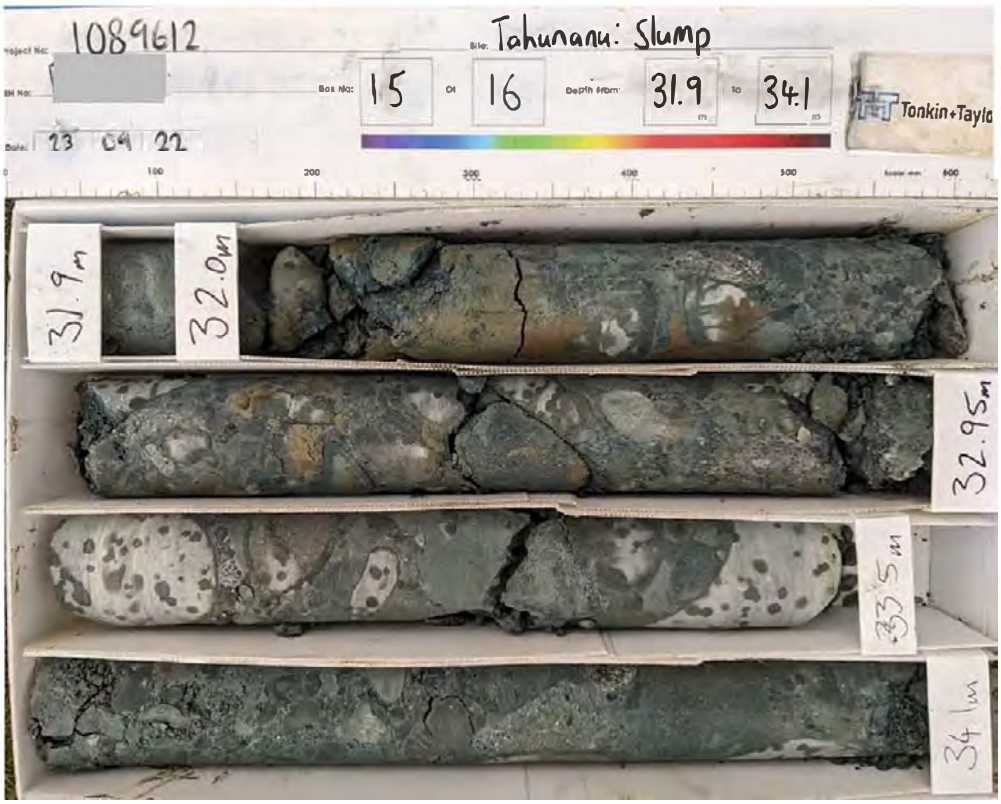
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 8 OF 8

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 19/09/2022
R.L.: 79.26m	DRILL METHOD: RC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)



31.90-34.10m

34.10-35.00m

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 1 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 22/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation
Fill	*0.00m:* Fine grading to coarse GRAVEL, some sand; grey. Tightly packed, moist. Gravel, angular.
Shallow Landslip Deposits	*0.30m:* Silty fine grading to coarse SAND, some gravel; orange brownish grey. Loosely packed, moist. Gravel, fine grading to coarse, angular, sandstone.
	0.85m: Silty fine grading to coarse SAND, some gravel, minor clay; orange brown. Loosely packed, moist. Gravel, fine grading to coarse, angular, sandstone.
	1.50m: NO RECOVERY.
	1.70m: Silty fine grading to coarse SAND, some gravel; orange brownish grey. Loosely packed, moist. Gravel, fine grading to coarse, angular, sandstone. Pervasively sheared.
	2.60m: S LT, some sand and some gravel, minor organics; greyish brown. Very stiff, moist, non-plastic. Sand, medium grading to coarse; gravel, fine grading to medium, mudstone. Potential shear fabric inclined at 15 .
Port Hills Gravel Formation	*3.45m:* Clayey SILT; orange brown, streaked grey. Stiff, moist, low plasticity. (Residual soil).
	4.50m: S LT, some sand and some gravel, minor clay; orange brown, streaked grey. Stiff, moist, non-plastic. Sand, fine; gravel, fine grading to medium, mudstone. (Completely weathered mudstone).

Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
		SNC	100		53	1										
		SNC	87		52	2										Box 1, 0.00-2.60m
		SNC	100		51	3										
					50	4									44mm PWT	
					49											

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:45:21 am - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 2 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 22/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	5.10m: S LT, some clay and some sand and some gravel; orange brown, streaked grey. Stiff, moist, non-plastic. Sand, fine; gravel, fine grading to medium, mudstone. (Completely weathered mudstone).			SNC	100		48	5										Box 2, 2.60-5.70m
	6.10m: Sandy SILT, minor gravel; orange brown. Stiff, dry, non-plastic Sand, ine; gravel, medium, mudstone (Completely weathered mudstone).			SNC	100		47	6							27/10/2022: VWP01			
				SNC	100		46	7				26						Box 3, 5.70-8.00m
	8.70m: Slightly weathered, grey, MUDSTONE. Very weak.						45	8					9.10m: J, 60° dip, PL, SM, T, CN 9.20m: J, 75° dip, UN, SL, T, CN 9.35m: J, 60° dip 9.40m: J, 70° dip					
	9.75m: Slightly weathered, grey, SANDSTONE. Very weak, fine grained.						44	9				36	9.70m: BF, 27° dip, PL, PO, T, CN, Oriented 200° to bedding 9.79m: J, 75° dip, UN, SM, T, CN, iron staining 9.90m: BF, 27° dip, PL, R, T, CM, iron			144mm PWT		

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 3 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 22/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*10.05m:* Slightly weathered, grey, SANDSTONE. Very weak, fine grained.			HQTT	107		43	11				96	staining					
				HQTT	100							100						
	11.20m: Slightly weathered, grey, MUDSTONE. Very weak.						42	12				86	11.25m: J, 65° dip, N, iron staining 11.62m: J, 60° dip, N, iron staining 11.75m: BF, 40° dip, VN					
	12.35m: Slightly weathered, brown, MUDSTONE. Very weak. Trace carbonaceous material.			HQTT	100								12.15m: J, 65° dip, N, iron staining 12.25 - 12.39m: J, 80° dip, T 12.34m: J, 65° dip, VN 12.37m: J, 70° dip, N, iron staining					
	12.67 - 12.90m: Brecciated zone, extremely weak, intact.						41	13				66	12.62m: J, 65° dip, N 12.67 - 12.80m: BZ, T, heavily jointed 13.08m: BF, 30° dip,					Box 5, 10.30-13.20m
	13.45 - 13.75m: Trace fine to medium gravels, SR-R, sandstone.						40	14					13.36m: BF, 30° dip, T 13.45m: J, 40° dip, N, iron staining. Oriented 200° to bedding 13.54m: J, 40° dip, T, iron staining. Oriented 200° to bedding 13.65m: J, 65° dip, N, iron staining					
	13.75m: Unweathered, greenish grey, CONGLOMERATE. Extremely weak. Clasts, 2 - 100mm, subrounded to rounded, sandstone. ne to coarse sand and fine to coarse gravels with trace cobbles. Matrix, sand, fine to coarse.																	
	14.65m: Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, subrounded to rounded, sandstone and						39					100						

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 4 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 22/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*15.00m:* Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, subrounded to rounded, sandstone and mudstone. Matrix, sand, fine to coarse.			HQTT	100		38	15				100						
				HQTT	100		37	16				100						
				HQTT	100		36	17				100	17.50m: J, 15° dip, N					
				HQTT	100		35	18				100						
				HQTT	100		34	19				100	19.60 - 19.70m: BZ, Broken along clasts and matrix contacts					
								20										

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 5 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 22/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*20.05m:* Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, subrounded to rounded, sandstone and mudstone. Matrix, sand, fine to coarse.						33	21										
	21.45m: Slightly weathered, grey, MUDSTONE. Very weak.			HQTT	100		32	22				53	21.47m: J, 15° dip, VN 21.54m: BF, 15° dip, VN 21.57m: BF, 15° dip, VN 21.63m: BF, 20° dip, VN 21.70m: BF, 15° dip, VN 21.95 - 22.05m: BZ 22.08 - 22.20m: BZ, 20° dip, T, heavily jointed 22.30 - 22.60m: BZ, T, heavily jointed					Box 8, 19.10-22.05m
	23.60m: Slightly weathered, grey, SANDSTONE. Very weak. Fine.			HQTT	100		31	23				75	22.68m: J, 3° dip, VN 22.75m: J, 40° dip, PL, SM, T, CN, Oriented 180° to bedding 22.80m: J, 25° dip, T 22.83m: BF, 15° dip, PL, SL, T, CN 22.86m: BF, 15° dip, PL, SL, T, CN 22.89m: BF, 15° dip, PL, SL, T, CN 22.90m: J, 40° dip, T, Oriented 180° to bedding 22.93m: J, 10° dip, N 23.15m: BF, 15° dip, N 23.28 - 23.42m: BZ, VN 23.50m: J, 15° dip, N 23.55m: BF, 15° dip, N					
	23.95m: Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, subrounded to rounded, sandstone and mudstone. Matrix, sand, fine to coarse.			HQTT	100		30	24				100	24.30m: BF, 5° dip, VN 24.35 - 24.50m: BZ, N 24.65m: BF, 3° dip, VN					
							29	25				50	24.75 - 24.83m: BZ, N					Box 9, 22.05-25.00m

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:45:21 am - Produced with CoreGS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 6 OF 7

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY: [redacted]
CHECKED:
START DATE: 22/09/2022
FINISH DATE: 23/09/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*25.05m:* Unweathered, greenish grey, CONGLOMERATE. Extremely weak. Clasts, 2 - 100mm, subrounded to rounded, granite, sandstone and mudstone. Matrix, sand, fine to coarse.			HQTT	100		28	25				50						
				HQTT	100			26				100						
				HQTT	100		27					100						
				HQTT	100			27				100						
				HQTT	100		26					100						
	28.50m: Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 2 - 100mm, subrounded to rounded, granite, sandstone and mudstone. Matrix, sand, fine to coarse.			HQTT	100		25	28				100						
				HQTT	100			29				100						
							24					100						
								30										

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:45:21 am - Produced with CoreGS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

SHEET: 7 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 22/09/2022

FINISH DATE: 23/09/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 53.59m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*30.10m:* Unweathered, greenish grey, CONGLOMERATE. Very weak. Well graded; fine to coarse sand and fine to coarse gravels with trace cobbles. Clast supported matrix - fine to coarse sand, fine gravels, grey clasts - medium to coarse gravels and cobbles. typically SR to R, sandstone and granite, UW, greenish grey clasts.			HQTT	100		23	30				100						Box 11, 27.80-30.50m
				HQTT	100		22	31				100						
	32.20m: Unweathered, greenish grey, CONGLOMERATE. Extremely weak. Clasts, 6 - 100mm, subrounded to rounded, granite, sandstone and mudstone. Matrix, sand, fine to coarse Recovered as sandy GRAVEL.			HQTT	100		21	32				100						
	33.20 - 33.50m: Very weak.			HQTT	100		20	33				100						Box 12, 30.50-33.50m
	33.50m: Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 6 - 100mm, subrounded to rounded, granite, sandstone and mudstone. Matrix, sand, fine to coarse.			HQTT	100		19	34				100	33.81m: J, 10° dip, VN					
	34.25m: Slightly weathered, grey, SANDSTONE. Very weak, fine grained.												34.50 - 34.82m: J, 80° dip, VN					
	34.75m: Unweathered, greenish grey, CONGLOMERATE. Very weak. Clasts, 6 - 100mm, subrounded to rounded, granite, sandstone and mudstone. Matrix, sand, fine to coarse.							35										
	35m: END OF BOREHOLE																	

COMMENT 1. A single vibrating wire piezometer (VWP01) has been installed at his location at 8.1 mbgl. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 1 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 22/09/2022
R.L.: 53.59m	DRILL METHOD: SNC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a [redacted] CHECKED: s9(2)(a)

0.00-2.60m

2.60-5.70m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 2 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 22/09/2022
R.L.: 53.59m	DRILL METHOD: SNC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

5.70-8.00m

8.00-10.30m

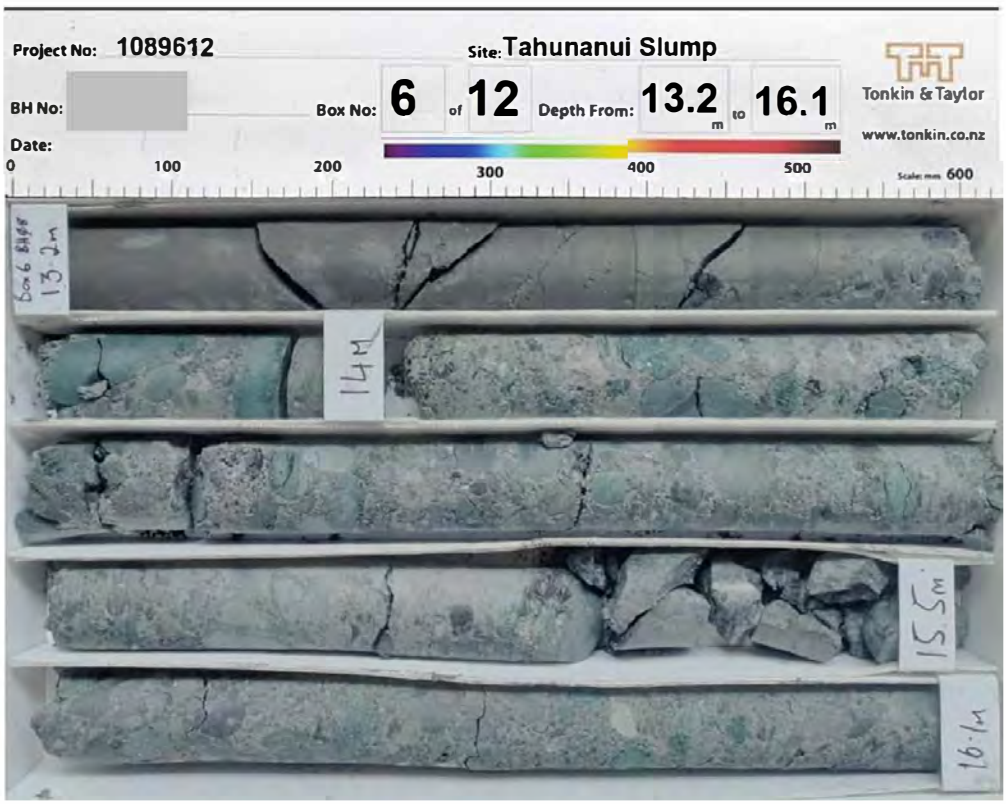
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 22/09/2022
R.L.: 53.59m	DRILL METHOD: SNC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

10.30-13.20m



13.20-15.10m

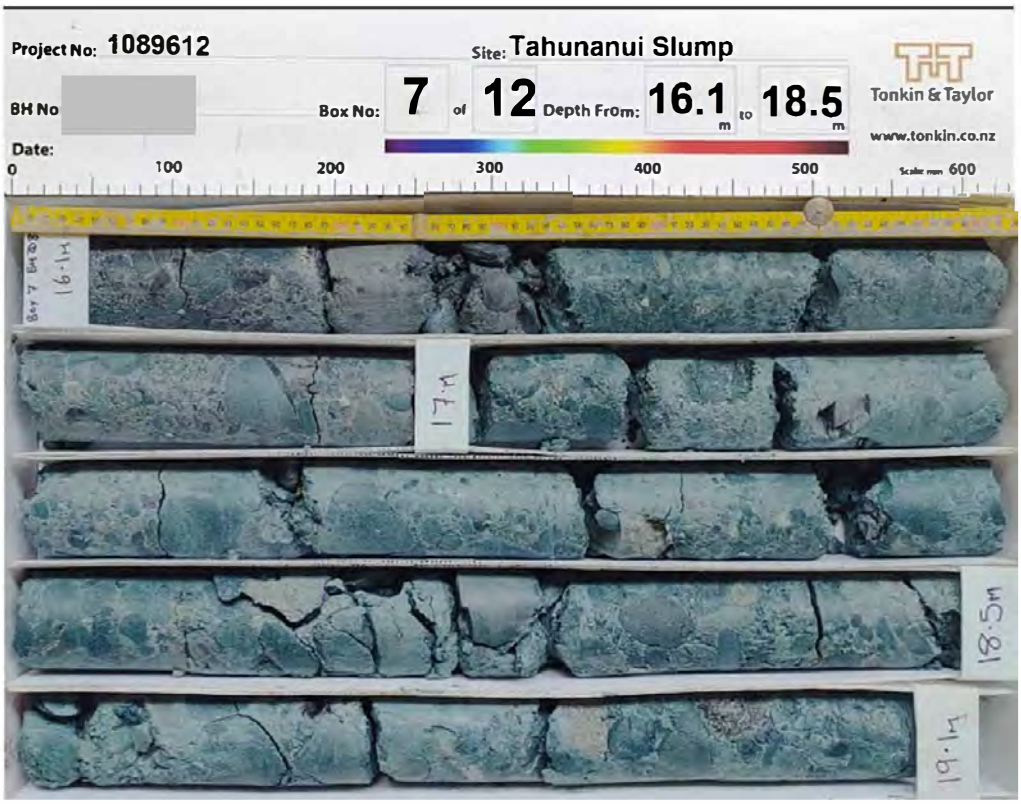
Tonkin+Taylor

CORE PHOTOS

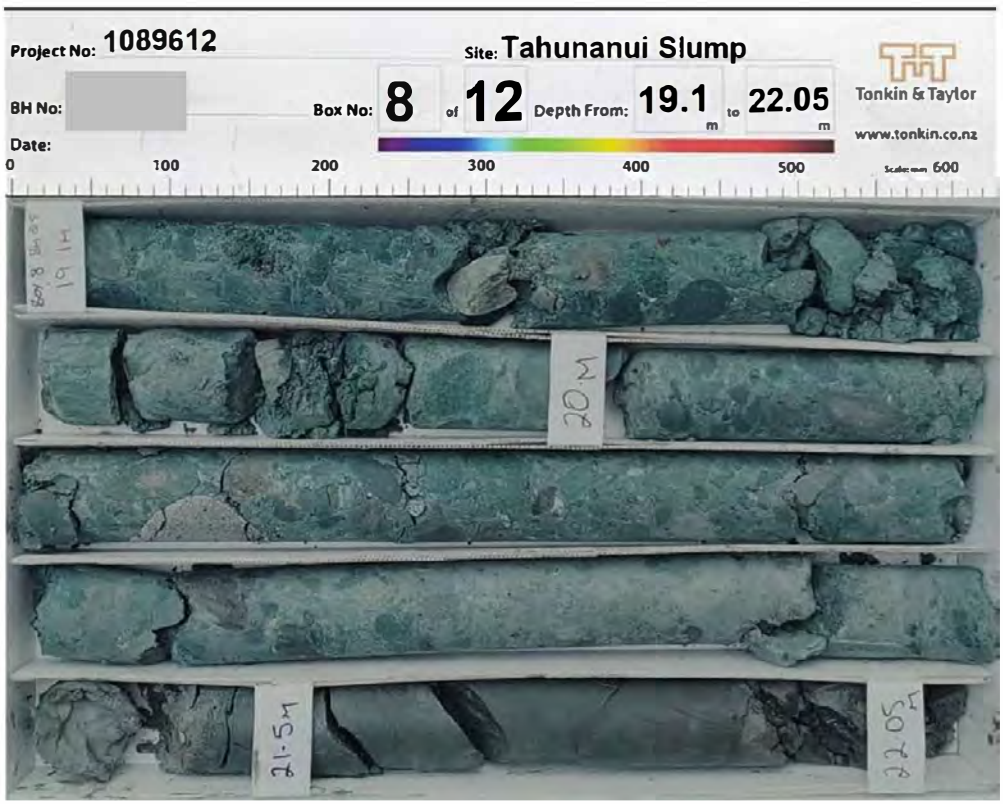
BOREHOLE No.: [redacted]

SHEET: 4 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 22/09/2022
R.L.: 53.59m	DRILL METHOD: SNC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



15.10-19.10m



19.10-22.05m

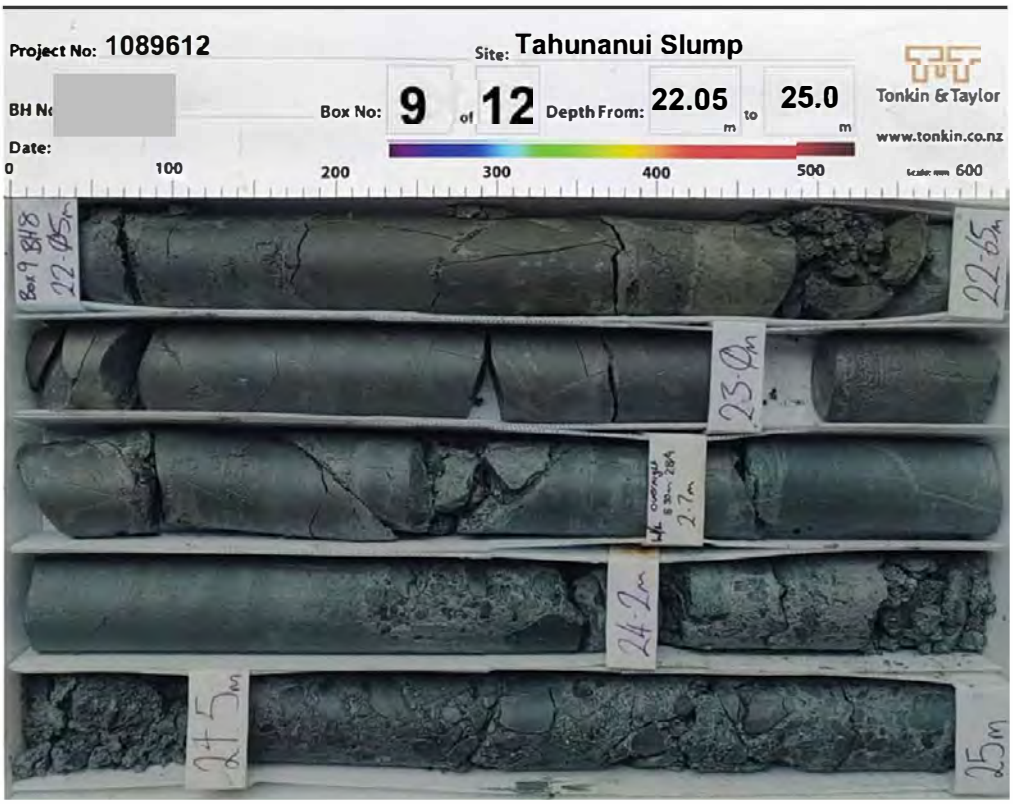
Tonkin+Taylor

CORE PHOTOS

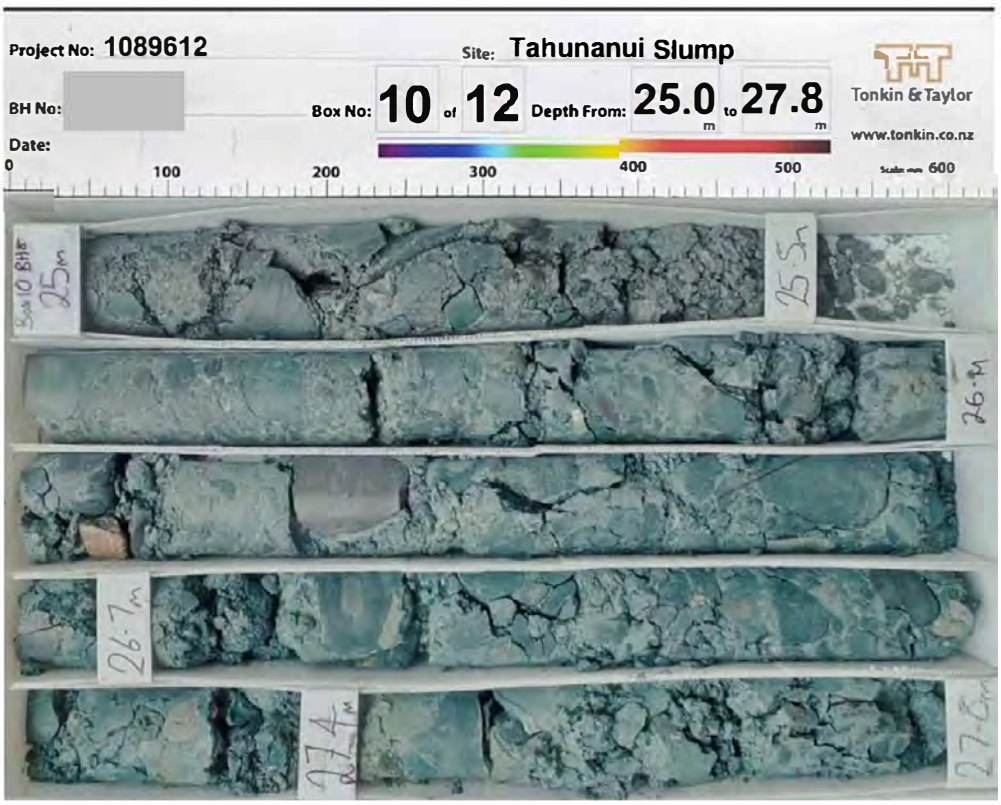
BOREHOL [redacted]

SHEET: 5 OF 6

PROJECT: Tahunanui Slump	LOCAT [redacted], Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL T	HOLE STARTED: 22/09/2022
R.L.: 53.59m	DRILL METHOD: SNC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



22.05-25.00m



25.00-27.80m

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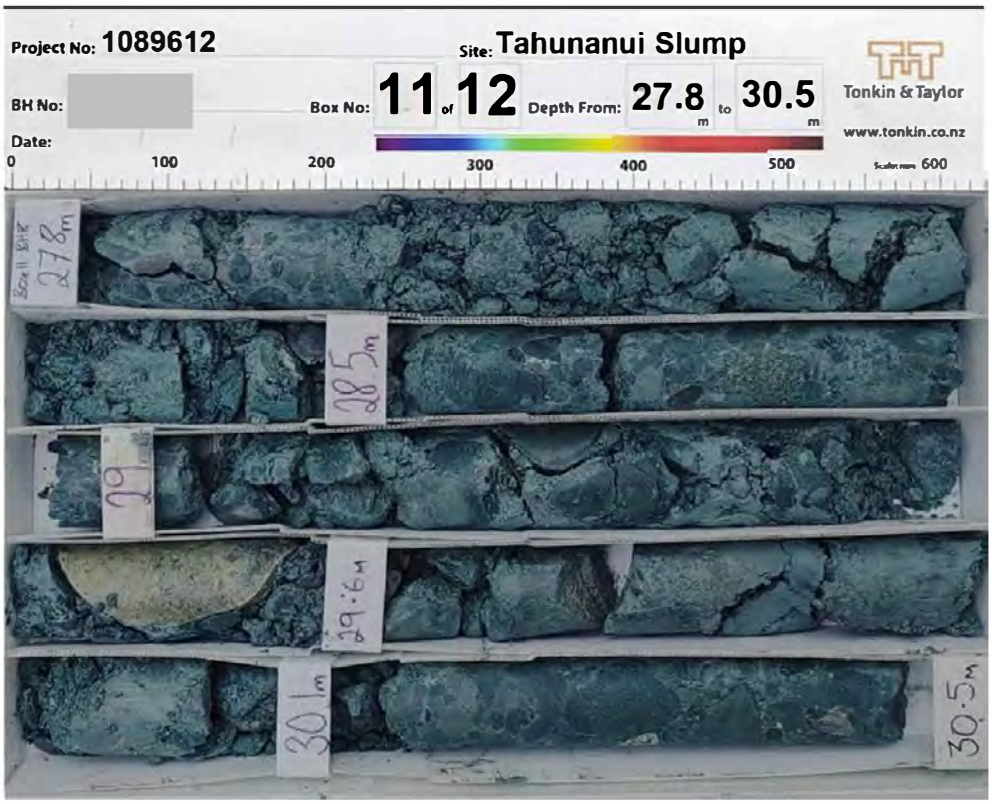
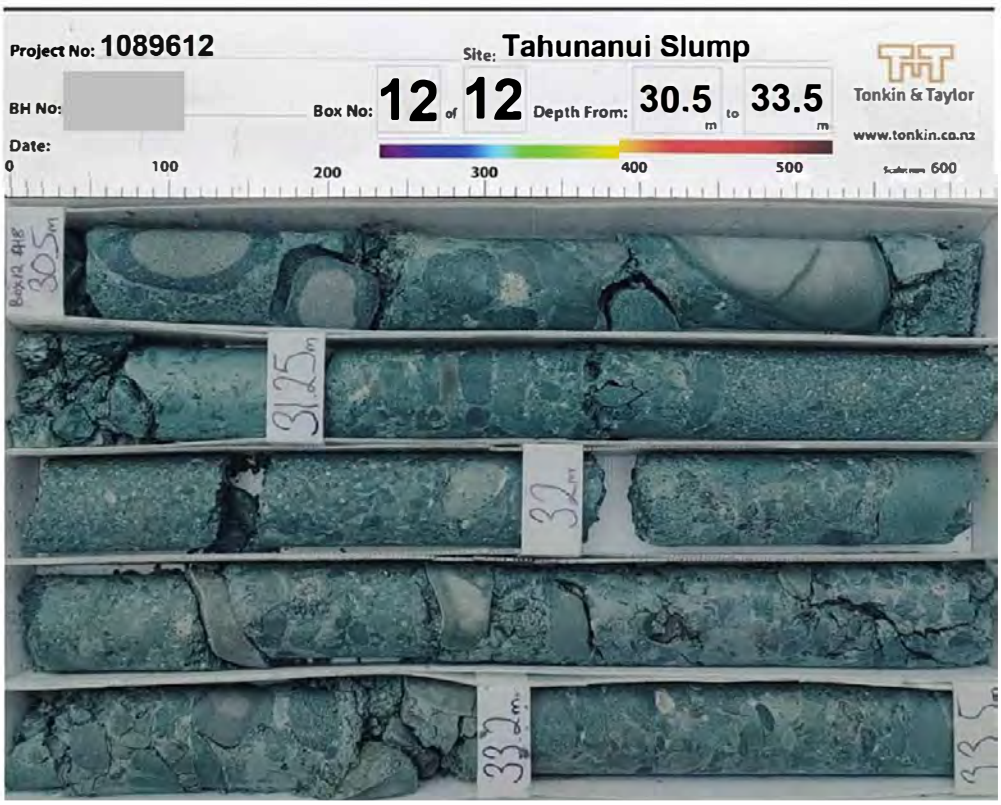
CORE PHOTOS

BOREHOL [redacted]

PROJECT: Tahunanui Slump	LOCAT [redacted], Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL T	HOLE STARTED: 22/09/2022
R.L.: 53.59m	DRILL METHOD: SNC	HOLE FINISHED: 23/09/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



27.80-30.50m



30.50-33.50m

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 1 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 03/10/2022

FINISH DATE: 04/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*0.00m:* NO RECOVERY. Hydro vac excavation for service clearance.			HVAC	0		48	0.5										
	1.60m: Silty medium to coarse GRAVEL, some sand, minor organics; orange brown. Loosely packed, moist. Gravel, rounded to sub-angular, mudstone; organics, rootlets.			SNC	64		47	1.0 1.5 2.0										
	2.50m: NO RECOVERY.						46	2.5										
	3.00m: Silty sandy medium to coarse GRAVEL, some cobbles; light brown. Loosely packed, moist. Gravel, sub-rounded to sub-angular, mudstone; sand, fine to medium.						45	3.0 3.5										
	3.50m: NO RECOVERY. Cobble blocked barrel.			SNC	67		44	4.0 4.5										
	4.50m: Silty medium to coarse GRAVEL; bluish grey. Tightly packed, moist to wet. Gravel, rounded to sub-rounded, mudstone, sandstone, and greywacke.															44mm PVT		

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 2 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 03/10/2022

FINISH DATE: 04/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*5.00m:* Silty medium to coarse GRAVEL; bluish grey. Tightly packed, moist to wet. Gravel, rounded to sub-rounded, mudstone, sandstone, and greywacke.			SNC	81		43	5.5										Box 1, 0.00-5.80m
	5.80m: NO RECOVERY.							6.0										
	6.10m: Gravelly S LT; dark brown with reddish brown staining. Very soft, saturated, non-plastic. Gravel, medium to coarse, sub-rounded to sub-angular, mudstone, sandstone, and greywacke.			SNC	100		42	6.5										
	6.20m: Gravelly S LT, some cobbles; dark brown with reddy brown staining. Stiff, moist, non-plastic. Gravel, medium to coarse, sub-rounded to sub-angular, mudstone; cobbles, sub-rounded to sub-angular.							7.0					*7.05 - 7.60m:* Baking of core by drilling process.					
	7.60m: S LT; light brown with grey inclusions. Soft, moist, non-plastic.			SNC	100		41	7.5				0						
	7.80m: Gravelly S LT; greyish blue. Stiff, moist, non-plastic. Gravel, fine to coarse, rounded, sandstone greywacke.							8.0					*7.80 - 8.45m:* Baking of core by drilling process.					Box 2, 5.80-8.45m
	8.45m: Silty fine to coarse GRAVEL; greyish blue. Tightly packed, moist, well graded. Gravel, rounded, sandstone greywacke.			HQTT	67		40	8.5				0	8.55m: J, 45° dip, PL, R-SM, T *8.75 - 9.05m:* Catcher knocked up barrel. Sample recovered as highly disturbed drill cuttings from inside drill string.					
	9.05m: NO RECOVERY.							9.0										
	9.40m: Silty fine to coarse GRAVEL; greyish blue. Tightly packed, moist, well graded. Gravel, rounded, sandstone greywacke.			HQTT	100		39	9.5				0						
	9.50m: NO RECOVERY.																	
	9.75m: Silty fine to coarse GRAVEL; greyish blue. Tightly packed, moist, well graded. Gravel, rounded, sandstone greywacke.			HQTT	50							0	9.80m: J, 45° dip, PL, R-SM, VN			44mm PVT		

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:45:57 am - Produced with Core-GS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: [redacted]

SHEET: 3 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 03/10/2022

FINISH DATE: 04/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*10.00m:* Silty fine to coarse GRAVEL; greyish blue. T ghtly packed, moist, well graded. Gravel, rounded, sandstone greywacke.			HQTT	80		38	10				0						
	10.40m: NO RECOVERY.																	
	10.50m: Silty fine to coarse GRAVEL; greyish blue. Tightly packed, moist, well graded. Gravel, rounded, sandstone greywacke.			HQTT	67							0			27/10/2022: VWP01			
	10.70m: NO RECOVERY.																	
	10.80m: Silty fine to coarse GRAVEL; greyish blue. Tightly packed, moist, well graded. Gravel, rounded, sandstone greywacke.			HQTT	100			11				0						
	11.30m: NO RECOVERY.			HQTT	47		37					0						
	11.75m: Gravelly S LT; greyish blue. Firm, moist, non-plastic. Gravel, fine to coarse, rounded, sandstone greywacke.			HQTT	86			12				0	*11.75 - 11.95m:* Highly disturbed by drilling process.					
	11.95m: NO RECOVERY.																	
	12.10m: Gravelly S LT; greyish blue. Firm, moist, non-plastic. Gravel, fine to coarse, rounded, sandstone greywacke.			HQTT	33		36	12				0	*12.10 - 12.60m:* Disturbed by drilling process.					
	12.60m: NO RECOVERY.							13				0			27/10/2022: VWP02			
	13.60m: S LT, some gravel; greyish blue. Soft, moist, non-plastic. Gravel, fine to coarse, rounded, sandstone greywacke.			HQTT	100		35					0				44mm PVT	Box 3, 8.45-11.75m	
							34	14				0						

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:45:57 am - Produced with CoreGS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

SHEET: 4 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 03/10/2022

FINISH DATE: 04/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*15.10m:* Gravelly S LT, some clay. Soft, moist, low plasticity. Gravel, fine to coarse, angular, mudstone. Pervasively sheared. (Completely weathered mudstone).			HQTT	100							0						
	15.30m: Grades to brownish grey.						33	15										
	16.10m: Grades to firm.			HQTT	100		32	16				0				144mm PWT		
	16.70m: Grades to brown, soft.							16.5										
								17										
	17.50m: Highly weathered, brown, sheared, MUDSTONE. Extremely weak to very weak.			HQTT	100		31	17.5				0	*17.50 - 18.20m:* Disturbed by drilling process					Box 5, 15.30-17.50m
Port Hills Gravel Formation	*18.10m:* Moderately weathered, dark brown, sheared, MUDSTONE. Extremely weak to very weak. Bedding is inclined between 25 and 30 . Chaotic multiple shears.			HQTT	100		30	18				37	18.20 - 18.60m: BZ, Very closely spaced joints, 50° dip, ST, PO, T, CN. Oriented 0° to bedding 18.25 - 18.29m: BF, 28° dip, PL, SM, T, CN 18.30m: J, 45° dip, PL, R-SM, T					
	18.60m: Unweathered, brownish grey, MUDSTONE. Weak. Interbedded sandstone beds up to 50mm thick and inclined between 25 and 30 .							18.5										
	18.80m: Unweathered, grey, silty SANDSTONE. Very weak, fine grained. Bedding is inclined between 30 and 35 .			HQTT	100		29	19				100	18.90m: BF, 34° dip, PL, SM, T					Box 6, 17.50-19.75m
	19.20m: Unweathered, grey with brown laminations and white speckles, SANDSTONE. Very weak, medium grained. Bedding is inclined at approximately 45 .																	
	19.60m: Bedding inclined between 30 and 35°.							19.5										
	19.90m: Unweathered, greyish brown with brown laminations,																	

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 5 OF 7

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 03/10/2022
FINISH DATE: 04/10/2022
CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m) / Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
'ort Hills Gravel Formation	*20.00m:* Unweathered, greyish brown with brown laminations, sandy S LTSTONE. Very weak to weak. Bedding is inclined between 30 and 35 .			HQTT	100		20.5				100						
	20.70m: Unweathered, grey, massive, SANDSTONE. Very weak, medium to coarse grained.			HQTT	100		21.0				100						
	22.25 - 22.32m: Very closely spaced, carbonaceous laminations, inclined at 40°.			HQTT	100		21.5				100						
	22.65m: Unweathered, brownish grey, MUDSTONE. Weak. Bedding is inclined between 15 and 20 .			HQTT	100		22.0				100	23.10 - 23.20m: BF, 20° dip 23.70m: BF, 18° dip 24.30m: BF, 5° dip, PL, R-SM 24.80m: J, 60° dip, PL, SM, T, Oriented 225° to bedding					Box 7, 19.75-22.60m

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

SHEET: 6 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 03/10/2022

FINISH DATE: 04/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*25.00m:* Unweathered, brownish grey, blocky, sheared, MUDSTONE. Weak. *25.10m:* Unweathered, bluish grey, MUDSTONE. Weak. Bedding is inclined between 25 and 30 .			HQTT	100		23	25				100	25.10m: J, 60° dip, Pl., R, T 25.80m: BF, 15° dip, PL, R, T					Box 8, 22.60-25.70m
								26										
				HQTT	100		22	26					26.30m: B, 25° dip					
								27										
	28.10 - 28.50m: 20mm thick, undulating, COAL bed, inclined at 80°. Bedding fractures inclined between 25 and 30°.			HQTT	100		21	27					27.82 - 27.92m: J, 60° dip, PL, SM, T, CN, Oriented 0° to bedding					
								28										
	28.60m: Slightly weathered, brownish grey, MUDSTONE. Very weak.						20	28										Box 9, 25.70-28.60m
								29					29.20m: J, 60° dip					
	29.75m: Grades to brown.						19	29				100	29.50m: J, 60° dip, Pl., R-SM, T					

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:45:57 am - Produced with Core-GS by GeRoc

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.:

SHEET: 7 OF 7

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 03/10/2022

FINISH DATE: 04/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 48.37m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	ROCK DEFECTS Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*30.00m:* Slightly weathered, brownish grey, MUDSTONE. Very weak.			HQTT	100		18	30				100	30.10 - 30.20m: DD, 0° dip, PL, MW, Very soft clay , 30.25m: B, 15° dip					
	30.50m: Unweathered to slightly weathered, greyish blue, sandy SILTSTONE. Very weak.			HQTT	100		17	31				86	30.60 - 30.70m: DD, 0° dip, PL, MN, Very soft clay 30.90m: J, 45° dip, PL, R-SM, T 31.20 - 31.30m: BZ					Box 10, 28.60-31.40m
	31.40m: Unweathered, greyish blue, conglomeratic SANDSTONE. Very weak, fine to coarse grained. Gravel, fine to medium, subrounded to rounded, sandstone and greywacke. *32.00 - 32.40m:* 40mm gravel beds inclined at 70°.			HQTT	100		16	32				100	31.40m: J, 40° dip, PL, SL, T, CM 32.00m: J, 45° dip, PL, R-SM, T 32.10 - 32.25m: BF, 70° dip, PL, SL, T, CN,					
	33.50m: Unweathered, greyish blue, CONGLOMERATE. Very weak. Gravel, subrounded to rounded, sandstone and greywacke..			HQTT	100		15	33				100						
							14	34									Box 11, 31.40-34.40m	
																		Box 12, 34.40-35.00m

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 16.5 and 34.0mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 35m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:45:57 am - Produced with CoreGS by GeRoc

Tonkin+Taylor

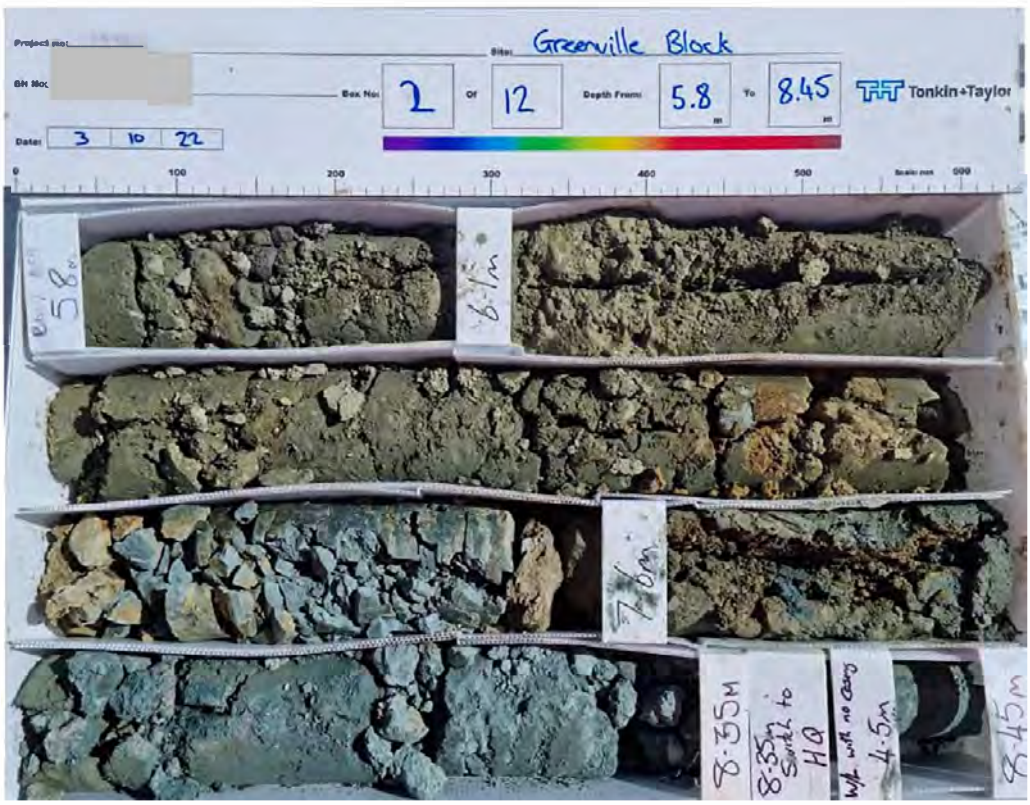
CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 1 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 03/10/2022
R.L.: 48.37m	DRILL METHOD: SNC	HOLE FINISHED: 04/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

0.00-5.80m



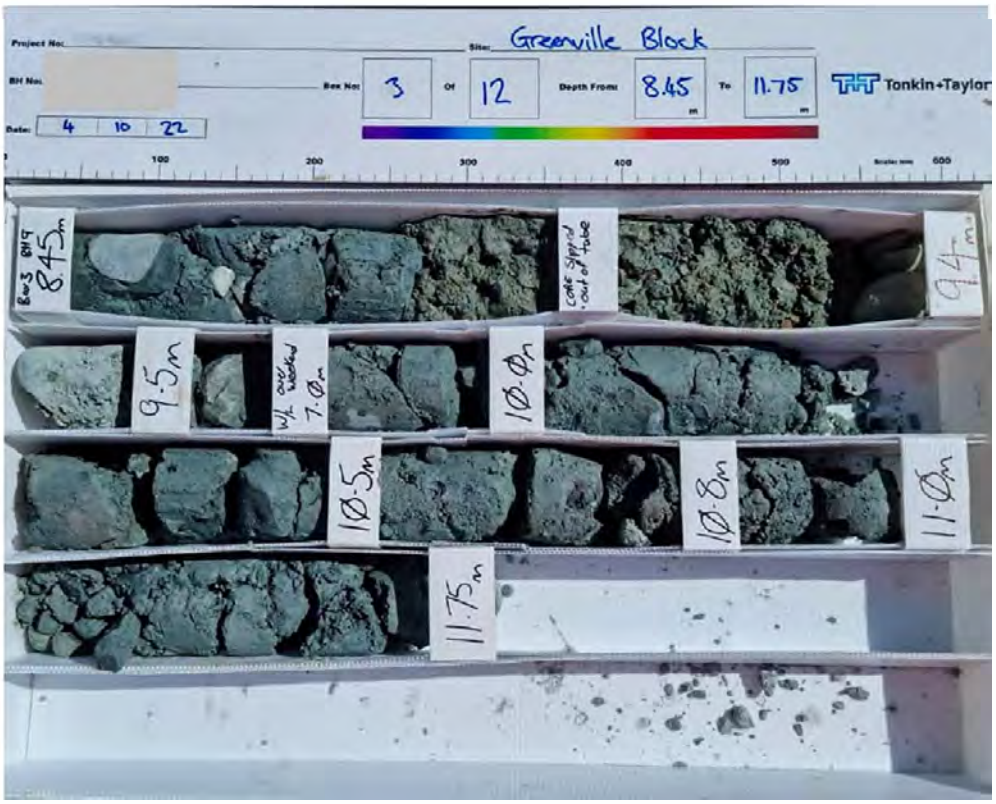
5.80-8.45m

Tonkin+Taylor

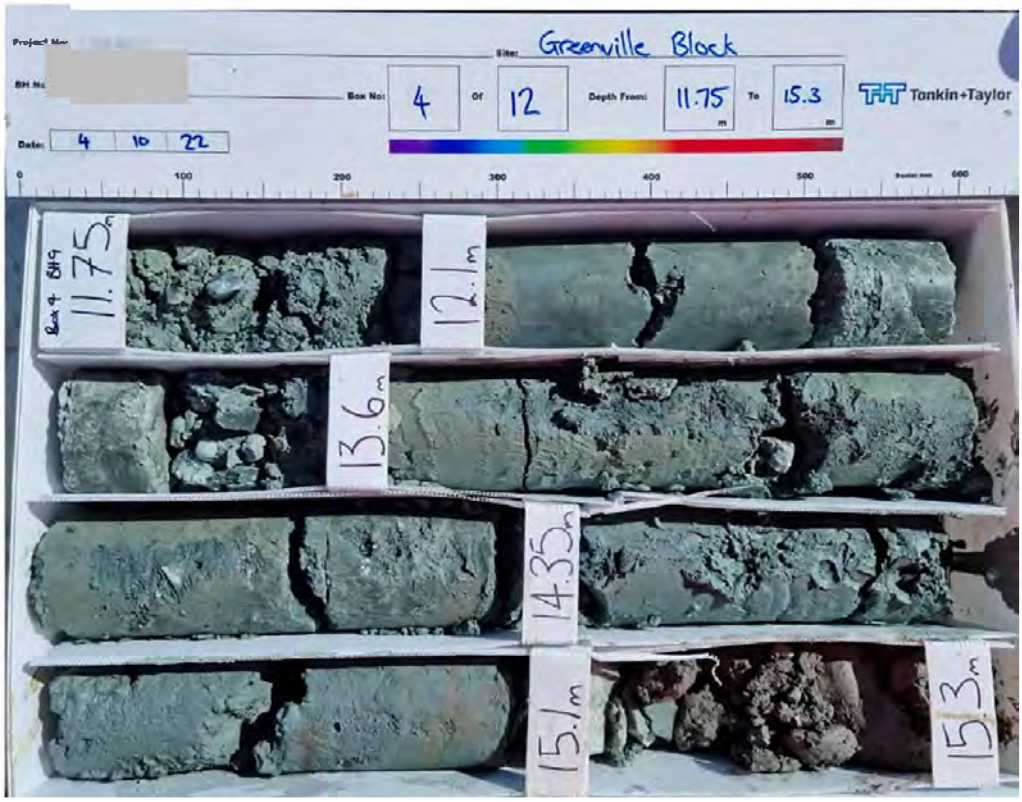
CORE PHOTOS

BOREHOLE No.: [redacted]

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 03/10/2022
R.L.: 48.37m	DRILL METHOD: SNC	HOLE FINISHED: 04/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



8.45-11.75m



11.75-15.30m

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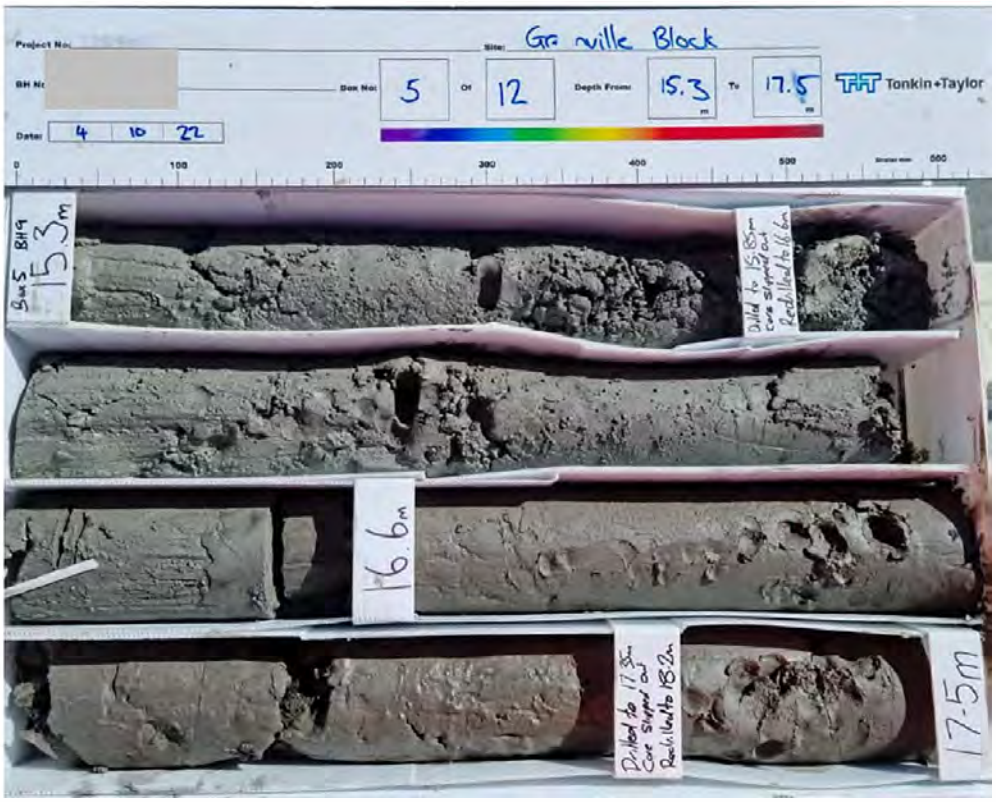
CORE PHOTOS

BOREHOLE No.: [redacted]

SHEET: 3 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 03/10/2022
R.L.: 48.37m	DRILL METHOD: SNC	HOLE FINISHED: 04/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



15.30-17.50m

17.50-19.75m

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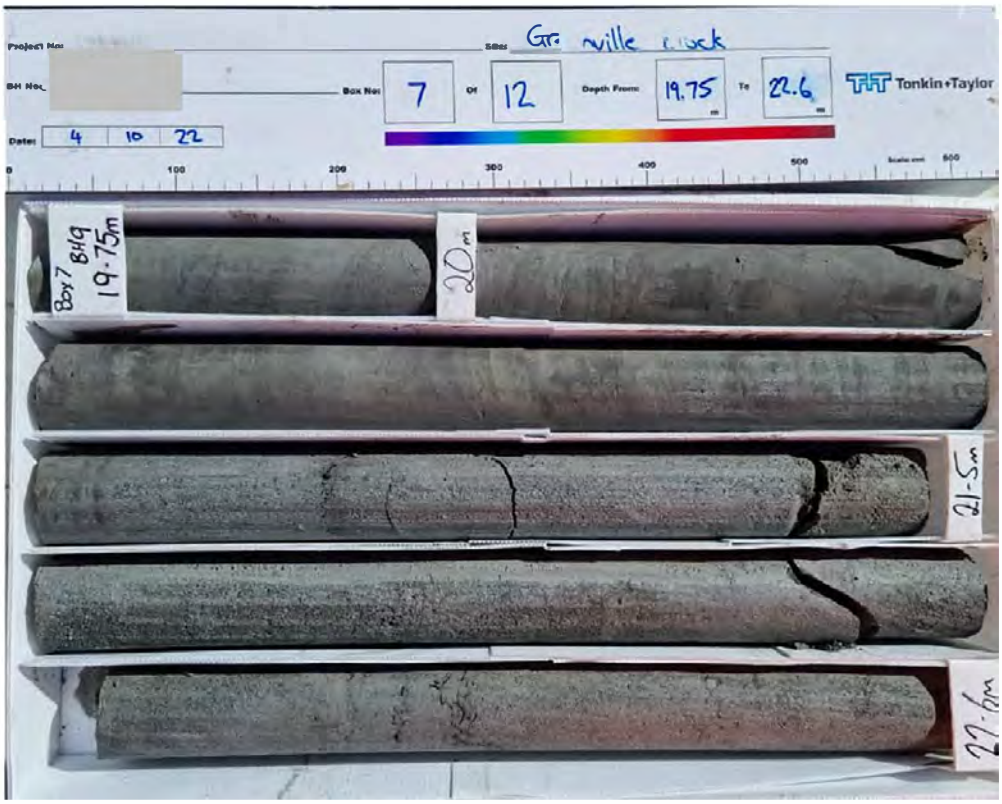
CORE PHOTOS

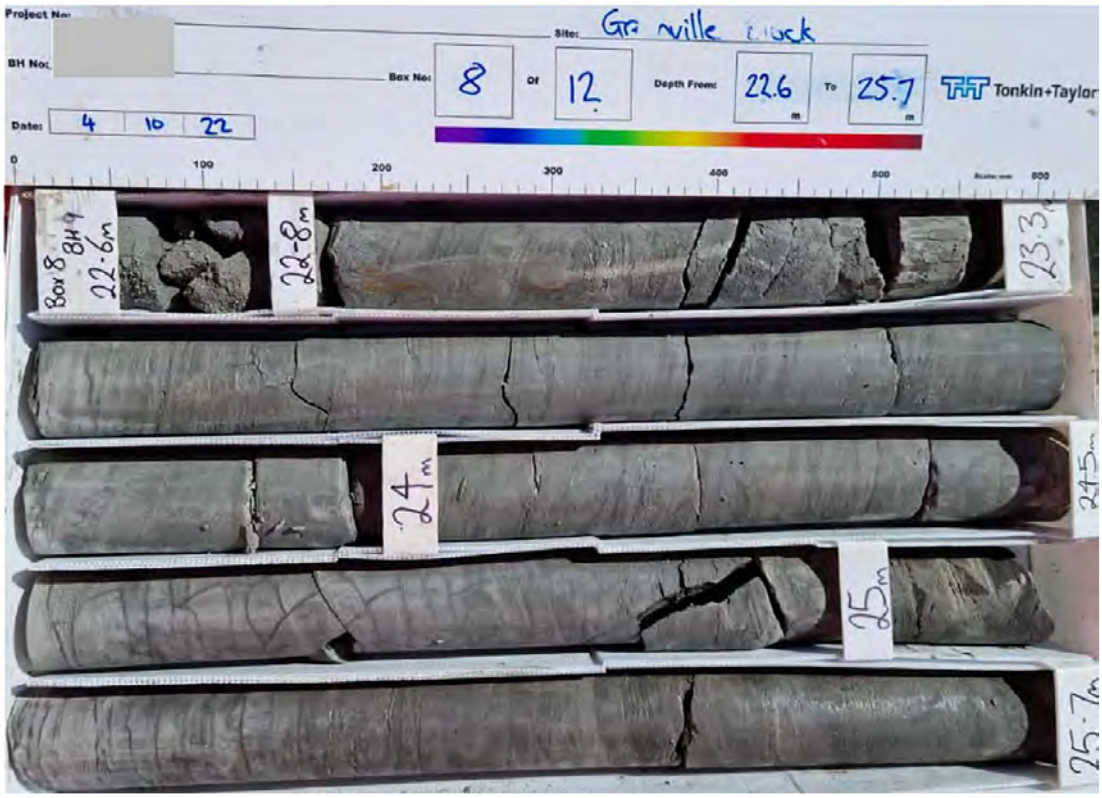
BOREHOLE No.: [redacted]

SHEET: 4 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 03/10/2022
R.L.: 48.37m	DRILL METHOD: SNC	HOLE FINISHED: 04/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



19.75-22.60m



22.60-25.70m

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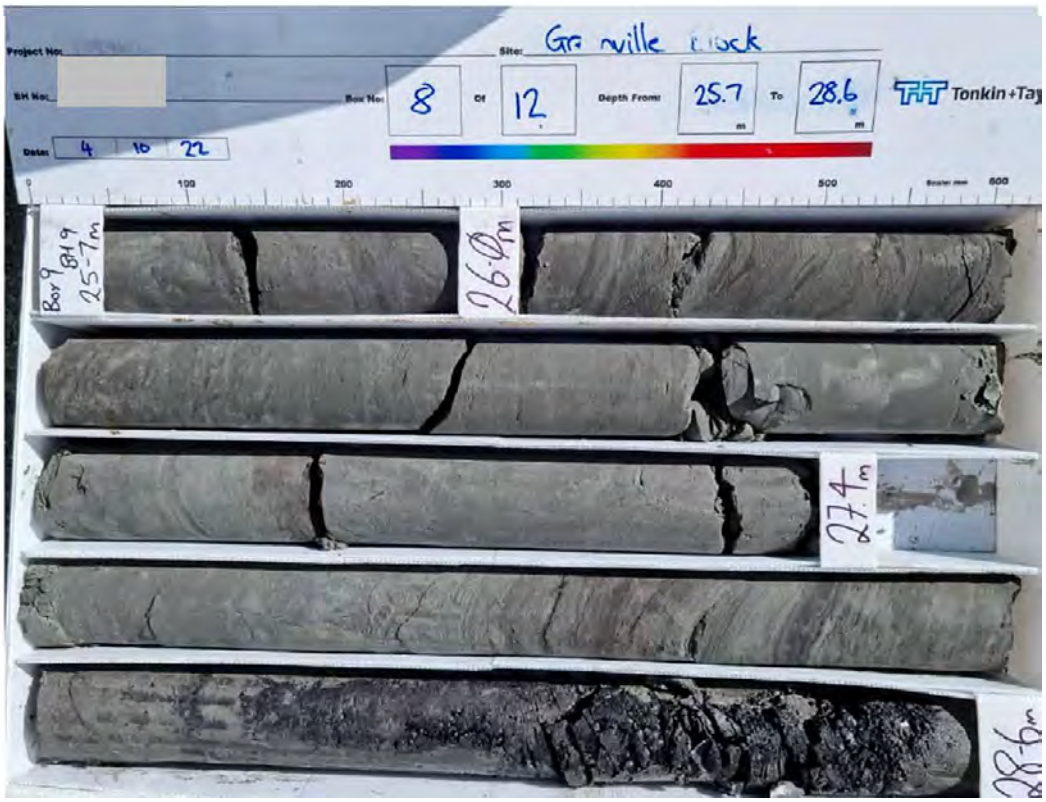
CORE PHOTOS

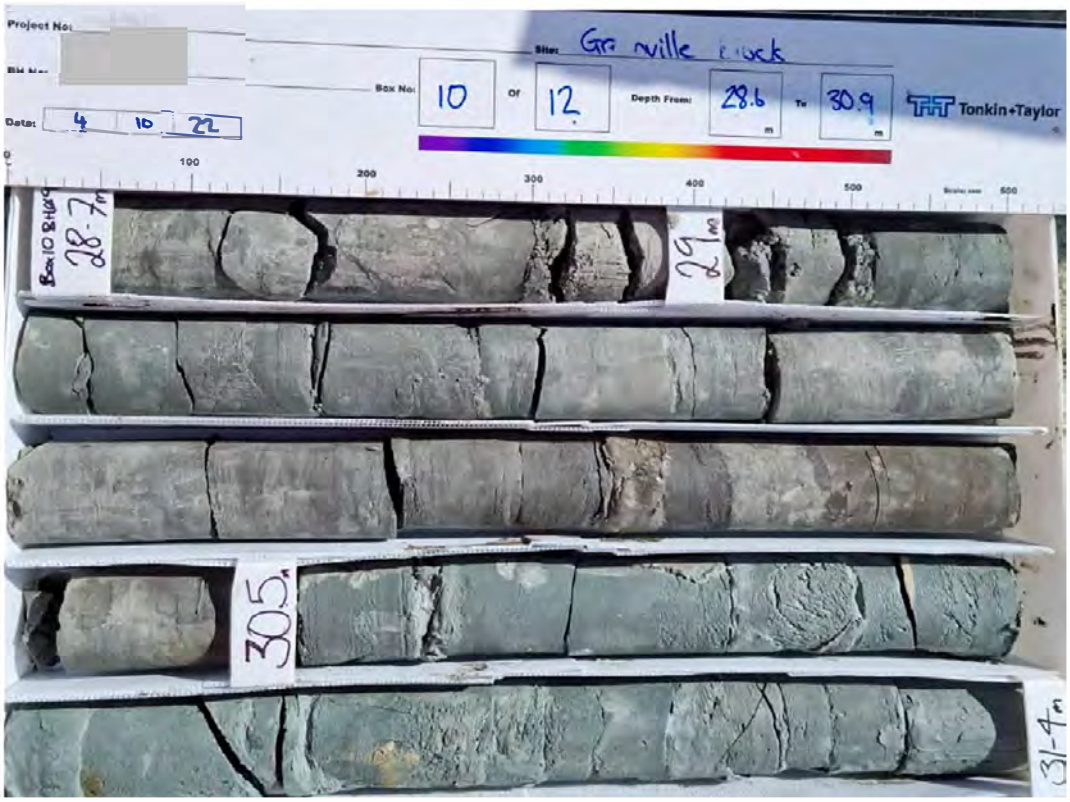
BOREHOLE No.: [redacted]

SHEET: 5 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 03/10/2022
R.L.: 48.37m	DRILL METHOD: SNC	HOLE FINISHED: 04/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)



25.70-28.60m



28.60-31.40m

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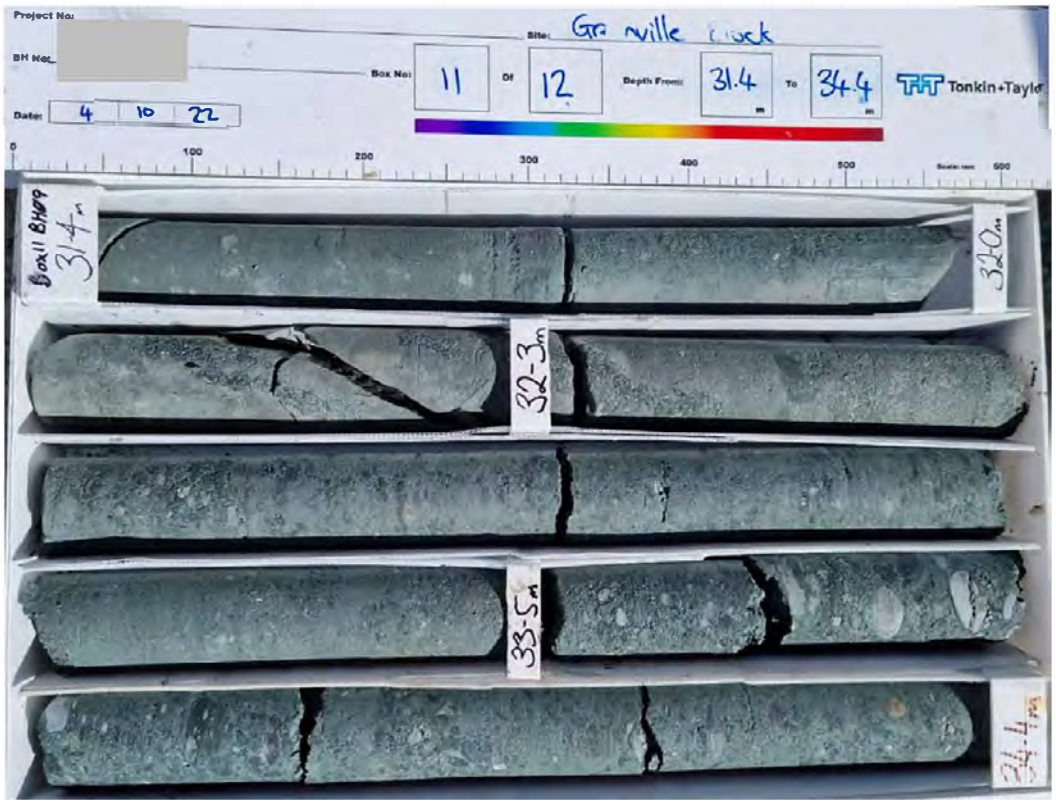
CORE PHOTOS

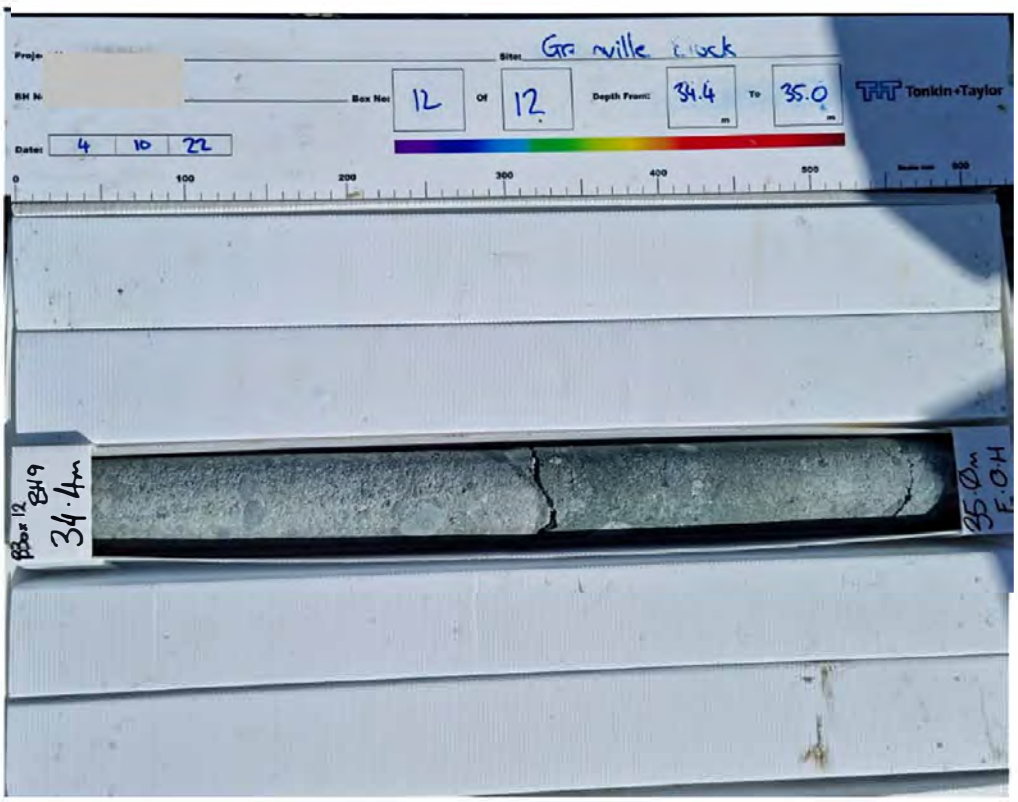
BOREHOLE No.: [redacted]

SHEET: 6 OF 6

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 03/10/2022
R.L.: 48.37m	DRILL METHOD: SNC	HOLE FINISHED: 04/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)



31.40-34.40m



34.40-35.00m

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 1 OF 4

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION:

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 89.55m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 10/10/2022
FINISH DATE: 13/10/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW SW MW HW CW)	Rock Strength (ES VS S MS W VW EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000 600 200 60 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25 50 75)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*0.00m:* NO RECOVERY. Hydro-vac excavated..			HVAC	0		89	0.5										
	1.30m: Silty fine to coarse SAND, some gravel; light orange brown. Tightly packed, moist. Gravel, fine to coarse, grey, iron stained fine sandstone and mudstone. *1.60 - 1.90m:* Cobbles; grey.			SNC	100		88	1.0 1.5										
	2.50m: Sandy fine to coarse GRAVEL, minor silt; orange brown. Tightly packed, wet. Gravel, sub-rounded to angular, fine sandstone and mudstone; sand, fine to coarse.			SNC	100		87	2.0 2.5										
	2.75m: Gravelly fine to coarse SAND; orange brown. Tightly packed, moist. Gravel, fine to coarse. *2.90 - 3.00m:* Cobble; grey. *3.00 - 3.10m:* Wet.																	
	3.10m: Fine SAND, minor silt; orange brown. Tightly packed, moist. *3.15m:* Gravelly fine to coarse SAND, some silt; orange brown. Tightly packed, moist. Gravel, fine to medium. *3.35 - 3.50m:* Light grey.			SNC	100		86	3.0 3.5										Box 1, 0.00-3.70m
	4.50m: NO RECOVERY.						85	4.0 4.5										
	4.65m: Gravelly fine to coarse SAND, some silt; orange brown. Tightly packed, moist. Gravel, fine to medium.															144mm PWT		

COMMENT

Hole Depth 16.7m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 2 OF 4

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 10/10/2022

FINISH DATE: 13/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION:

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 89.55m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*5.00m:* Fine to coarse SAND, some silt and some gravel; orange brown streaked grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular.			SNC	100													
	6.00m: Fine to coarse SAND, some silt and some gravel; orange brown streaked grey. Tightly packed, moist. Gravel, fine to coarse, sub-rounded to sub-angular. *6.35 - 6.50m:* Cobbles, *6.60 - 6.80m:* Recovered as sandy fine to coarse GRAVEL; light orange grey. Loosely packed, dry. Sand, fine to coarse.			SNC	100		84	5.5										Box 2, 3.70-6.00m
				SNC	100		83	6.5										
				SNC	100		82	7.5										
	8.25 - 8.40m: Cobble.			SNC	100			8.0										Box 3, 6.00-8.25m
				SNC	100		81	8.5								144mm PWT		
	8.60m: Gravelly fine to coarse SAND, some silt and some cobbles; orangish brown matrix. Tightly packed, moist. Gravel, sub-rounded to sub-angular, sandstone and siltstone, some medium to coarse; cobbles, up to 100mm.			PQTT	100			9.0				100						
				PQTT	100		80	9.5				100						
												83						

COMMENT

Hole Depth 16.7m

Scale 1:25

Rev.: A

General Log _ - 21/04/2023 12:46:12 am - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 3 OF 4

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION:

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 89.55m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 10/10/2022
FINISH DATE: 13/10/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*10.70 - 10.80m:* Cobble; grey.			PQTT	83		79	10.5				100						
				PQTT	100							100						Box 4, 8.25-10.70m
	11.10 - 11.40m: Granite clasts present.			PQTT	100			11.0				100						
	11.32m: CORE LOSS.			PQTT	64		78	11.5				64						
	11.50m: Gravelly fine to coarse SAND, some silt and some cobbles; orangish brown matrix. Tightly packed, moist. Gravel, sub-rounded to sub-angular, sandstone and siltstone, some medium to coarse; cobbles, up to 100mm.			PQTT	100							0	*11.50 - 12.00m:* Drilled twice, fines blown out ("broken zone")					
	11.60m: Moderately weathered, greenish grey, CONGLOMERATE. Extremely weak to very weak. Clasts; 2 - 150mm, subrounded to rounded, sandstone, siltstone, and granite.			PQTT	100			12.0				100						
				PQTT	100		77	12.5				100	12.85m: J, 15° dip, UN, R, VN					
								13.0				100						Box 5, 10.70-13.10m
							76	13.5				100						
								14.0				100						
	14.85 - 15.50m: Extremely weak. Matrix, soft						75	14.5				100						

COMMENT

Hole Depth 16.7m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 4 OF 4

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 10/10/2022

FINISH DATE: 13/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION:

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 89.55m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Tahunanui Slump Landslip Deposits	*15.00m:* Moderately weathered, greenish grey, CONGLOMERATE. Extremely weak to very weak. Clasts; 2 - 150mm, subrounded to rounded, sandstone, siltstone, and granite.	UW SW MW HW CW	ES VS S MS W VW EW	PQTT	100		74	15 5				100						Box 6, 13.10-15.50m
				PQTT	100			16 0				100	*16.10m:* Drill rig struggling, sand material squeezing around rods					
				PQTT	100		73	16 5				100						Box 7, 15.50-16.70m
	16.7m: END OF BOREHOLE						72	17 0 17 5 18 0					*16.70m:* Hole collapsed back to 15.5m					
							71	18 5 19 0										
							70	19 5										

COMMENT

Hole Depth 16.7m

Scale 1:25

Rev.: A

CORE PHOTOS

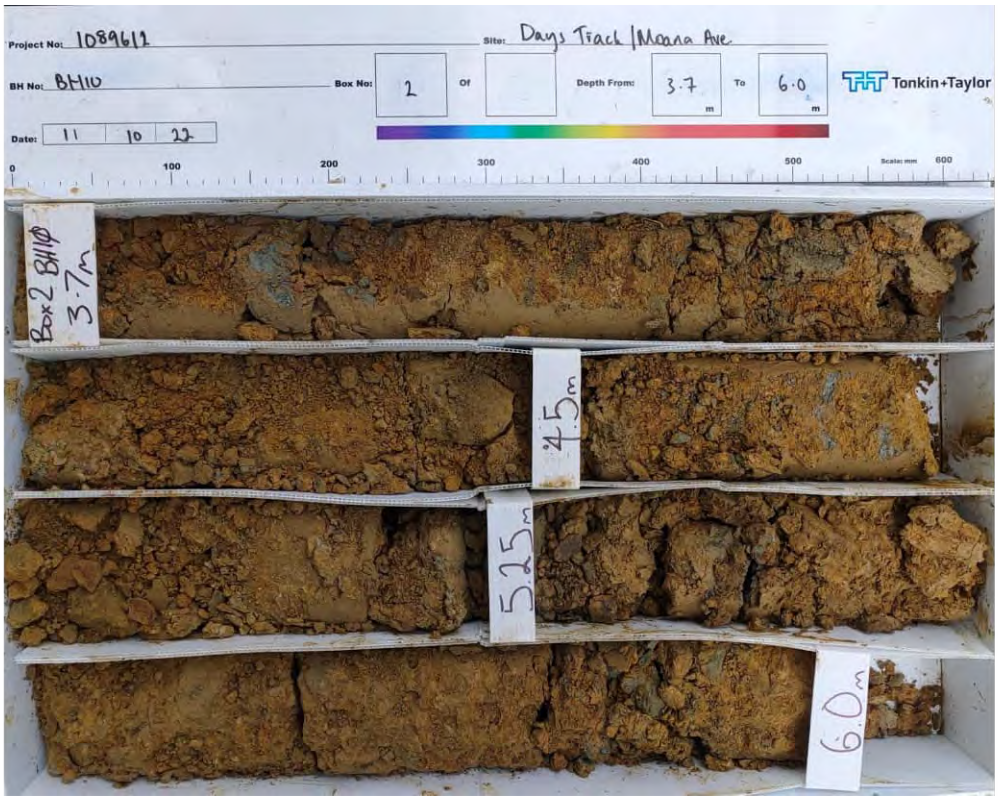
BOREHOLE No.

Hole Location:

SHEET: 1 OF 4

PROJECT: Tahunanui Slump		LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)		DRILL TYPE: Fraste	HOLE STARTED: 10/10/2022
R.L.:	89.55m	DRILL METHOD: SNC	HOLE FINISHED: 13/10/2022
DATUM	NZVD2016		DRILLED BY: ProDrill
			LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

0.00-3.70m



3.70-6.00m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]
Hole Location: [redacted]

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 10/10/2022
R.L.: 89.55m	DRILL METHOD: SNC	HOLE FINISHED: 13/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

6.00-8.25m

8.25-10.70m

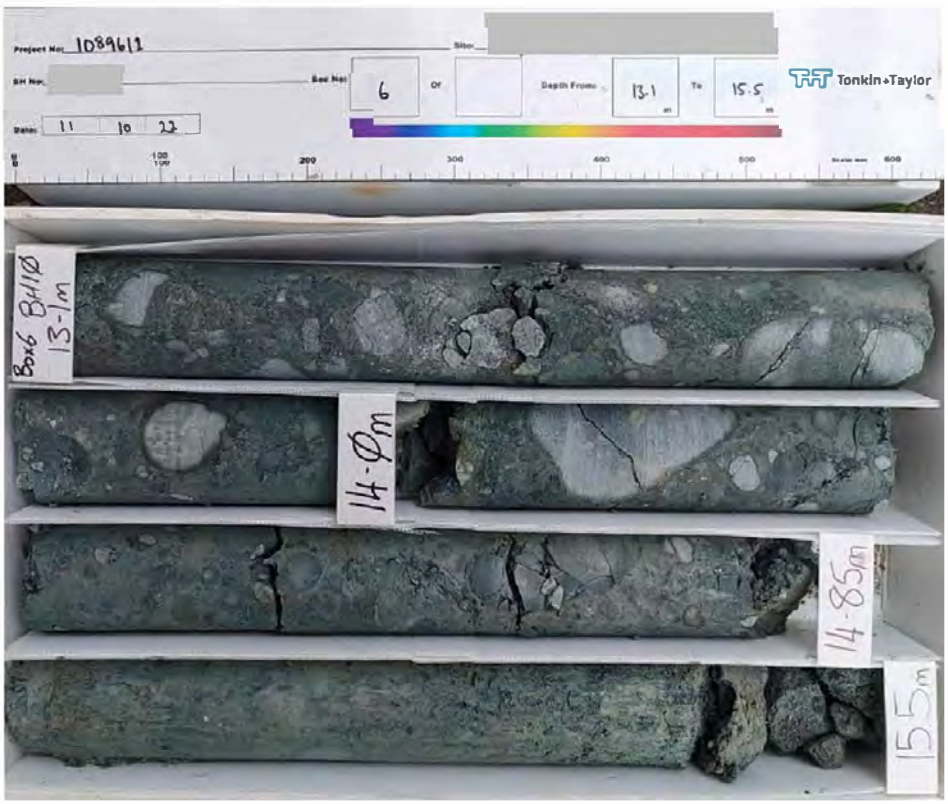
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]
Hole Location: [redacted]
SHEET: 3 OF 4

PROJECT: Tahunanui Slump		LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	[redacted]	DRILL TYPE: Fraste	HOLE STARTED: 10/10/2022
R.L.:	89.55m	DRILL METHOD: SNC	HOLE FINISHED: 13/10/2022
DATUM	NZVD2016		DRILLED BY: ProDrill
			LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

10.70-13.10m



13.10-15.50m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: [redacted]
Hole Location: [redacted]
SHEET: 4 OF 4

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: Fraste	HOLE STARTED: 10/10/2022
R.L.: 89.55m	DRILL METHOD: SNC	HOLE FINISHED: 13/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

15.50-16.70m

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 1 OF 6

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 31.32m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 07/10/2022
FINISH DATE: 12/10/2022
CONTRACTOR: ProDrill

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	R.L. (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Fill	*0.00m:* Gravelly CLAY; yellowish brown. Firm, moist, high plasticity. Gravel, fine grading to coarse, sub-rounded, greywacke and tuff.																	
	0.20m: NO RECOVERY.																	
Tahunanui Slump Landslip Deposits	*0.50m:* Gravelly CLAY; greenish grey. Firm, wet, high plasticity. Gravel, fine grading to medium, sub-rounded, greywacke, tuff, mudstone.			PQTT	80		31	0.5										
	1.05m: Silty CLAY, minor gravel; greyish brown with orange brown mottles. Firm and Stiff, moist, low plasticity. Gravel, fine grading to medium, sub-angular, mudstone.							1.0										
	1.50m: Silty CLAY, some gravel; greyish brown with orange brown and dark grey mottles. Soft, moist grading to wet, low plasticity. Gravel, fine grading to medium, angular, mudstone.			PQTT	100		30	1.5										
	2.10m: Gravelly S LT, some clay; light grey. Stiff, moist, low plasticity. Gravel, fine grading to medium, angular, mudstone, extremely weak. Pervasively sheared.						29	2.0										
	3.10m: CLAY, some gravel; greenish grey with brown mottles. Soft and Firm, moist, high plasticity. Gravel, fine grading to medium, angular, mudstone, extremely weak. Pervasively sheared.			PQTT	97		28	2.5										
	4.00m: CLAY; greenish grey with trace of light orange brown streaks. Firm, moist, high plasticity.						27	3.0										
	4.50m: CLAY, some gravel; greenish grey with orange brown mottles. Firm, moist, high plasticity. Gravel, fine grading to medium, angular, mudstone, extremely weak. Pervasively sheared.							3.5										
	4.90m: Grades to orange brown.							4.0										
								4.5										

26/10/2022: VWP01

24mm HWT casing

Box 1, 0.00-2.70m

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 4.9 and 12.3mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 30m

Scale 1:25

Rev.: A

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 2 OF 6

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 07/10/2022

FINISH DATE: 12/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 31.32m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)
Port Hills Gravel Formation	*5.20m*: Moderately weathered, yellowish grey, MUDSTONE. Very weak.
	5.42 - 5.52m: Moderately thin (100mm) bed of gravelly CLAY. Gravel, fine to medium, angular, siltstone. Potential shear zone.
	6.47m: Highly weathered, orange brown, SANDSTONE. Extremely weak. Sand, fine to medium. Soil description: SAND; dense.
	6.83 - 6.93m: Extremely closely spaced, steeply inclined (50°) carbonaceous laminations.
	7.10 - 7.15m: Thin (50mm) bed of gravelly CLAY. Gravel, fine to medium, angular, siltstone. *7.12 - 7.22m*: Extremely closely spaced, steeply inclined (50°) carbonaceous laminations. *7.20m*: Grades to light grey. *7.26 - 7.36m*: Extremely closely spaced, steeply inclined (50°) carbonaceous laminations.
	7.65m: Slightly weathered, grey with occasional orange brown streaks, MUDSTONE. Very weak.
	9.20m: Highly weathered, light grey, SANDSTONE. Extremely weak. Sand, fine. Soil description: SAND; dense.
	9.60m: Unweathered, light greenish grey with blackish brown laminations, MUDSTONE. Weak. Bed inclination is increasing with depth and is between 25 to 35 .

Rock Weathering | Rock Strength | Sampling Method: PQTT | Core Recovery (%): 100 | Testing | RL (m) / Depth (m) | Graphic Log | Defect Log | Fracture Spacing (mm) | RQD (%): 76, 6, 80, 100

ROCK DEFECTS — Description & Additional Observations

- 5.56m: J, 30° dip, PL, SM, VN, CV
- *8.00 - 9.50m*: Driller notes that open barrel drill method has resulted in a 300mm stretch of the 1500mm long core run. Switching from open barrel to PQ3 drill method.
- 9.20m: J, 75° dip, PL, SM, VN, CV
- 9.60m: BF, 25° dip, PL, SM, T, CN
- 9.73m: BZ, 25° dip, PL, R, N, angular gravel.
- 9.77m: BF, 25° dip, PL, PO, N, CV

Fluid Loss (%) | Water Level: 26/10/2022; VWP02 | Casing: 24mm HWT casing | Installation: Box 3, 5.20-7.50m; Box 4, 7.50-9.50m | Core Box No

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 4.9 and 12.3mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 30m

Scale 1:25

Rev.: A

General Log - 19/12/2023 12:46:24 am - Produced with CoreGS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 3 OF 6

DRILLED BY: s9(2)(a)
LOGGED BY:
CHECKED:
START DATE: 07/10/2022
FINISH DATE: 12/10/2022
CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump
JOB No.: 1089612.0000
LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 31.32m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*10.00m:* Unweathered, light greenish grey with blackish brown laminations, MUDSTONE. Weak. Bed inclination is increasing with depth and is between 25 to 30 .			PQTT	100		21	10				100	10.20m: J, 50° dip, PL, R, T, CN, Oriented 225° to bedding 10.31m: BF, 25° dip, PL, SM, T, CN 10.38m: J, 70° dip, PL, R, T, CN, Oriented 185° to bedding					
	11.22 - 11.23m: 30mm rip-up clast; light brown.			PQTT	100		20	11				80	10.85m: BF, 30° dip, PL, SM, VN, CV 10.87m: J, 60° dip, PL, SM, T, CN, Oriented 180° to bedding 11.22m: BF, 30° dip, PL, SM, T, CN 11.38m: BF, 30° dip, PL, SM, T, CN 11.60m: J, 80° dip, PL, SM, T, CM, Oriented 225° to bedding *11.48 - 11.60m:* DD within closely spaced jointed zone.					
	11.60 - 12.00m: Bed inclination is increasing with depth and is between 30 to 45°.			PQTT	100		19	12				28	*11.60 - 11.76m:* Very closely spaced, steeply inclined carbonaceous bedding fractures; BF, 35° dip, PL, SL, T, CN. 11.81m: J, 65° dip, UN, R, T, CN, Oriented 180° to bedding 11.90m: BF, 45° dip, PL, SL, T, CM, Polished, carbonaceous *12.05 - 12.45m:* Very closely spaced, steeply inclined bedding fractures; BF, 55° dip, PL, SL, T, CN.					Box 5, 9.50-11.60m
	12.00 - 12.70m: Bed inclination is between 45 to 55°.																	
	12.70 - 13.60m: Massive.			PQTT	100		18	13				100	12.02m: BF, 40° dip, PL, SL, VN, CG, Polished 12.04m: J, 45° dip, PL, SM, T, CN 12.10m: J, 65° dip, PL, SM, T, CN 12.37m: J, 60° dip, PL, SM, T, CN 12.57m: J, 30° dip, PL, SM, T, CN 12.58m: J, 65° dip, PL, PO, T, CN 12.87m: BF, 60° dip, PL, SM, T, CN 13.27m: J, 45° dip, PL, PO, T, CN					
	13.65 - 14.80m: Bed inclination is between 30 to 45°.																	Box 6, 11.60-13.65m
	14.38 - 14.62m: Brecciated zone along bedding; extremely week, healed.						17	14				62	13.65m: BF, 50° dip, PL, SM, T, CN 13.75m: BF, 30° dip, PL, SM, T, CN 13.86m: BF, 30° dip, PL, SM, T, CN 14.08m: BF, 45° dip, PL, PO, T, CN 14.29m: BF, 35° dip, PL, PO, T, CN 14.38m: BF, 35° dip, PL, SL, MW, CG				1mm HWT casing	
	14.80 - 15.50m: Massive.												14.92m: BF, 30° dip, PL, PO, T, CN					

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 4.9 and 12.3mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 30m

Scale 1:25

Rev.: A

General Log - 19/4/2023 12:46:24 am - Produced with CoreGS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 4 OF 6

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 07/10/2022

FINISH DATE: 12/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 31.32m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	***15.00m:*** Unweathered, light greenish grey with blackish brown laminations, MUDSTONE. Weak.			PQTT	90		16	15				62	15.07m: J, 45° dip, ST, R, T, CN, Oriented 255° to bedding 15.30m: J, 45° dip, PL, R, T, CN					
	15.50 - 16.10m: Bed inclination is between 45 to 55°.							15 5					15.55m: J, 70° dip, PL, SL, T, CN, Oriented 0° to bedding ***15.90 - 16.10m:*** Relict joint, 70° dip, UN, SM, VN, CV.					
	15.97 - 16.00m: 2-4mm thick, gently inclined, lenticular coal seam. ***16.10 - 16.50m:*** Blackish brown, massive.							16 0					15.90m: BF, 55° dip, PL, PO, T, CN 16.10m: BF, 65° dip, UN, SL, T, CN,					Box 7, 13.65-16.10m
	16.30 - 16.41m: Steeply inclined (55°), very thin (20mm) coal seam. ***16.50 - 17.25m:*** Massive.			PQTT	100		15	16 5				1m						
	17.25 - 17.85m: Bed inclined at 30°.							17 0					17.00m: BF, 35° dip, PL, SL, T, CN 17.25m: BF, 35° dip, PL, SM, T, CN					
	17.57 - 17.65m: Thin bed of clay. ***17.65 - 17.80m:*** Brecciated zone; blackish brown, extremely week, intact.						14	17 5				80	17.45m: J, 50° dip, UN, SL, T, CN, Oriented 0° to bedding 17.46m: BF, 35° dip, PL, PO, T, CN, Coal bed 17.60m: BF, 30° dip, PL, SL, MW, CG above carbonaceous BF. 17.63m: BF, 30° dip, PL, R, T, CN 17.75m: BF, 30° dip, PL, SM, VN, CG 17.85m: J, 50° dip, PL, SL, T, CN, Oriented 0° to bedding 17.85 - 18.32m: J, 80° dip, PL, SM, T, CN, Oriented 90° to bedding					Box 8, 16.10-18.35m
	17.85m: Unweathered, light greenish grey, massive, MUDSTONE. Weak.			PQTT	100			18 0										
	19.45 - 19.55m: Thin bed of gravelly CLAY. Gravel, fine to medium, angular, siltstone.						13	18 5				90	18.46m: BF, 45° dip, PL, SM, T, CN 18.69m: BF, 40° dip, PL, SM, T, CN 18.78m: J, 65° dip, UN, SL, T, CN, Oriented 255° to bedding					
	19.65m: Unweathered, light bluish grey, SANDSTONE. Weak. Sand, fine to coarse. ***19.90 - 20.35m:*** Thick bed of conglomeratic SANDSTONE. Gravel, fine to coarse, subrounded to rounded. Bedding contacts inclined at 35°.			PQTT	100		12	19 0					***19.08 - 19.80m:*** Iron stained incipient fracturing. 19.72m: J, 20° dip, PL, SM, T, CN			114mm HWT casing		Box 9, 18.35-20.00m

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 4.9 and 12.3mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 30m

Scale 1:25

Rev.: A

General Log - 21/04/2023 12:46:24 am - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.:

SHEET: 5 OF 6

DRILLED BY: s9(2)(a)

LOGGED BY:

CHECKED:

START DATE: 07/10/2022

FINISH DATE: 12/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 31.32m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity. ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
'ort Hills Gravel Formation	*20.00m:* Unweathered, light bluish grey, SANDSTONE. Weak. Sand, fine to coarse.			PQTT	100		11	20 5				100	*20.62 - 20.75m:* Relict joint, 60° dip, UN, SM, VN, CV.					
	20.75 - 20.85m: Moderately thin bed of conglomeratic SANDSTONE. Gravel, fine to coarse, subrounded to rounded. Bedding contacts inclined at 35°.							21 0										
	21.30m: Unweathered, bluish grey, CONGLOMERATE. Extremely weak to very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite.			PQTT	100		10	21 5				100						
				PQTT	100		9	22 0				100	*22.40m:* Core bound.					
				PQTT	100			22 5				100	*22.88m:* J, 55° dip, PL, R, T, CN					
	23.00m: NO RECOVERY.						8	23 0										
	23.45m: Unweathered, bluish grey, CONGLOMERATE. Extremely weak to very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite.			PQTT	63			23 5				63						Box 10, 20.00-23.00m
							7	24 0										
								24 5				90						

ROCK DEFECTS

COMMENT 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 4.9 and 12.3mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 30m

Scale 1:25

Rev.: A

General Log - 10/4/2023 12:46:24 am - Produced with CoreGS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: [redacted]

SHEET: 6 OF 6

DRILLED BY: s9(2)(a)

LOGGED BY: [redacted]

CHECKED:

START DATE: 07/10/2022

FINISH DATE: 12/10/2022

CONTRACTOR: ProDrill

PROJECT: Tahunanui Slump

JOB No.: 1089612.0000

LOCATION: Tahunanui, Nelson

CO-ORDINATES: [redacted] (NZTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 31.32m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	ROCK DEFECTS Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Port Hills Gravel Formation	*25.00m*: Unweathered, bluish grey, CONGLOMERATE. Extremely weak to very weak. Clasts, 2 - 100mm, angular to to subrounded, greywacke, mudstone, and granite. *25.72 - 25.74m*: 120mm granite boulder. *26.10 - 26.60m*: Weak to moderately strong.			PQTT	97		6 5 4 3 2	25 26 27 28 29				90	25.46m: J, 50° dip, UN, R, T, CN					
				PQTT	100							100	26.53m: J, 20° dip, PL, SM, T, CN					Box 11, 23.00-26.60m
				PQTT	100							100	27.30m: Core bound.					
				PQTT	100							100						
				PQTT	100							85	29.66m: BF, 45° dip, UN, R, T, CN 29.72m: BF, 45° dip, UN, R, T, CN					Box 12, 26.60-29.50m
													30.00m: Core bound.					Box 13, 29.50-30.00m

COMMENT: 1. Two vibrating wire piezometers (VWP) have been installed at this location. VWP01 and VWP02 have been installed at 4.9 and 12.3mbgl respectively. 2. An inclinometer has also been installed at this location to 35mbgl.

Hole Depth 30m

Scale 1:25

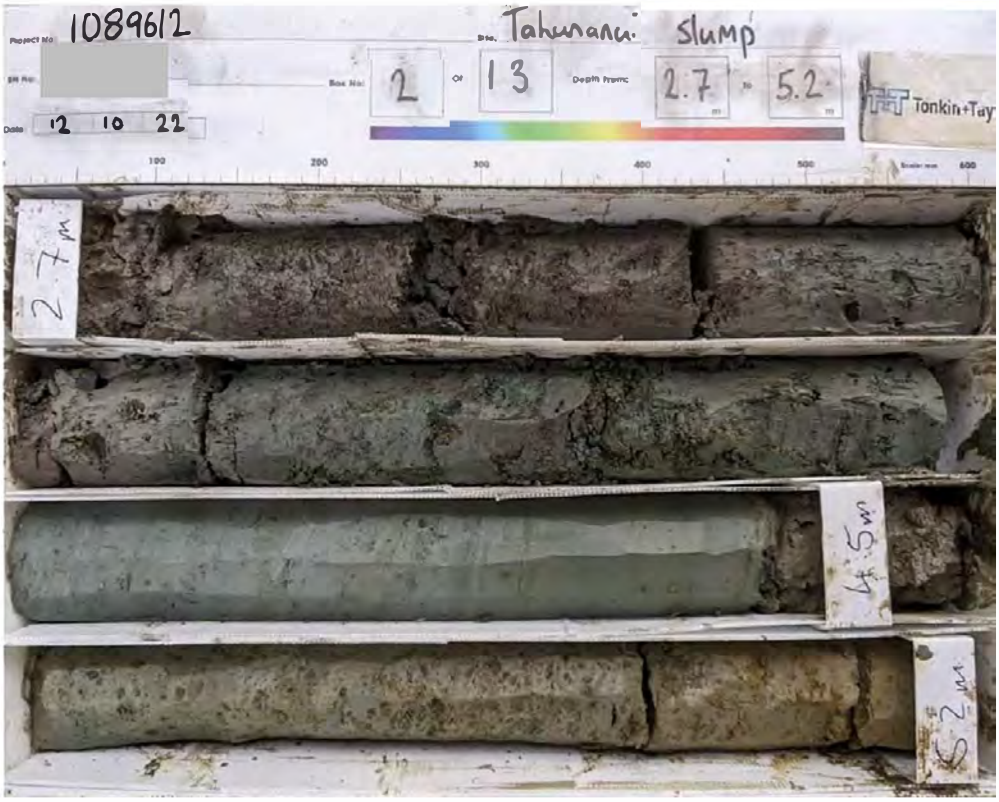
Rev.: A

CORE PHOTOS

BOREHOLE No. [redacted]

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted] R.L.: 31.32m DATUM NZVD2016	DRILL TYPE: SLG Rotary DRILL METHOD: RC	HOLE STARTED: 07/10/2022 HOLE FINISHED: 12/10/2022 DRILLED BY: ProDrill LOGGED BY: s9(2)(a) [redacted] CHECKED: s9(2)(a)

0.00-2.70m



2.70-5.20m

CORE PHOTOS

Tonkin+Taylor

BOREHOLE No. [redacted]

SHEET: 2 OF 7

PROJECT: Tahunanui Slump		LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	[redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 07/10/2022
			HOLE FINISHED: 12/10/2022
R.L.:	31.32m	DRILL METHOD: RC	DRILLED BY: ProDrill
DATUM	NZVD2016		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

5.20-7.50m

7.50-9.50m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No. [redacted]

SHEET: 3 OF 7

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 07/10/2022
R.L.: 31.32m	DRILL METHOD: RC	HOLE FINISHED: 12/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

9.50-11.60m

11.60-13.65m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) R.L.: 31.32m DATUM NZVD2016	DRILL TYPE: SLG Rotary DRILL METHOD: RC	HOLE STARTED: 07/10/2022 HOLE FINISHED: 12/10/2022 DRILLED BY: ProDrill LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

13.65-16.10m

16.10-18.35m

Tonkin+Taylor

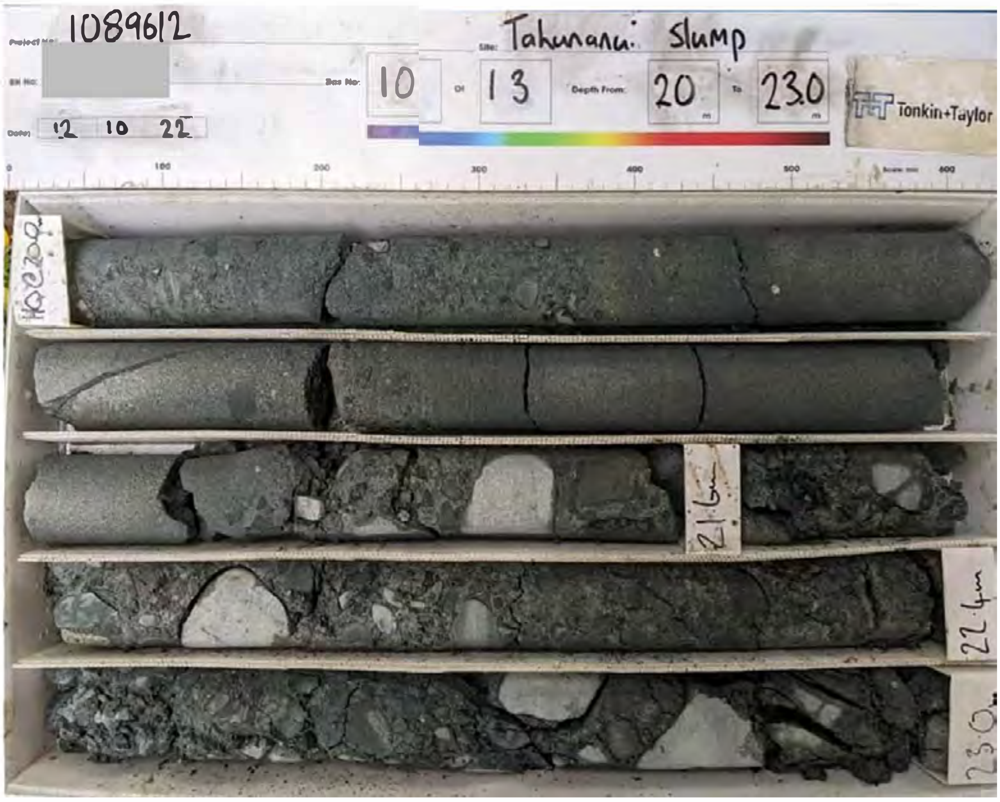
CORE PHOTOS

BOREHOLE No.

SHEET: 5 OF 7

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) R.L.: 31.32m DATUM NZVD2016	DRILL TYPE: SLG Rotary DRILL METHOD: RC	HOLE STARTED: 07/10/2022 HOLE FINISHED: 12/10/2022 DRILLED BY: ProDrill LOGGED BY: s9(2)(a) CHECKED: s9(2)(a

18.35-20.00m



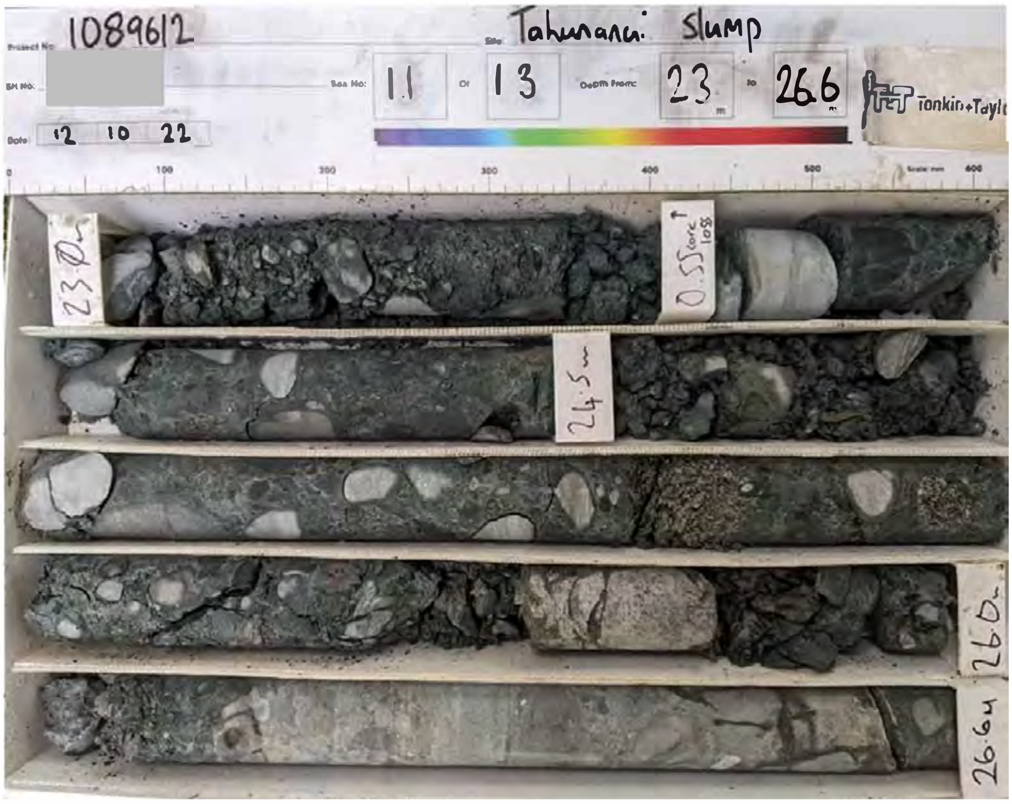
20.00-23.00m

CORE PHOTOS

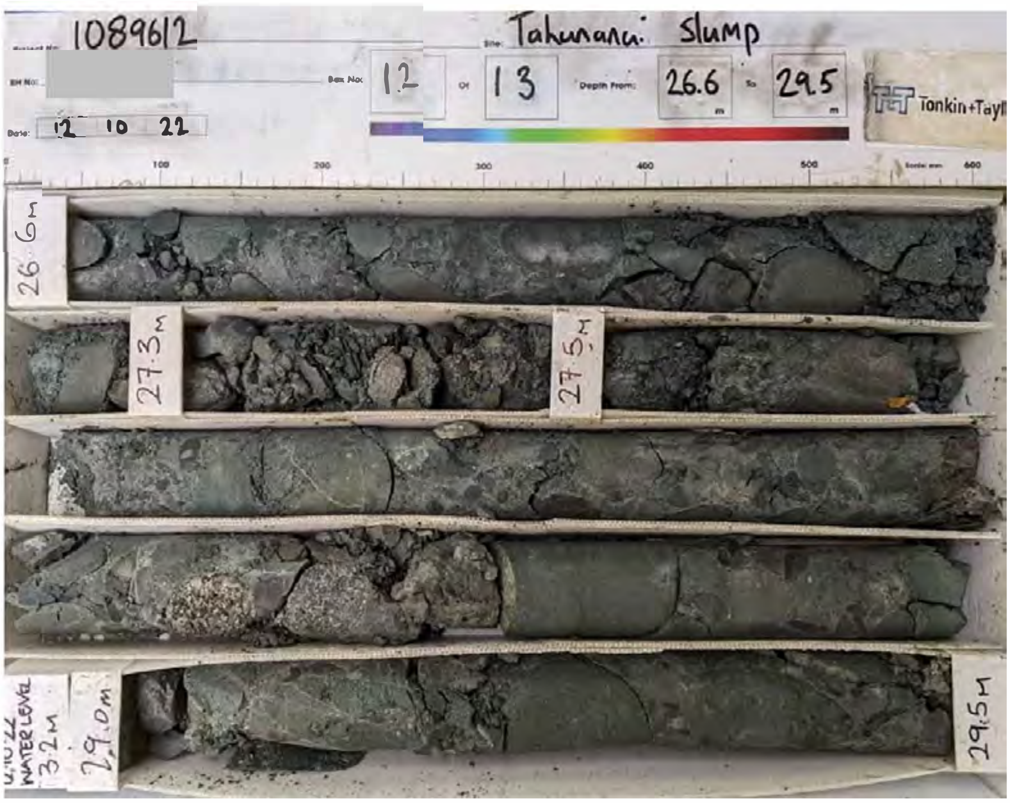
BOREHOLE No.

SHEET: 6 OF 7

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) R.L.: 31.32m DATUM NZVD2016	DRILL TYPE: SLG Rotary DRILL METHOD: RC	HOLE STARTED: 07/10/2022 HOLE FINISHED: 12/10/2022 DRILLED BY: ProDrill LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)



23.00-26.60m



26.60-29.50m

Tonkin+Taylor

CORE PHOTOS

BOREHOLE No. [redacted]

SHEET: 7 OF 7

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000) [redacted]	DRILL TYPE: SLG Rotary	HOLE STARTED: 07/10/2022
R.L.: 31.32m	DRILL METHOD: RC	HOLE FINISHED: 12/10/2022
DATUM NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

29.50-30.00m

EXCAVATION LOG

Tonkin+Taylor

Excavation Id.:

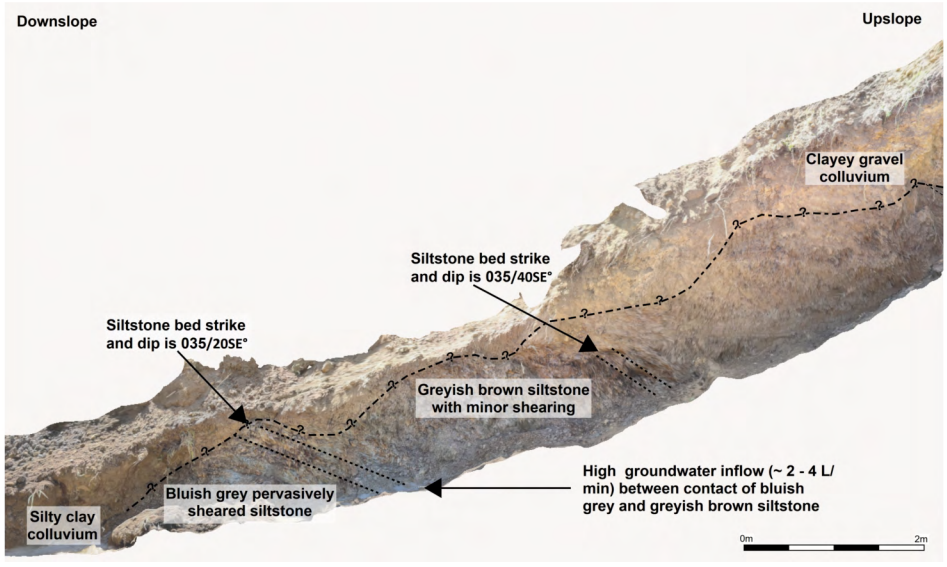
SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson		JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	EXPOSURE METHOD: TP	EXCAV. STARTED: 08/11/2022	
	EQUIPMENT:	EXCAV. FINISHED: 08/11/2022	
R.L.: 60.10m	OPERATOR: s9(2)(a)	LOGGED BY: s9(2)(a)	
DATUM: NZVD2016	D MENSIONS: 15m by 1m	CHECKED BY:	

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
1 2 3	None		2 - 4 L/min		60 59 58 57	0.5 1.0 1.5 2.0 2.5 3.0 3.5		*0.00m:* Silty CLAY, minor gravel; orange brownish grey. Soft to firm, wet, high plasticity. Gravel, fine to coarse, sub-angular to angular, mudstone. *1.65m:* Gravelly CLAY; bluish grey. Soft, saturated, high plasticity. Gravel, fine to coarse, angular, mudstone. Pervasively sheared. (Completely weathered mudstone. Extremely weak). 2.25m: END OF INVESTIGATION	W S	S-F S	10 25 50 100 200	*0.0 - 2.6m:* The soil profile provided in the engineering description column represents the downslope end of the test pit. The upslope end of the test pit is summarised below. *0.0 - 1.6m:* Clayey fine to coarse GRAVEL and minor cobbles; yellowish brown. Tightly packed, moist, well graded. (shallow landslip deposits) *1.65 - 2.6m:* Silty fine to coarse GRAVEL; dark brown with red mottles. Tightly packed, moist, gap graded. Gravel, angular, sheared mudstone. (Highly weathe ed mudstone. Extremely weak)	Shallow Landslip Deposits Tahunanui Slump Lands p Deposi ts

SKETCH / PHOTO:



COMMENTS: 1. Sheared siltstone striking at approximately 035° and dipping upslope (south-east) between 20° and 40°. 2. High groundwater flows, in the order of 2 – 4 L/m, were encountered along the contact between the greyish brown siltstone and the underlying bluish grey pervasively sheared siltstone.

Hole Depth 2.25m

Scale 1:33

Rev.: A

EXCAVATION LOG

Excavation Id.:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump | LOCATION: Tahunanui, Nelson | JOB No.: 1089612.0000

CO-ORDINATES: (NZTM2000)

R.L.: 50.70m

DATUM: NZVD2016

EXPOSURE METHOD: TP

EQUIPMENT:

OPERATOR: s9(2)(a)

D MENSIONS: 2m by 1m

EXCAV. STARTED: 08/11/2022

EXCAV. FINISHED: 08/11/2022

LOGGED BY: s9(2)(a)

CHECKED BY:

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE \ WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
1 2 3					50	0.5		*0.00m:* Clayey SILT, some gravel, minor organics; greyish brown. Soft to firm, moist, low to medium plasticity. Gravel, fine to coarse, sub-angular to angular, mudstone; organics, roots greater than 2mm diameter.	M	S-F	10 25 50 100 200		Fill
	None				49	1.0							
						1.5							
						2.0		*1.80m:* CLAY; orange brown with grey streaks. Soft to firm, wet, high plasticity.	W				Shallow Landslip Deposits
			0.1 - 0.2 L/min		48	2.5		*2.50m:* Clayey sandy fine to coarse GRAVEL, minor silt; greenish grey. Loosely packed, saturated, uniformly graded. Gravel, rounded to sub-rounded, mudstone and sandstone; sand, fine to coarse.	S				
						3.0							
					47	3.5		3.5m: END OF INVESTIGATION					

SKETCH / PHOTO:

COMMENTS: 1. Minor groundwater seepage at 2.5 mbgl, along the contact between the clay and underlying clayey gravel.

Hole Depth 3.5m

Scale 1:33

Rev.: A

EXCAVATION LOG

Tonkin+Taylor

Excavation Id.:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	EXPOSURE METHOD: TP	EXCAV. STARTED: 08/11/2022
	EQUIPMENT:	EXCAV. FINISHED: 08/11/2022
R.L.: 43.00m	OPERATOR: s9(2)(a)	LOGGED BY: s9(2)(a)
DATUM: NZVD2016	D MENSIONS: 2m by 1.5m	CHECKED BY:

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
1 2 3	None	DRY 08/11/2022			42	0.5 1.0 1.5		*0.00m:* Silty fine to coarse GRAVEL; greyish brown. Very stiff to hard, dry, gap graded. Gravel, angular, mudstone. Pervasively sheared.	D		10 25 50 100 200		Tahunanui Slump Landslip Deposits
					41 40	2.0 2.5 3.0 3.5		1.8m: END OF INVESTIGATION					

SKETCH / PHOTO:

COMMENTS: 1. Sheared siltstone striking at approximately 050° and dipping upslope (south-east) at 30°

Hole Depth 1.8m

Scale 1:33

Rev.: A

HAND AUGER LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: 5430350 mN (NZTM2000) 1621306 mE	DRILL TYPE:	HOLE STARTED: 20/10/2022
	DRILL METHOD: HA+DCP	HOLE FINISHED: 20/10/2022
R.L.: 18.92m		DRILLED BY: T+T
DATUM: NZVD2016		LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	WATER	CORE RECOVERY (%)	METHOD	SCALA PENETROMETER (Blows/50mm) 0 1 2 3 4 5 6 7 8 9	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	Description and Additional Observations
Tahunanui Slump Landslip Deposits				1 2 3 / 1 2 / 1 / 1 / 1 2 / 1 2 / 1 / 1 2 3 / 1 2 / 1 3 3 / 2 3 / 2 3 / 2 2 2 2 / 3 3 3 / 2 3 3 3 / 4 3 4 / 2 4 4 / 30 >> / 15 >>			18 17	0 5 1 0 1 5 2 0	TS	M			*0.00m:* SILT, minor sand, trace rootlets and brick fragments; brown. Moist, low plasticity. Sand, fine. *0.30m:* SILT, some clay, trace organics, trace charcoal; pale brown. Firm to stiff, moist, low plas icity. *1.60m:* With gravel, fine to medium and subangular, becomes brown mottled yellow. *1.90m:* Trace gravel.
							16 15 14	2 5 3 0 3 5 4 0 4 5					2.2m: Refusal

COMMENTS:

Hole Depth 2.2m

Scale 1:25

Rev.: A

HAND AUGER LOG

HOLE Id: **HA02_SC11**

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 20/10/2022
	DRILL METHOD: HA+DCP	HOLE FINISHED: 20/10/2022
R.L.: 64.68m		DRILLED BY: T+T
DATUM: NZVD2016		LOGGED BY s9(2)(a) CHECKED s9(2)(a)

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	Description and Additional Observations
Tahunanui Slump Landslip Deposits	*0.00m:* Gravelly SILT, some clay; brown. Stiff to very stiff, dry, non-plastic to low plasticity. Gravel, fine grading to coarse, rounded to angular.
	0.35m: Becomes moist.
	0.40m: Sandy SILT, some clay and some gravel; greyish brown. Firm, moist. Gravel, fine grading to medium, rounded to angular.
	0.71m: Refusal

COMMENTS:

Hole Depth 0.71m

Scale 1:25

Rev.: A

Tonkin+Taylor

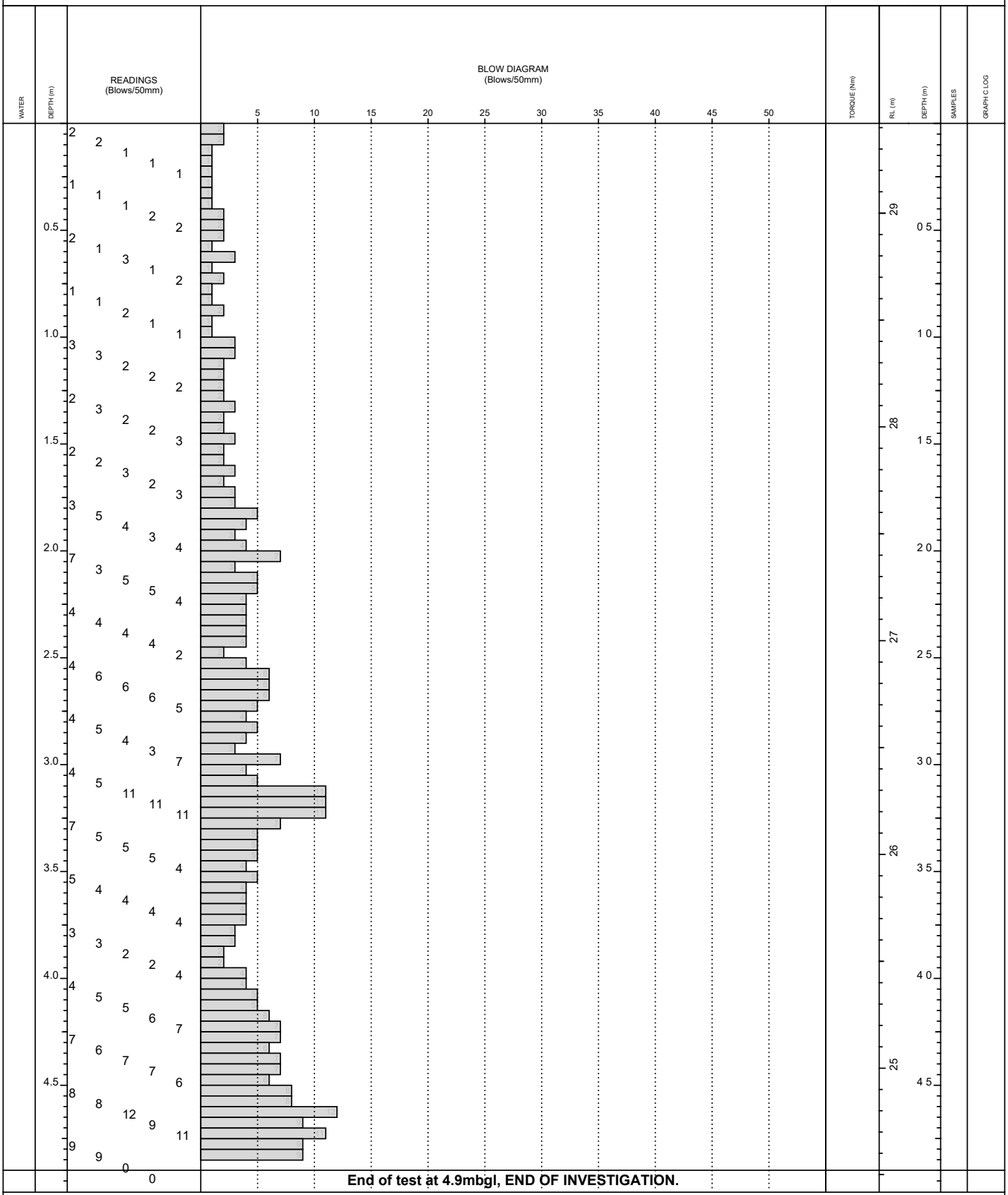
DYNAMIC PROBE LOG

HOLE Id

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 20/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 20/10/2022
R.L.: 29.42m	TEST TYPE:	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: Hammer Drop: Cone Angle: Anvil: Damper:



COMMENTS:

Hole Depth 4.9m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:06:34 am - Produced with Core-GS by GeRoc

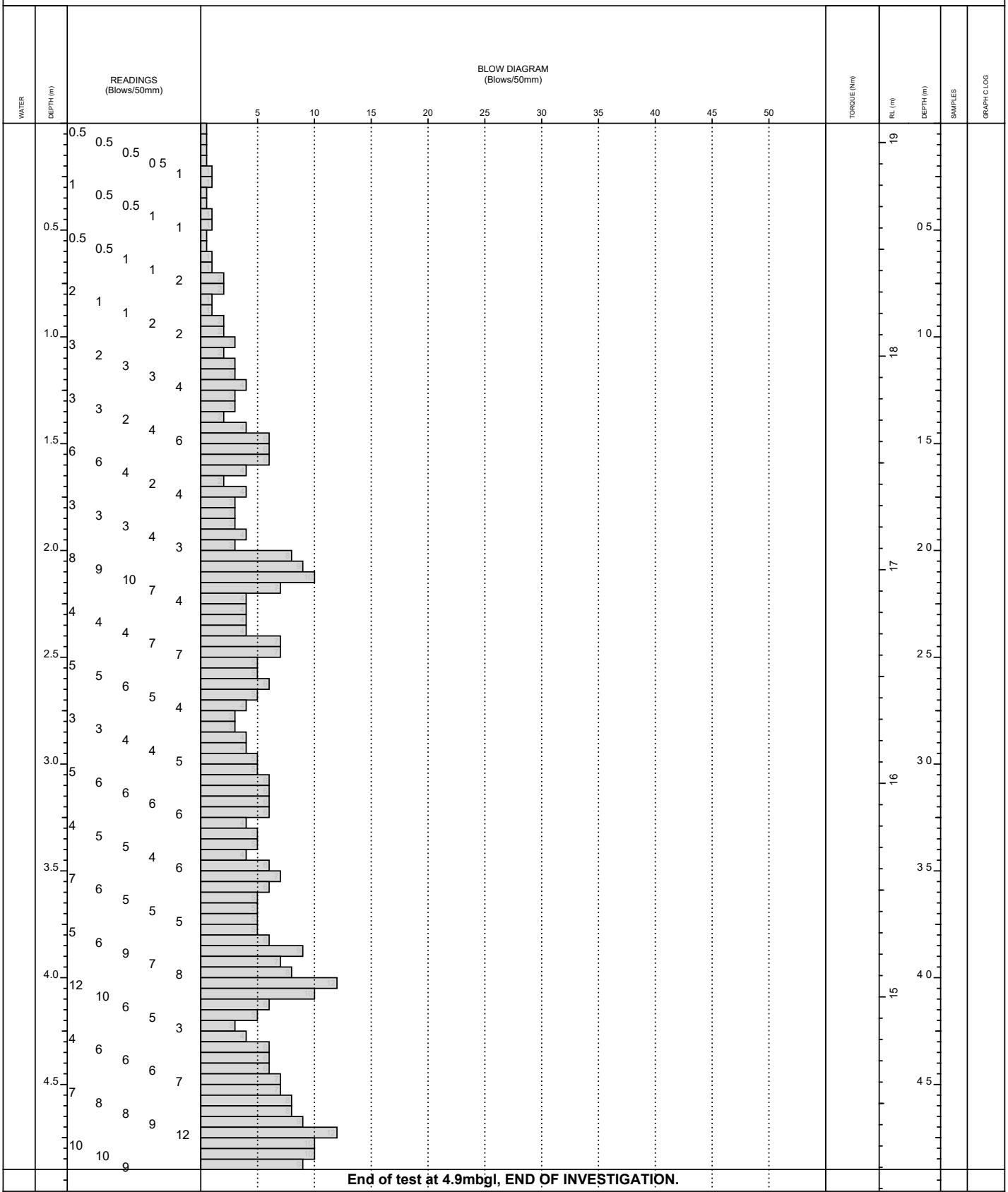
DYNAMIC PROBE LOG

HOLE Id

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 20/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 20/10/2022
R.L.: 19.09m	TEST TYPE:	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 4.9m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:06:39 am - Produced with Core-GS by GeRoc

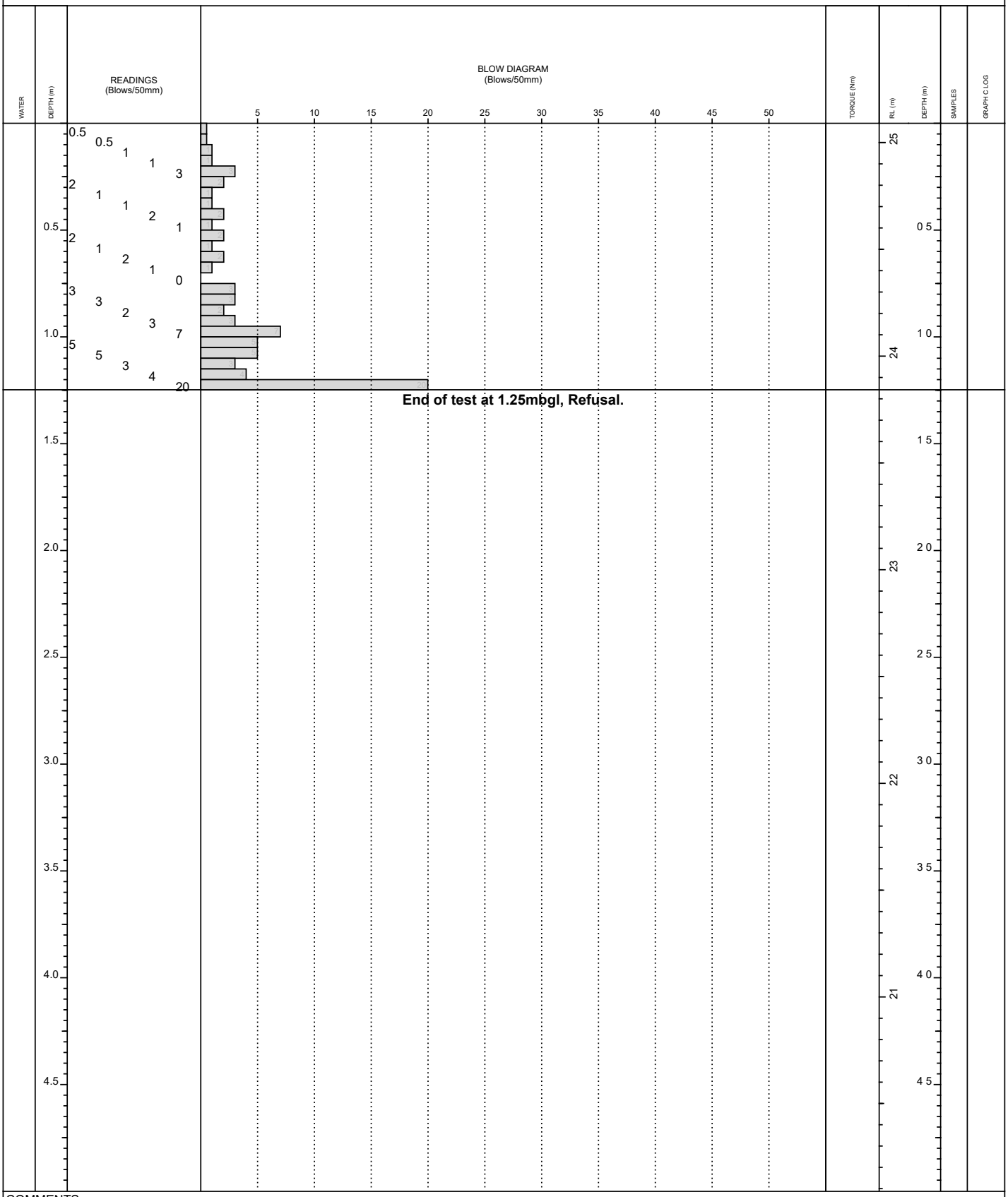
DYNAMIC PROBE LOG

HOLE Id

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 20/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 20/10/2022
R.L.: 25.09m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 1.25m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:06:45 am - Produced with Core-GS by GeRoc

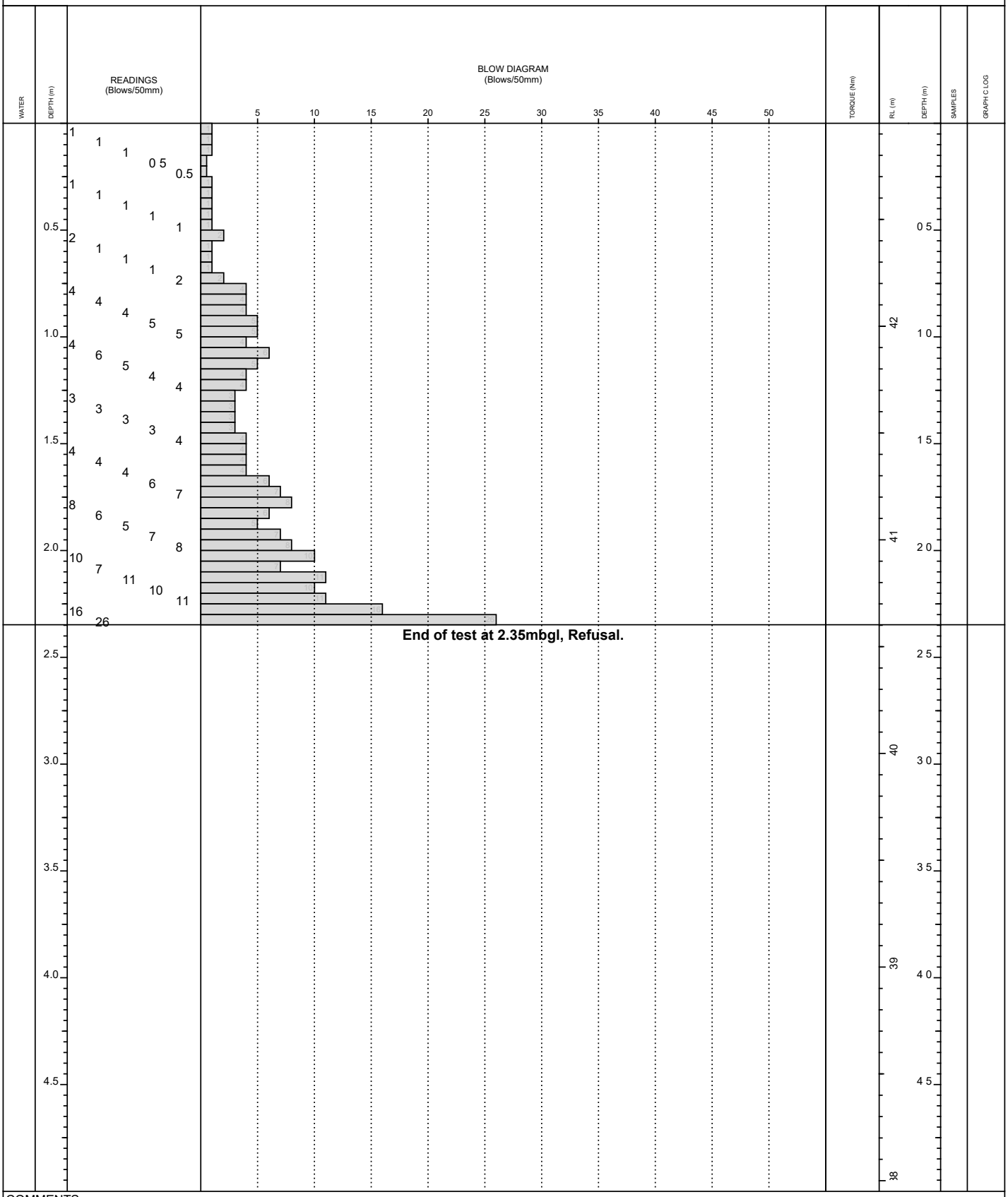
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 21/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 21/10/2022
R.L.: 42.95m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



End of test at 2.35mbgl, Refusal.

COMMENTS:

Hole Depth 2.35m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:06:51 am - Produced with Core-GS by GeRoc

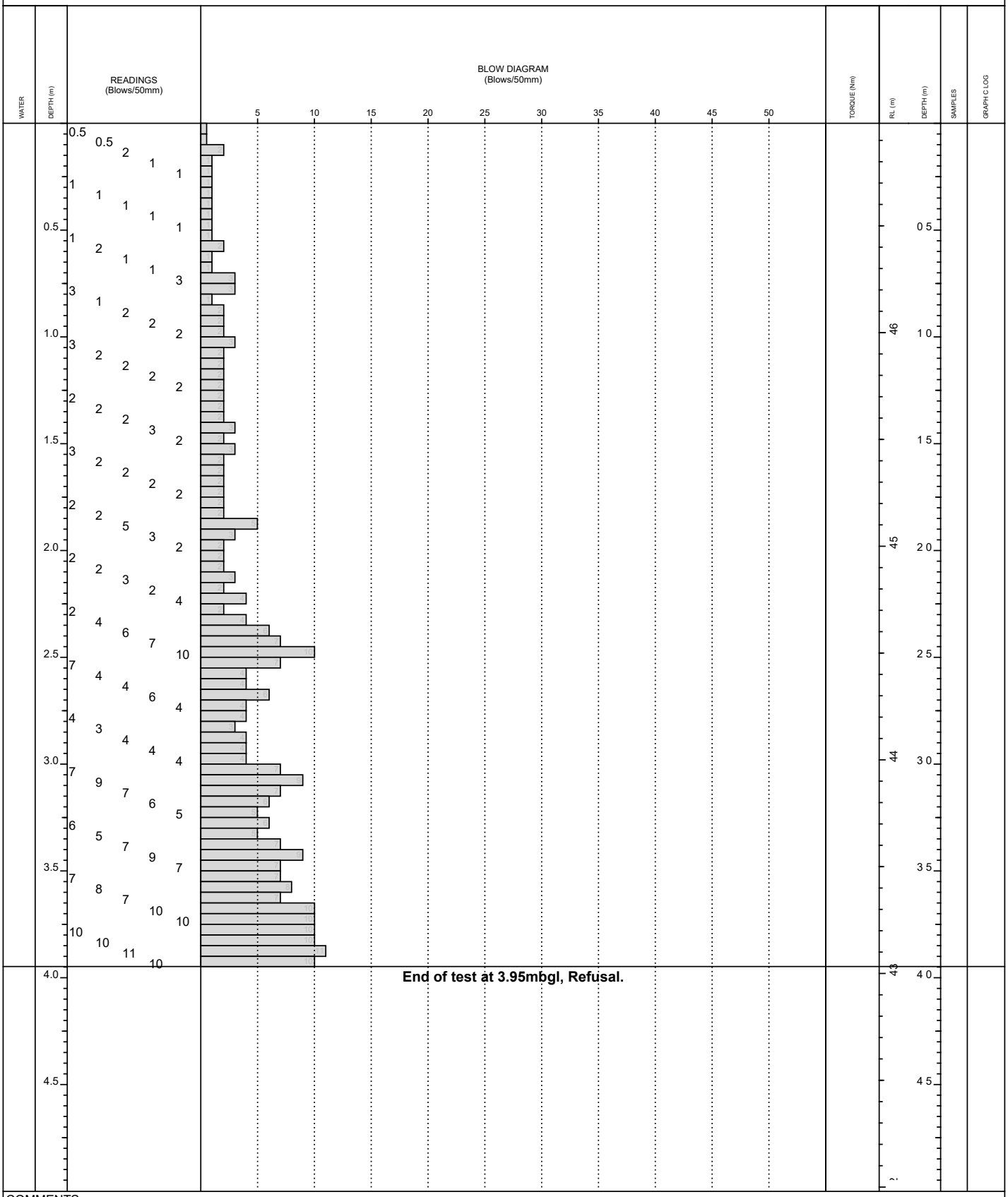
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 19/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 19/10/2022
R.L.: 46.98m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 3.95m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:06:56 am - Produced with Core-GS by GeRoc

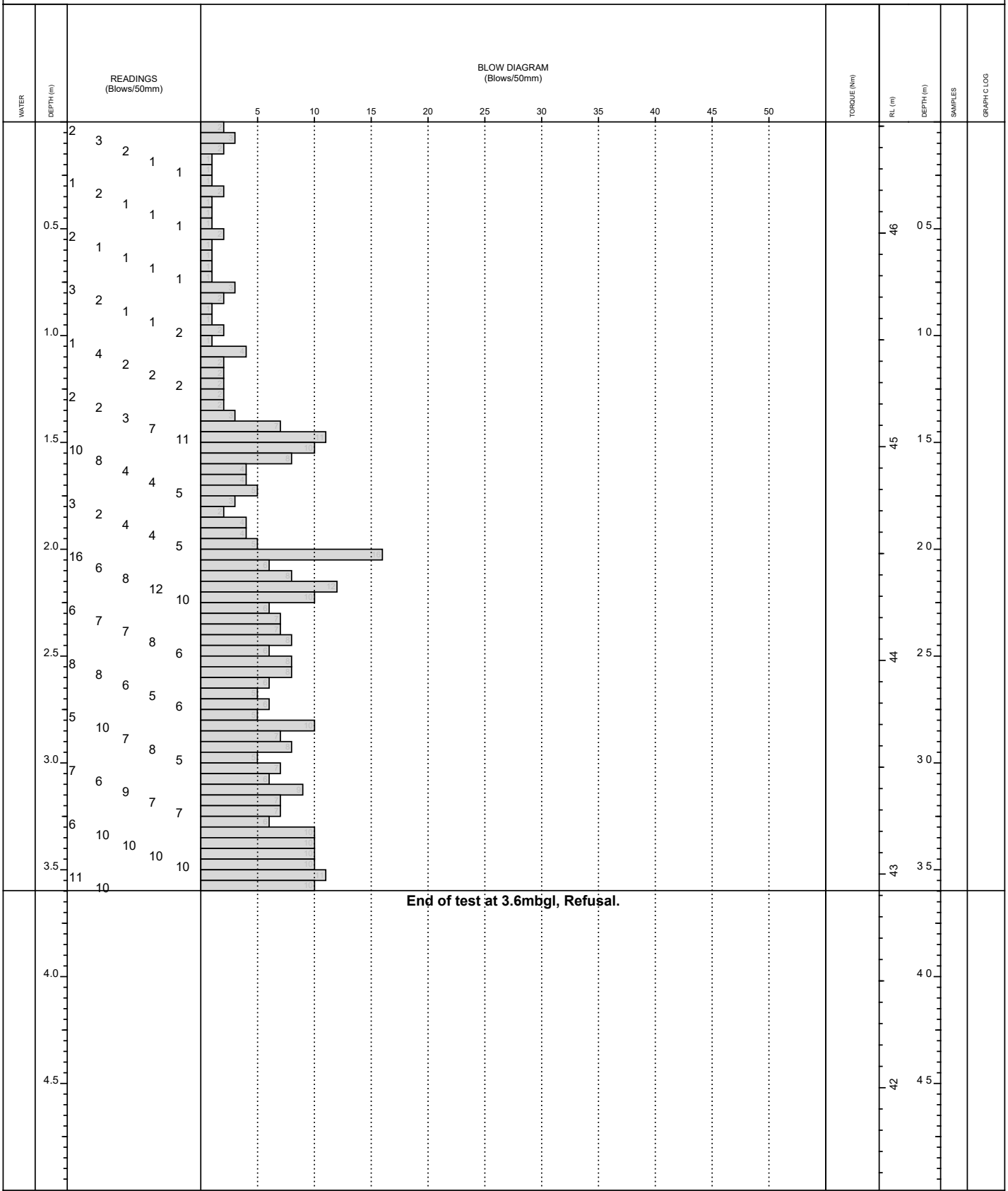
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 19/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 19/10/2022
R.L.: 46.52m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



End of test at 3.6mbgl, Refusal.

COMMENTS:

Hole Depth 3.6m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:03 am - Produced with Core-GS by GeRoc

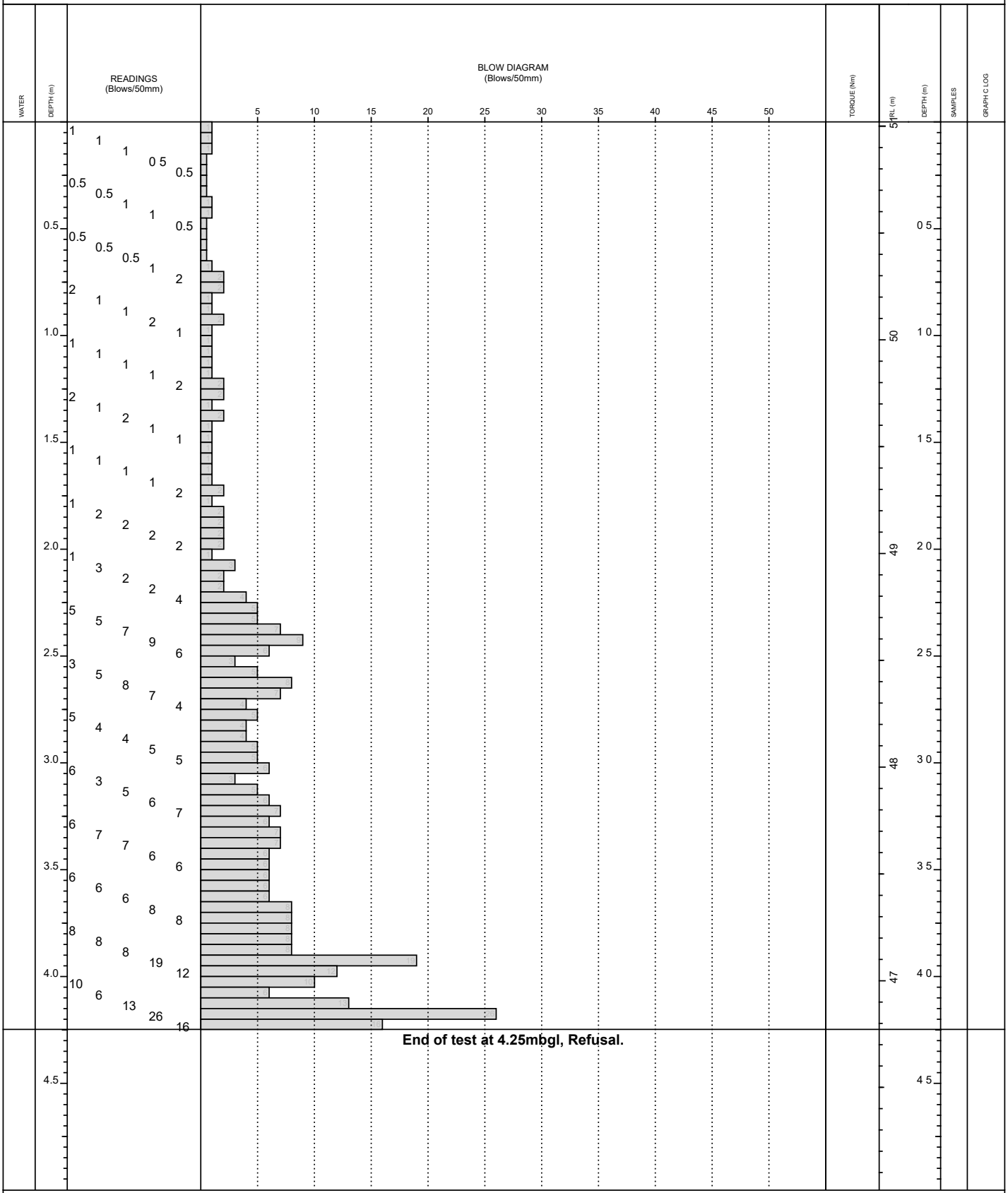
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 19/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 19/10/2022
R.L.: 51.02m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY s9(2)(a) CHECKED s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 4.25m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:12 am - Produced with Core-GS by GeRoc

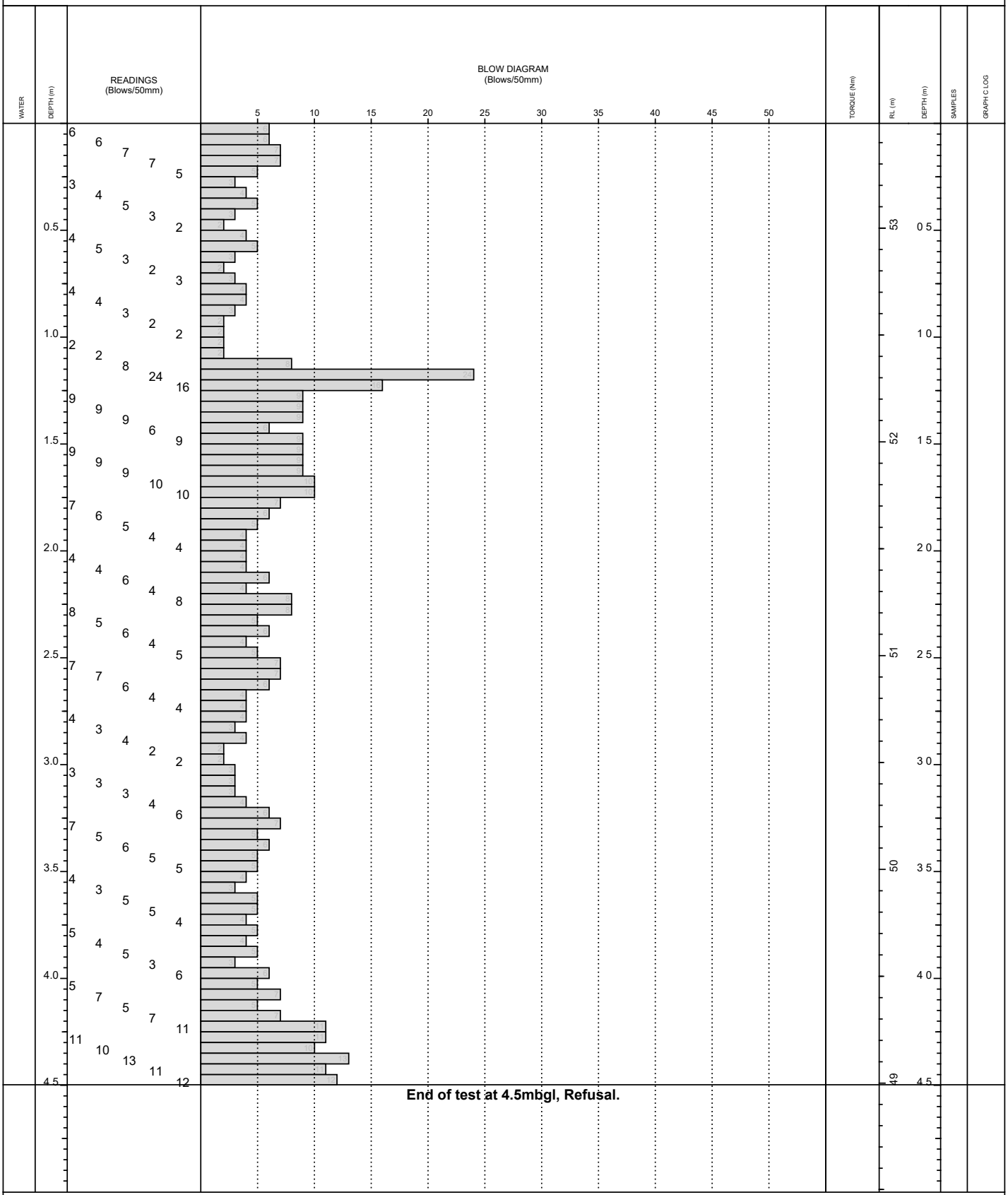
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 19/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 19/10/2022
R.L.: 53.49m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 4.5m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:17 am - Produced with Core-GS by GeRoc

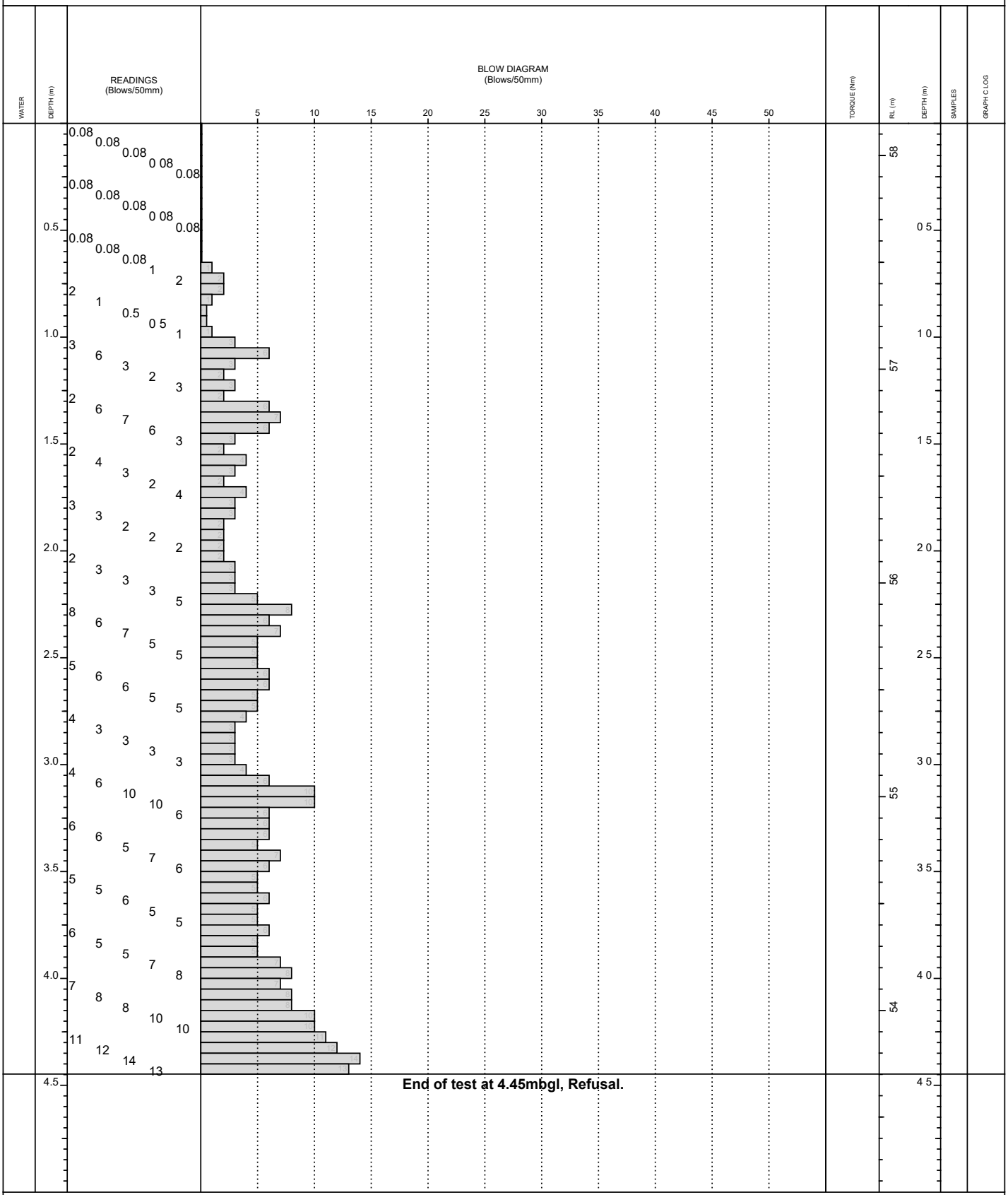
DYNAMIC PROBE LOG

HOLE Id

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 19/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 19/10/2022
R.L.: 58.15m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 4.45m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:24 am - Produced with Core-GS by GeRoc

Tonkin+Taylor

DRAFT
This data has not been fully reviewed. It may be subject to change.

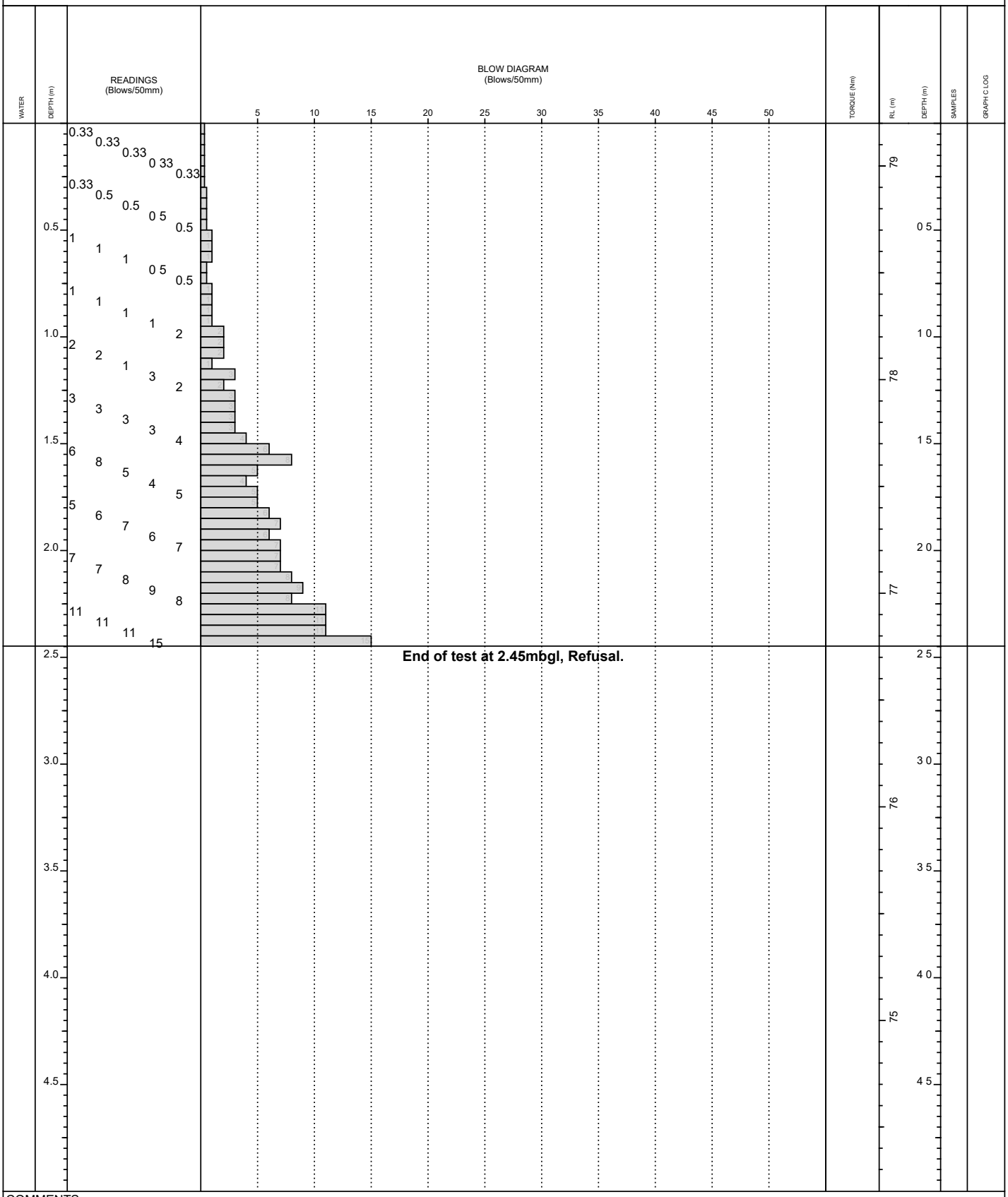
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 20/10/2022
	DRILL METHOD: DCP	HOLE FINISHED: 20/10/2022
R.L.: 79.20m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 2.45m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:27 am - Produced with Core-GS by GeRoc

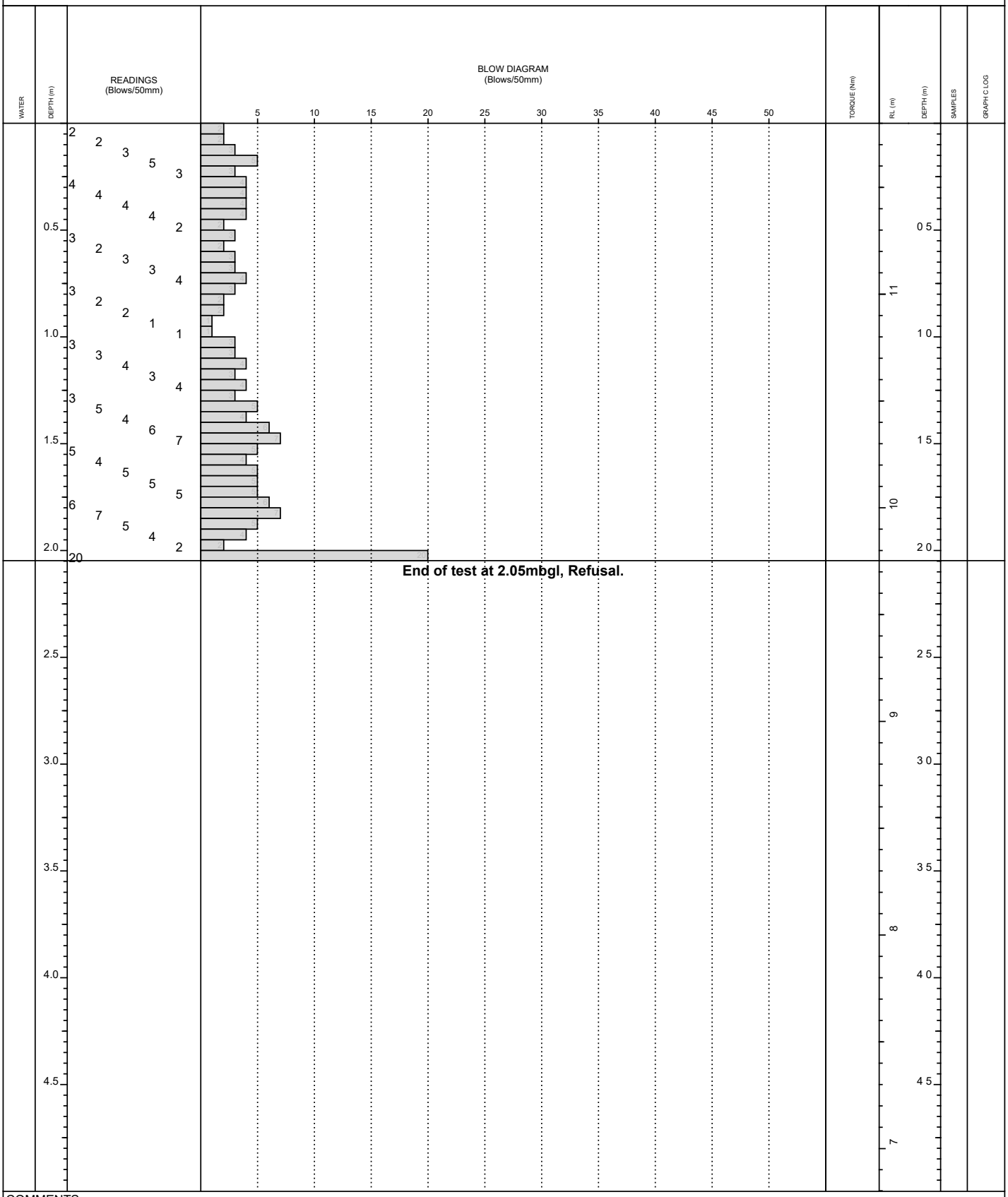
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 11.80m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



End of test at 2.05mbgl, Refusal.

COMMENTS:

Hole Depth 2.05m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:31 am - Produced with Core-GS by GeRoc

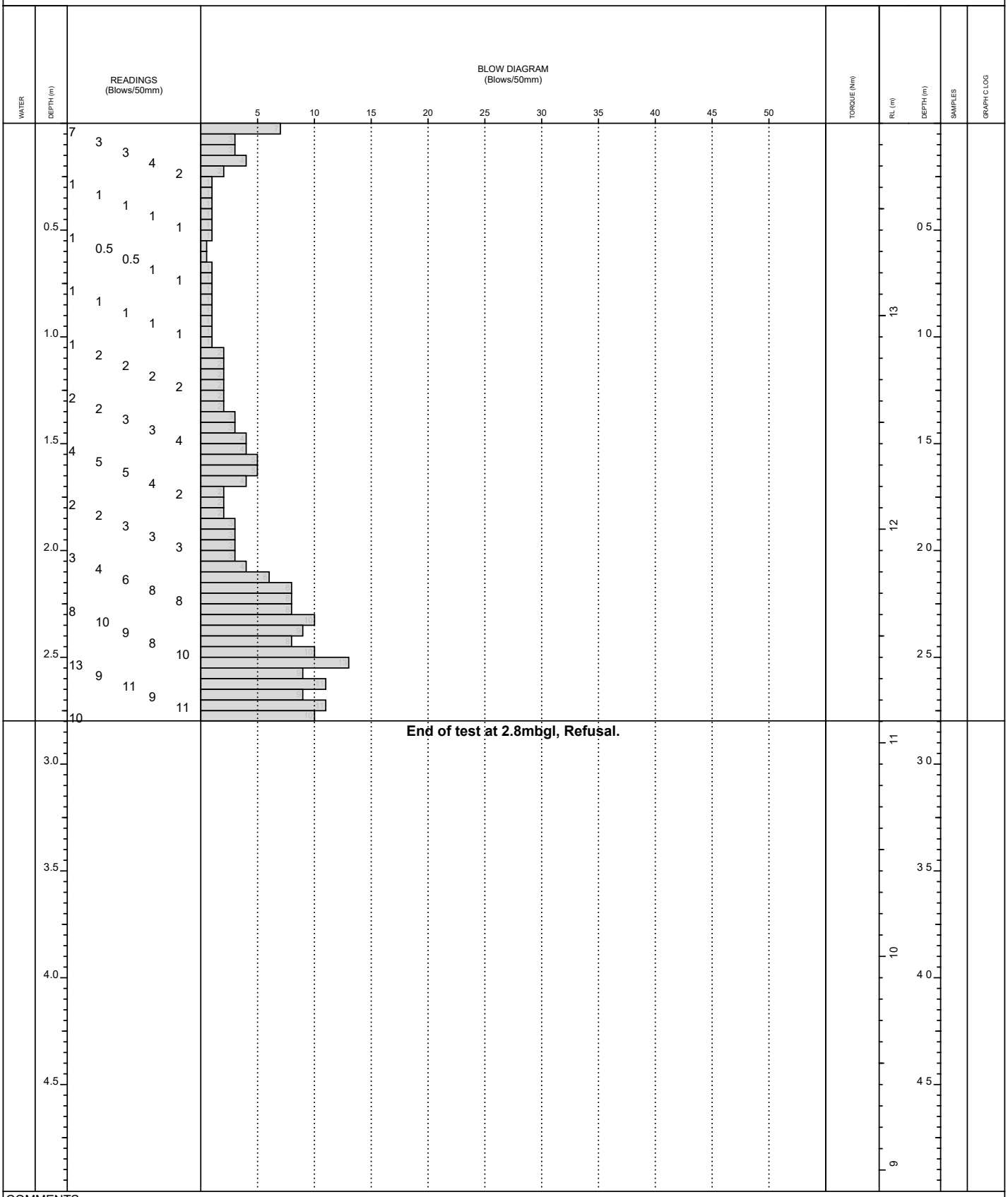
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 13.90m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



End of test at 2.8mbgl, Refusal.

COMMENTS:

Hole Depth 2.8m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:35 am - Produced with Core-GS by GeRoc

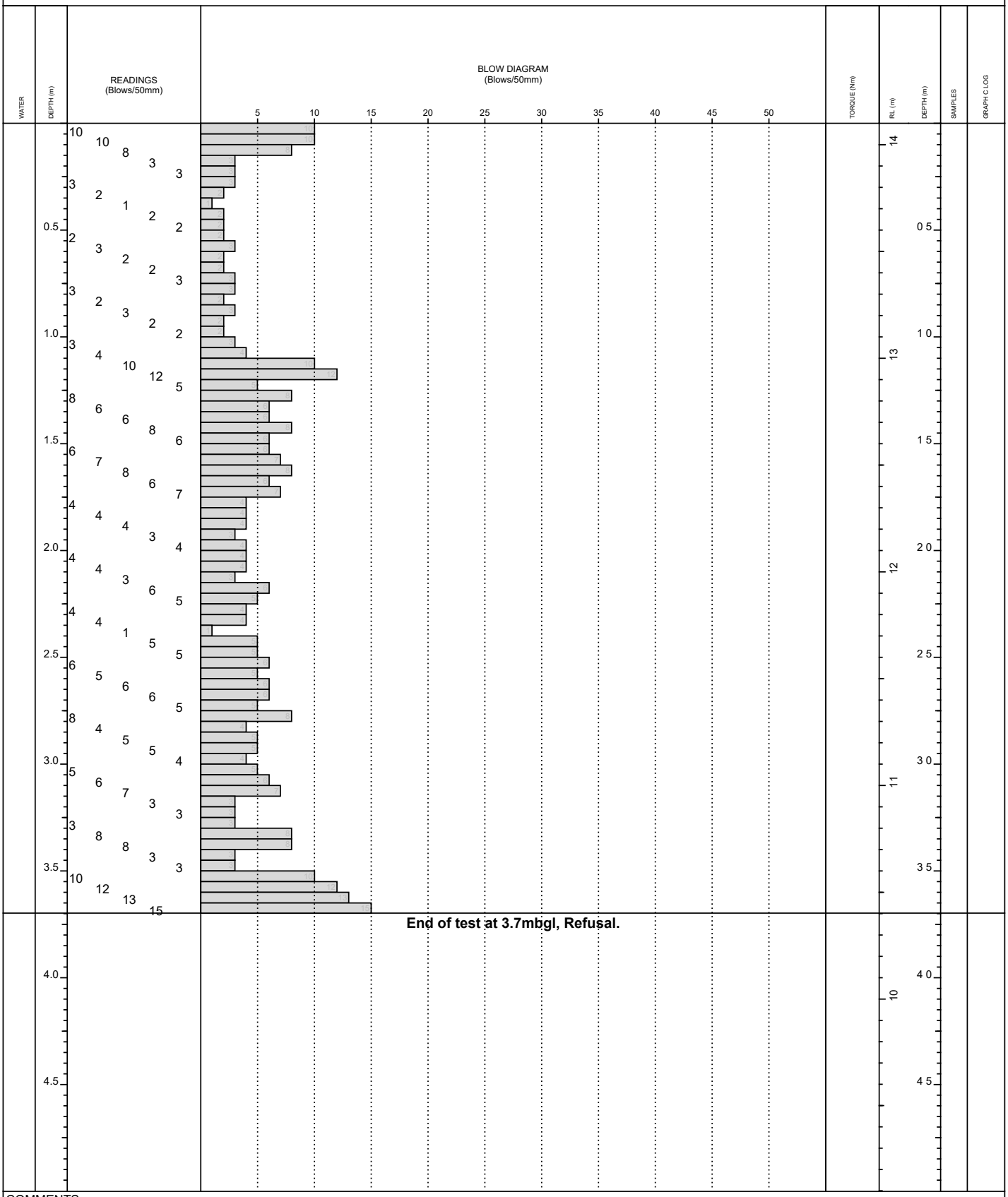
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 14.10m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 3.7m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:38 am - Produced with Core-GS by GeRoc

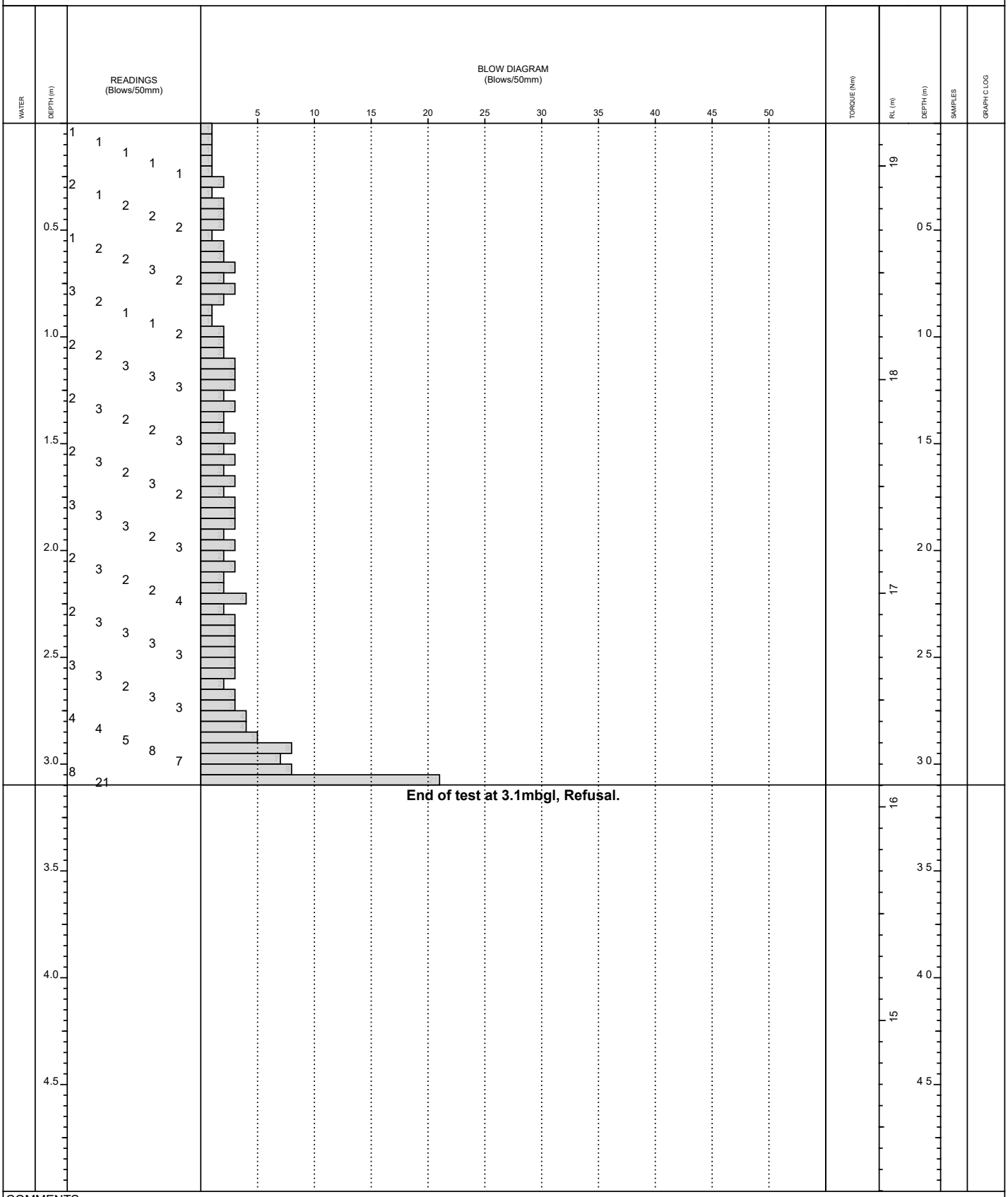
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 19.20m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY s9(2)(a) CHECKED s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 3.1m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:42 am - Produced with Core-GS by GeRoc

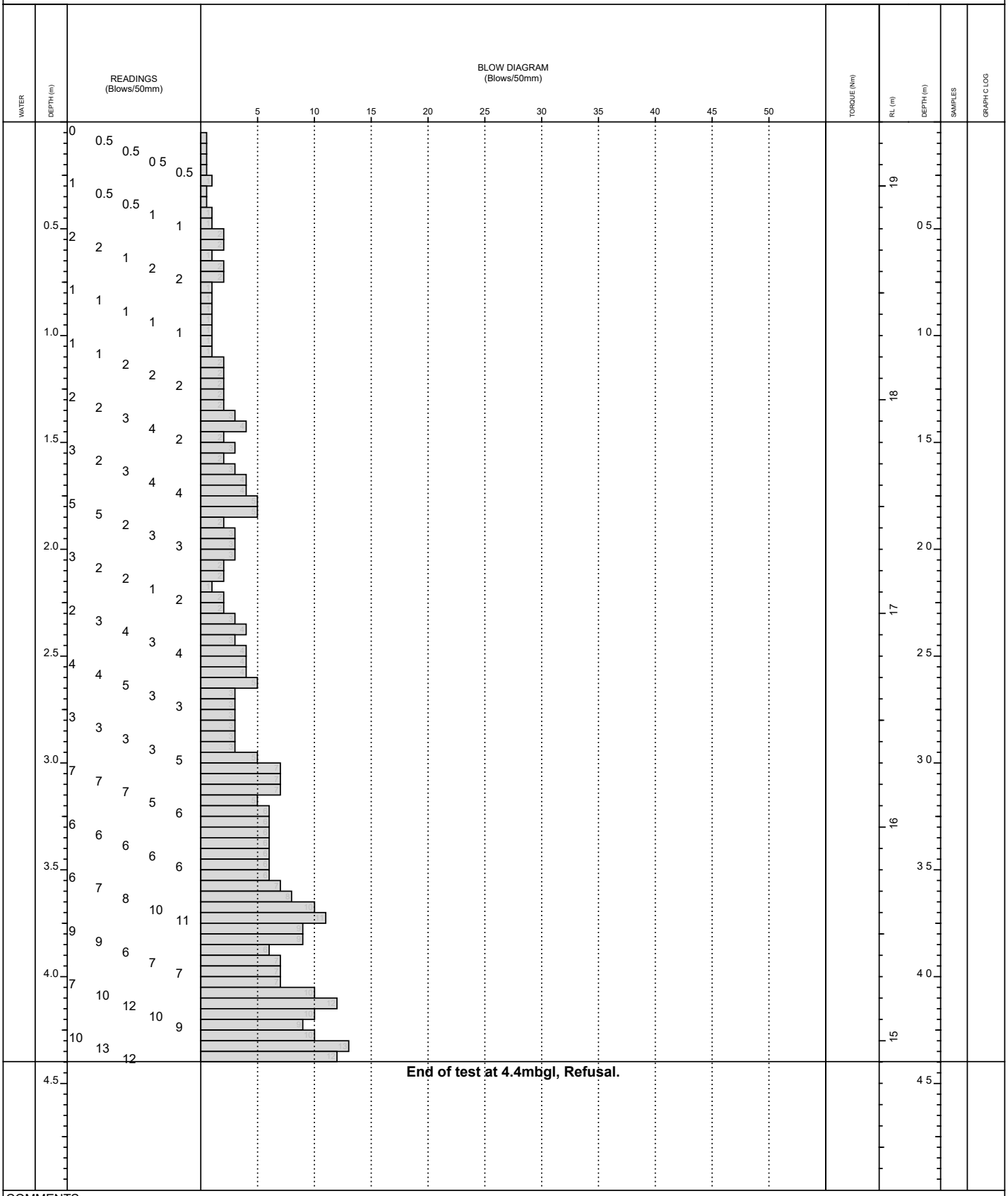
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 19.30m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 4.4m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:46 am - Produced with Core-GS by GeRoc

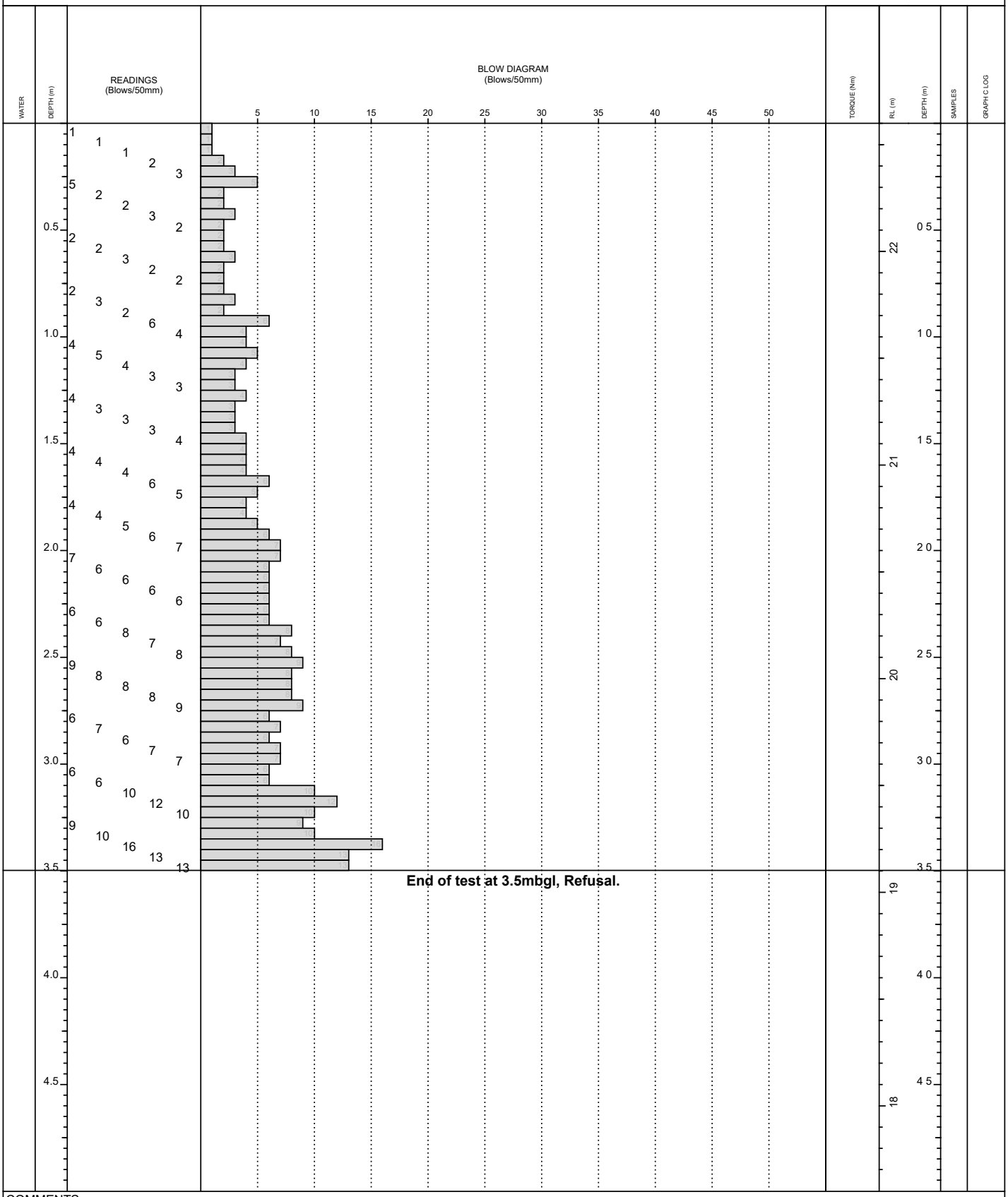
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 22.60m	TEST TYPE:	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 3.5m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:49 am - Produced with Core-GS by GeRoc

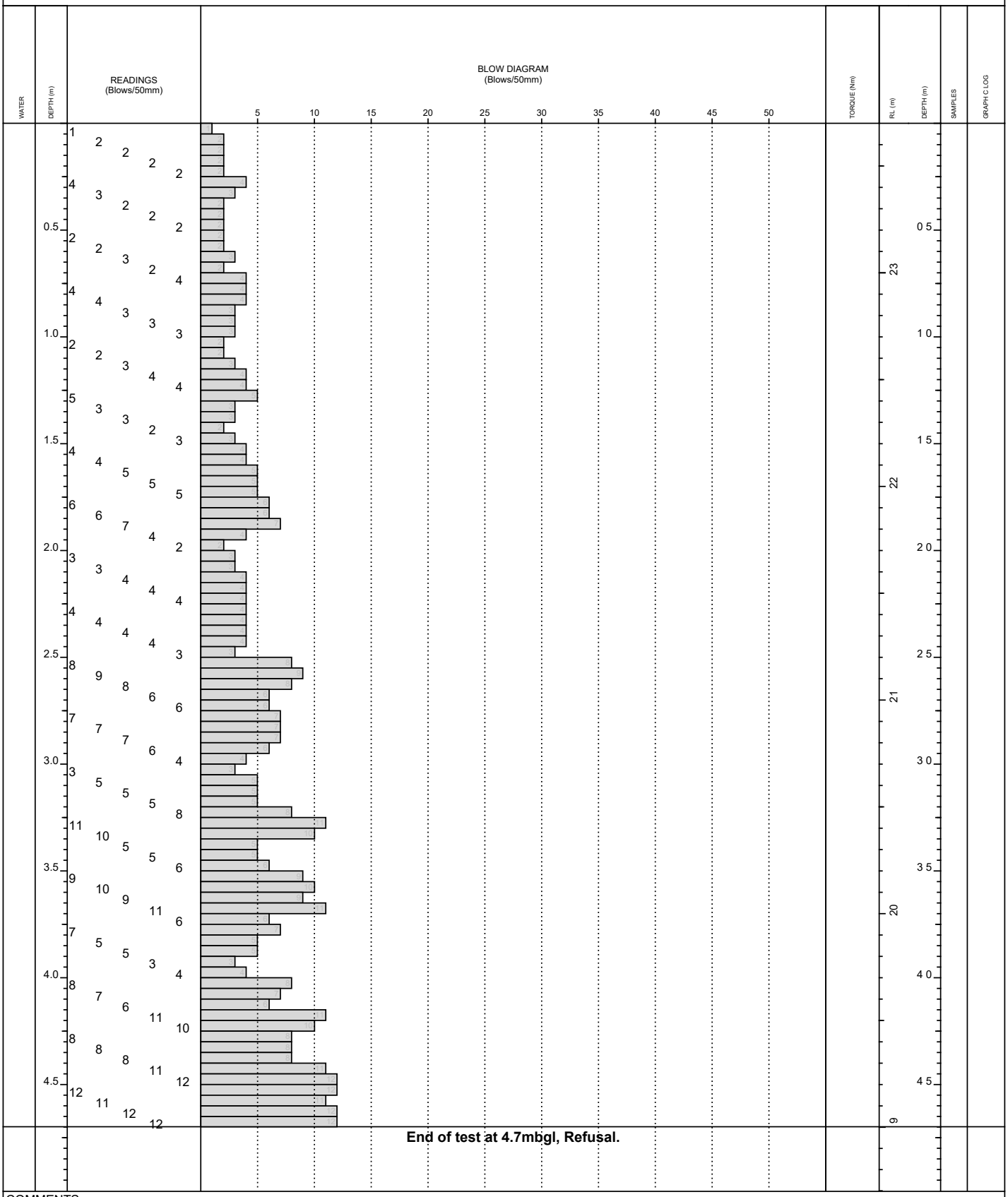
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 23.70m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



End of test at 4.7mbgl, Refusal.

COMMENTS:

Hole Depth 4.7m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:52 am - Produced with Core-GS by GeRoc

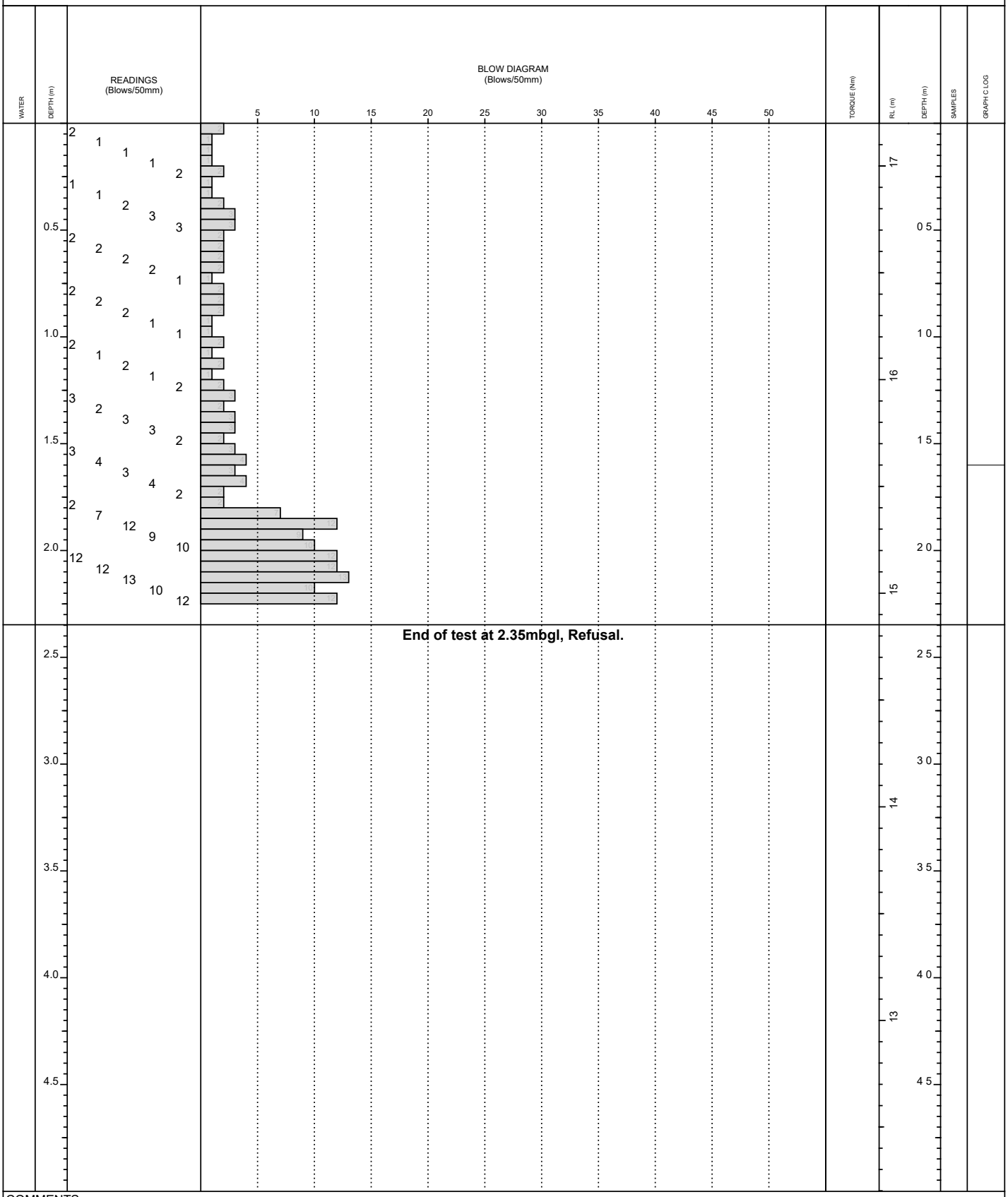
DYNAMIC PROBE LOG

HOLE Id

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 17.20m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



COMMENTS:

Hole Depth 2.35m

Scale 1:25

Rev.: A

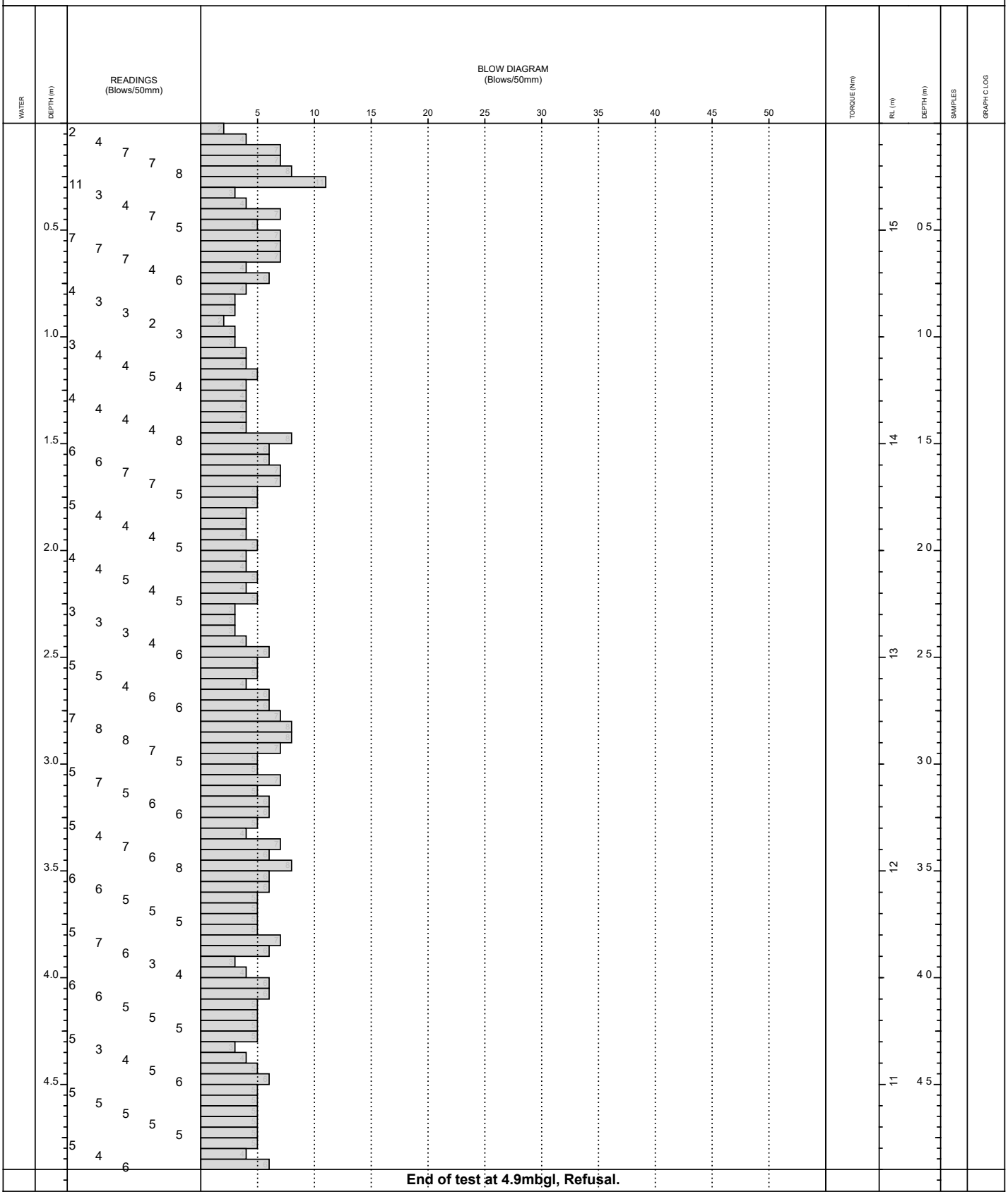
DYNAMIC PROBE LOG

HOLE Id:

SHEET: 1 OF 1

PROJECT: Tahunanui Slump	LOCATION: Tahunanui, Nelson	JOB No.: 1089612.0000
CO-ORDINATES: (NZTM2000)	DRILL TYPE:	HOLE STARTED: 16/11/2022
	DRILL METHOD: DCP	HOLE FINISHED: 16/11/2022
R.L.: 15.50m	TEST TYPE: SC	DRILLED BY: T+T
DATUM: NZVD2016	PREDRILL DEPTH:	LOGGED BY: s9(2)(a) CHECKED: s9(2)(a)

Hammer Mass: 9.02kg | Hammer Drop: | Cone Angle: | Anvil: | Damper:



End of test at 4.9mbgl, Refusal.

COMMENTS:

Hole Depth 4.9m

Scale 1:25

Rev.: A

DynamicProbeLog-v20 - 21/04/2023 4:07:59 am - Produced with Core-GS by GeRoc

TONKIN & TAYLOR LTD

BORE HOLE LOG

BOREHOLE No: [redacted]

SHEET 1 OF 1

DRILLED BY: Speight Drilling
LOGGED BY: [redacted]
CHECKED: [redacted]
START DATE: 01/05/13
FINISH DATE: 02/05/13

PROJECT: Grenville Block.
LOCATION: [redacted] Nelson
CO-ORDINATES: [redacted]

JOB No: TBA 870982.250
DIRECTION: Vertical
ANGLE FROM HORIZ.: 90°

R.L. GROUND: 96.4m
R.L. COLLAR: 96.4m
DATUM: NZGD1949

CONTRACTOR/RIG: Speight Drilling CS1000

GEOLOGICAL UNIT | DESCRIPTION OF CORE | Rock Weathering | Rock Strength | Sampling Method | Core Recovery (%) | Testing | RL (m) | Depth (m) | Graphic Log | ROCK DEFECTS & SPT's: Defect Log | Fracture Spacing (cm) | RQD % | Description | Water Loss (%) | Water Level | Casing | Installation | Core Box

SOIL: Classification, colour, consistency / density, moisture, plasticity

ROCK: Weathering, colour, fabric, name, strength, cementation, texture

Description: Type, Orientation, Spacing, Shape, Persistence, Roughness, Aperture, Weathering, Infill

0-1m (poor recovery) GRAVEL w Clayey SILT matrix, Tan Brown & Grey, Loose, moist Cdrill disturbance (G=F-C)

1-2.1m (drill disturbed) GRAVEL w minor to some clayey silt matrix, Green Grey, Loose, Wet. (G=F-m, sub-ang - sub-rounded clasts)

Change from loose gravel to SILT matrix slump material.
—?— —?— —?— —?—

2.1m Clayey SILT w minor gravel, Tan Brown, Firm, moist, low plasticity. shearing observed (Slumped unit).

2.8m Becoming SILT w some clay, Grey Brown, stiff, moist. Non-plastic, sheared, Oxidised Surfaces.

Polished Shear surfaces observed @ 3.8-4m.

Multiple polished Shear surfaces @ 4.5m

5m Clayey SILT, Low Plasticity.

6m Polished Surface

6-7m No Core Recovery - SPTs only.

7.2m Clayey SILT to Silty CLAY, Moderate Plasticity. Shearing continues to 7-7.5m. No Obvious Contact, Change from —?Soil to —?Ext. Weak —?Rock.

7.7m Becoming Hard, Becoming an Extremely Weak SILTSTONE.

7.7m-10m, Moderately Weathered, Light Grey, SILTSTONE, Ext. Weak, Ext. Closely Spaced defects. some oxidised defect surfaces, rare polished defect faces.

9-10m Very Closely Spaced Defects, Extremely Weak.

Note: Rock Mass governs strength, not defects due to closely spaced nature.

Depth (m)	Core Recovery (%)	Sampling Method
0-1	12%	
1-2	25%	HQ3
2-3	60%	SPT
3-4	40%	HQ3
4-5	50%	HQ3
5-6	67%	SPT
6-7	50%	HQ3
7-8	84%	SPT
8-9	10%	HQ3
9-10	58%	SPT
	65%	HQ
	60%	SPT
	95%	HQ3
	100%	HQ3

SPT@2m = 2, 2, 2, 2, 1, 3 n=8

C2-2.45m Core, SPT Redrill)

Shear surface plane in unit (see photos)

SPT@4m = 2, 4, 4, 5, 5, 5 n=19

36° Shear Surface

SPT@6m = 1, 2, 5, 5, 5, 7. n=22

SPT@7m = 0, 1, 2, 4, 7, 9. n=22

J70°, PL, SM, T, Fest.

SPT@8m = 2, 16, 33, 30/0x (150mm) n=50+

Polished Surfaces

7.7-9m Extremely Closely Spaced Defects - Multiple Defect Orientation, Tight, no infill. Very 9-10m Closely Spaced Defects.

J70°, UN, SM, T.

Water Loss (%): 25 50 75

Water Level: Drilling. 2.0m At End of Drilling. 4.2m - 31/05/13

Casing: BOX 1, BOX 2, BOX 3

Installation: 150mm Capt Cement. Bentonite 2m. Bentonite 7.6m. Sand 8.5m.

Core Box

COMMENTS:

Survey method:

Log Scale 1:50

T+T DATATEMPLATE.GDT amm

GENERAL LOG GENERAL LOG.GPJ 28/6/12

TONKIN & TAYLOR LTD

BORE HOLE LOG

BOREHOLE No: [redacted]

SHEET 1 OF 1

PROJECT: Grenville Block

LOCATION: [redacted]

CO-ORDINATES: [redacted]

JOB No: TBA 870982.250

DIRECTION: Vertical

ANGLE FROM HORIZ.: 90°

R.L. GROUND: 96.4 m

R.L. COLLAR: 96.4 m

DATUM: NZGD1949

DRILLED BY: Speight Drilling

LOGGED BY: s9(2)(a)

CHECKED: s9(2)(a)

START DATE: 01/05/13

FINISH DATE: 02/05/13

CONTRACTOR/RIG: Speight Contracting C51000

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation, texture	Rock Weathering (UW SW MW HW CW)	Rock Strength (EW VW MW S VS EX)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (cm)	RQD %	Description: Type, Orientation, Spacing, Shape, Persistence, Roughness, Aperture, Weathering, Infill	Water Loss (%)	Water Level	Casing	Installation	Core Box
SILTSTONE	SPT Redrill @ 10m. Moderately Weathered, Light Brown Grey, SILTSTONE, Extremely Weak, Very Closely to Extremely Closely Spaced Defects. (NB; Minor - Some Clay Content) 10.8-11 m Drilling Induced Breaks. 11.2-11.3m (See Below) * 12-12.4m SPT Redrill 12.4-12.8m Core Disturbance, Possible Sheared, Softened Zone. 12.9m Carbonaceous content. 13m Becoming Low Range very Weak (1-2 MPa?) 13m Fresh to Sl. Weathered, Light Grey w red/brown Staining, SILTSTONE, very Weak, Very Closely Spaced Defects, Carbonaceous Content. 14m SPT Redrill. END OF BH @ 15.22 m			SPT HQ3 HQ3 SPT HQ3 HQ3 SPT HQ3 SPT	100% 100% 100% 100% 100% 90% 100% 100% 100%		10 11 12 13 14 15	SPT 10m 6,16,19, 31(150mm) n=50+ SPT 10m 3,8,9, 15,27, 2/55mm n=50+ SPT 14m 2,5,13, 22,15/ 120mm n=50+ SPT 15m 6,31,50/ 220mm n=50+			J50°, PL, SM, T, FeSt. J65°, PL, SM, T, FeSt. J70°, P, SM, T, FeSt. Multiple Jt, P, SM, T, FeSt. J30°, P, SM, T, FeSt. Unknown Orientated 11.2-11.3 Sheared zone), Softened Soil Property Material (multiple defects Shearing either side of soil to 12m (rare Slickensided surfaces). 12.5m Sheared, softened zone, Possible SPT disturbance? 12-13m Multiple Defects, no predominant orientation. J30°, P, R, T, FeSt & J40° J30°, P, R, T, FeSt B50° - Possible Steep 90° bedding structure? J50°, P, SM, T. J50, ST, R, T, FeSt. J30°, ST, R, T, FeSt. J60°, P, R, T, FeSt					BOX 3 BOX 4 BOX 5

*11.2-11.3m Clayey SILT, Tan Brown, Stiff to very stiff, moist, Low Plasticity.

COMMENTS:

Survey method:

T+T DATATEMPLATE.GDT amm

Log Scale 1:50

GENERAL LOG GENERAL LOG.GPJ 28/6/12

TONKIN & TAYLOR LTD

BORE HOLE LOG

BOREHOLE No: 2
BH 2
SHEET 1 OF 1

DRILLED BY: Speight Drilling
LOGGED BY: s9(2)(a)
CHECKED: s9(2)(a)
START DATE: 03/05/2013
FINISH DATE: 03/05/2013

PROJECT: Grenville Block
LOCATION: [redacted] Nelson
CO-ORDINATES: [redacted]

JOB No: TBA 870982.250
DIRECTION: Vertical
ANGLE FROM HORIZ.: 90°
CONTRACTOR/RIG: Speight Contracting CS1000

R.L. GROUND: 97.6 m
R.L. COLLAR: 97.6 m
DATUM: NZGD 1949

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation, texture)	Sampling Method	Core Recovery (%)	Testing / Depth (m)
TOPSOIL & ROOTS	Topsoil & Roots - Organic SILT, Brown, Firm, moist (rootlets @ surface).	HQ3	60%	
FILL	SILT w minor gravel, organics, Stiff, Moist, Non-plastic.			
BURIED TOPSOIL	Buried Topsoil - SILT w some organics, Stiff, Brown, Moist.	HQ3	80%	1
TAHUNANUI SLUMP MATERIAL - LANDSLIDE DEBRIS	1.1-2.5m SILT w minor to some clay and gravel, orange brown, stiff to very stiff, moist, Low Plasticity. 2-2.5m SPT Re-drill.	SPT	40%	2
	2.5m Silty GRAVEL to Gravelly SILT w minor cobbles & (boulders?) G=f-m, sub-rounded to sub-angular, Tan Brown, V.Stiff/Medium Dense, moist, Moved Landslide material - Highly Disturbed. (also drilling disturbance)	HQ3	80% / 100%	3
	4m SPT Re-drill. 4m SPT strength = Dense - SPT likely to be distorted by Cobbles/Boulders. From 4.5m Rare Subrounded, Fine to medium polished gravel clasts.	SPT	47%	4
	5-5.5m Gravel/Cobble layer - possibly drilled through a boulder?	HQ3	60% / 80%	5
	6m SPT Re-drill. 6-8m Cobbles/Boulders with minor to some gravelly SILT matrix, Grey clasts, Tan Brown matrix, Very Dense SPT results (unlikely to be accurate due to cobbles/boulders) Moist, Non-Plastic.	SPT	80%	6 — SPT@6m 4,8,15, 21,14 (95mm) n=50+
		HQ3	80% / 90%	7
	8m SPT Re-drill. 8m. Silty GRAVEL w some clay, Tan Brown, Very Dense, moist, Matrix is Low Plasticity.	SPT	70%	8 — SPT@8m 12,27, 32,18 (180mm) n=50+
	8.9m - 9.5m (As per 6-8m above)	HQ3	70%	9
	9.5-10.3m (As per 8-8.9m above).	HQ3	10%	
		SPT	100%	10 — SPT@10m 10,20,32, 20(150mm) n=50+

Rock Weathering: N.A.
Rock Strength: N.A.
Defect Log: N.A.
Fracture Spacing (cm): N.A.
RQD %: N.A.

ROCK DEFECTS & SPTS — Description (Type, Orientation, Spacing, Shape, Persistence, Roughness, Aperture, Weathering, Infill):

SPT @ 2m = 2,2,6,7,7,9. n=29

SPT @ 4m = 7,15,12,10,12,12 n=46

Water Level: 5.0m - 31/05/13

Installation: Cap & sealed. Bentonite (to 2m); Sand; Bentonite (7.65 - 8.65); Backfilled

Core Box: BOX 1, BOX 2, BOX 3, BOX 4

COMMENTS:
END OF BH2 @ 10.3m

Survey method:

Log Scale 1:50

T+T DATATEMPLATE.GDT amm

GENERAL LOG GENERAL LOG.GPJ 28/6/12

TONKIN & TAYLOR LTD

EXCAVATION LOG

EXCAVATION No: [redacted]
Location:
SHEET ..../..... OF ..../....

PROJECT: [redacted] LOCATION: [redacted] JOB No: 870982.2500

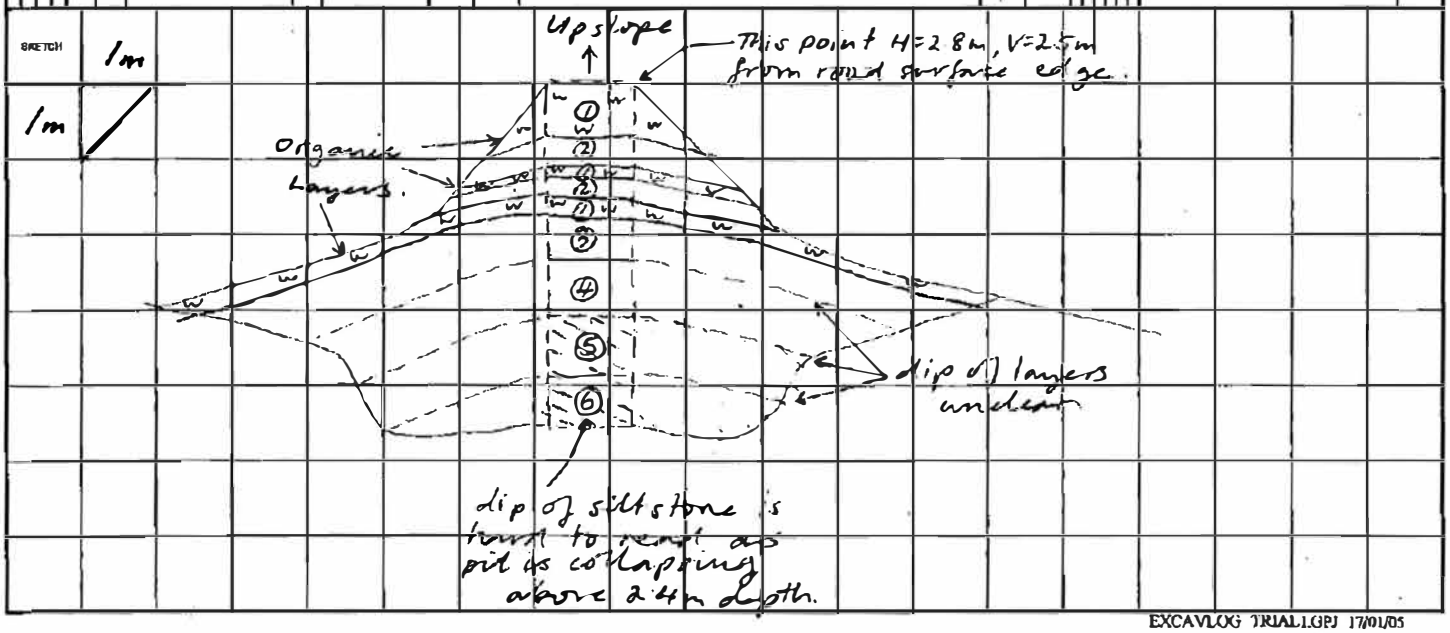
CO-ORDINATES mN [redacted]
mE
R.L. 93.0 m
DATUM NZGD 1949

EXPOSURE TYPE: Test pit
EQUIPMENT: 10T Excavator
OPERATOR: s9(2)(a)
DIMENSIONS: 5.0 x 1.0 x 4.6m

HOLE STARTED: 28/06/13
HOLE FINISHED: 28/06/13
LOGGED BY: s9(2)(a)
CHECKED BY: [redacted]

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
1 2 3							OM	SILT: Non-plastic, organics, roots, rootlets, house hold waste, dark brown.	m	L		FILL	①
							MH	SILT: moderately plastic; minor high plasticity clay, minor sand, orange mottled blue grey	w	S		FILL	②
					1		OM	SILT: as in ① above	m	L		FILL	①
							MH	SILT: as in ② above	w	S		FILL	②
							OM	SILT: as in ① above	m	L		FILL	①
					2		ML CH	SILT: moderate plasticity, with some high plasticity clay, and minor sand, yellow/orange mottled grey, gravelly layer at base, rounded pumice, fine to medium gravel, water bearing	w	S		FILL	③
			seepage on gravel layer ~5L/hr.		3		ML CH	SILT: moderate plasticity as in ③ above, with occasional sub-rounded to angular moderately to highly weathered fine to medium gravel, orange/brown.	m	F / St		COLLUVIUM	④
							ML CH	SILT: moderate plasticity as in ④ above, some rock fabric visible	m - d	VSt - H		PORT HILLS GRAVEL SILTSTONE completely weathered	⑤
					4			3.7m - fine to coarse gravel-sized fragments of green 500kPa well bedded siltstone	d	D - I		SILTSTONE Moderately Weathered	
								green/grey SILTSTONE: hard to extremely weak, highly weathered, closely-spaced discontinuous manganese coated light defects, some free water on defects 500kPa - 1MPa.	d	EW - I			
					5			End of test pit at 4.6m - pit collapsing					
								Strengths based on field assessments					



TONKIN & TAYLOR LTD

EXCAVATION LOG

EXCAVATION No:
Location:
SHEET....1..... OF ....1.....

PROJECT: | LOCATION: | JOB No: 870982.2500

CO-ORDINATES

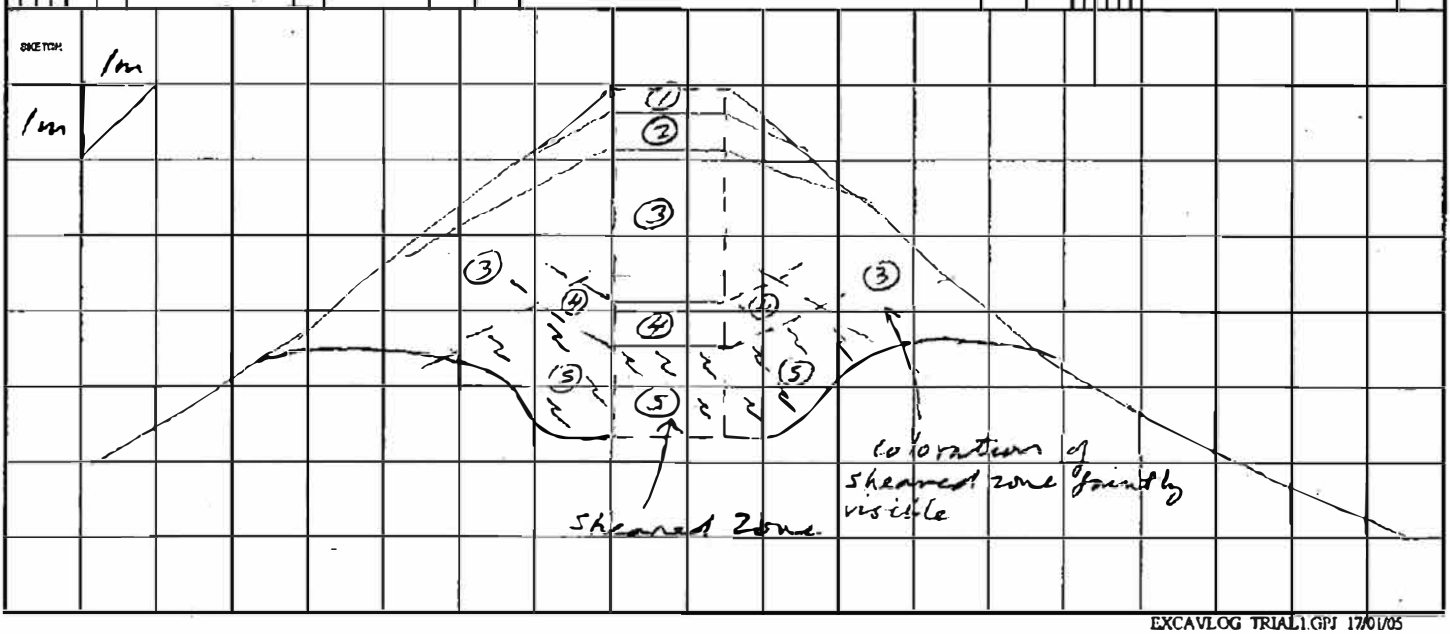
R.L. 93.0 m
DATUM NZGD 1949

EXPOSURE TYPE: test pit
EQUIPMENT: 10T Excavator
OPERATOR: s9(2)(a)
DIMENSIONS: 4.0 x 1.0 x 4.6m(d)

HOLE STARTED: 28/6/13
HOLE FINISHED: 28/6/13
LOGGED BY: s9(2)(a)
CHECKED BY:

EXCAVATION TESTS						ENGINEERING DESCRIPTION					GEOLOGICAL	
PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
1 2 3					0		ML MH	SILT: moderate plasticity, with fine to coarse angular highly weathered siltstone gravel. yellow/brown.	m	F/St	10 20 50 100 200	RESIDUAL SOIL	(1)
							GM	GRAVEL: with minor silt, angular clasts of fine to coarse gravel-sized highly weathered siltstone, very closely spaced fractures, weathered in situ, orange/brown.	m	L		PORT HILLS GRAVEL SILTSTONE Extremely Weathered gradational contact	(2)
	N/A				1			green/grey SILTSTONE: hand to Extremely weak, well-bedded, closely-spaced discontinuous joints, manganese-stained 500kPa - 1MPa, some free-water on joints. mottled orange/brown locally;	m/w	D / ehw		PORT HILLS GRAVEL SILTSTONE Highly Weathered J_1 S=060 (Bedding) D=28E J_2 S=360 D=60-90E J_3 S=090 D=60-90N J_4 S=060 D=70SE J_5 S=310 D=60°W	(3)
					2			gradational contact...				gradational contact	
					3			grey/green SILTSTONE: as above but less weathered, recovered as 75MPa core/gravel to cobble sized blocks. locally orange/brown	m	VWk		PORT HILLS GRAVEL SILTSTONE Moderately Weathered	(4)
					4		ML MH	SILT: moderate plasticity, with some coarse sand, highly sheared, polished surfaces throughout, highly disturbed, shearing is sub-parallel to bedding. dark grey mottled white and black	m	VSt		SHEARED ZONE Highly sheared siltstone.	(5)
					5			End of test pit at 4.6m depth. - pit collapsing above 2m Strengths based on field assessments.					

SKETCH:



Tonkin+Taylor

Engineering log terminology

General

Soil and rock descriptions follow the "Guidelines for the field classification and description of soil and rock for engineering purposes" by the New Zealand Geotechnical Society (2005). Refer to this document for methods of field determination.

Water

Water level on date shown

Water inflow

Water outflow

Core recovery

Expressed as percentage of the length of the core run recovered.

Drilling method/casing

Common types:

OB	Open barrel
W	Wash
HQ3	HQ triple tube
PQ3	PQ triple tube
HSA	Hollow Stem Auger
WS	Window Sampler
HA	Hand Auger
HFS	High Frequency Sonic Drilling
LFS	Low Frequency Sonic Drilling

Graphic logs

The graphic log shows soil and rock types. The defect log indicates the location, orientation and abundance of defects of all types.

Typical material symbols:


Organic material


Clay


Silt


Sand


Gravel or Conglomerate


Igneous rock


Mudstone


Siltstone


Sandstone


Metamorphic Rock

Tests

- **N=22**:SPT uncorrected blow count for 300 mm
- **75/12**:Undrained shear strength (peak /residual as measured by field vane.

Laboratory test(s) carried out:

PMT	Pressuremeter test
LT	Lugeon test
LV	Laboratory vane
AL	Atterburg limits
UU	Undrained triaxial
PSD	Particle size distribution
c' Ø'	Effective stress
CONS	Consolidation
DS	Direct shear
COMP	Compaction
UCS	Unconfined compression
IS_{50}	Point load

Installation type


Standpipe


VWP


Filter pack


Slotted screen


Bentonite seal

Sample type


SPT


Thin-wall tube


Bulk sample


Core


Other


Core or Sample loss

Soil description

Moisture content

D	Dry, looks and feels dry
M	Moist, no free water on hand when remoulding
W	Wet, free water on hand when remoulding
S	Saturated, free water present on sample

Consistency/undrained shear strength

		S_u(kPa)
VS	Very soft	< 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very stiff	100 to 200
H	Hard	> 200

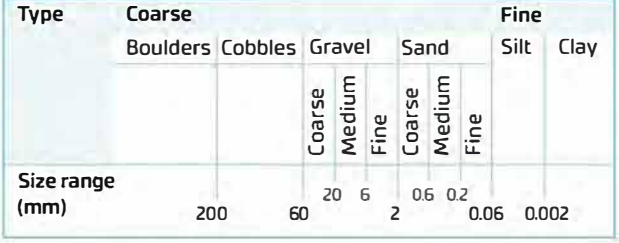
Density index

		SPT(N) - uncorrected
VL	Very loose	0 to 4
L	Loose	4 to 10
MD	Medium dense	10 to 30
D	Dense	30 to 50
VD	Very dense	> 50

Proportional terms definition (Coarse soils)

Fraction	Term	% of soil mass	Example
Major	(UPPER CASE)	Major constituent	GRAVEL
Subordinate	(lower case)	> 20	Sandy
Minor	with some... with minor...	12 - 20 5 - 12	with some sand with minor sand
	with trace of... (or slightly)...	< 5	with trace of sand (slightly sandy)

Grain size criteria



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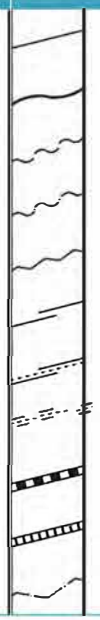
Engineering log terminology

Rock description

Significant defects

B	Bedding
J	Joint
Sc	Schistosity
Cl	Cleavage
BZ	Broken zone/crushed zone
F	Fault
Fg	Fault with gouge
SZ	Shear zone
Iz	Infilled seam
XD	Extremely weathered seam
DD	Drilling - induced defect



Weathering

UW	Unweathered
SW	Slightly weathered
MW	Moderately weathered
HW	Highly weathered
CW	Completely weathered
RS	Residual soil

Defect shape

ST	Stepped
UN	Undulating
PL	Planar

Roughness of defect surface

R	Rough
SM	Smooth
SL	Slickensided

Field strength

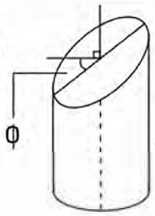
		UCS (MPa)	$I_{S(50)}$ (MPa)
EW	Extremely weak	< 1	N/A
VW	Very weak	1 - 5	N/A
W	Weak	5 - 20	N/A
MS	Moderately strong	20 - 50	1 - 2
S	Strong	50 - 100	2 - 5
VS	Very strong	100 - 250	5 - 10
ES	Extremely strong	> 250	> 10

Defect coding

Type
Angle (perpendicular to core axis)
Infilling description (as per soil description)

J 60°, PL, SL, T, CV, STIFF GREEN CLAY

- Infilling/coating type
- Aperture
- Roughness
- Shape



Defect Orientation: for vertical unoriented boreholes defect orientation is measured normal to core axis e.g horizontal = 0°(see diagram). For angled boreholes defect orientation is measured relative to core axis e.g parallel to core axis = 0°.

Aperture

		Aperture (mm)
T	Tight	nil
VN	Very narrow	0 - 2
N	Narrow	2 - 6
MN	Moderately narrow	6 - 20
MW	Moderately wide	20 - 60
W	Wide	60 - 200
VW	Very wide	> 200

Infillings and coatings

CG	Clay gouge	Joints have openings between opposing faces of intact rock substance in excess of 1 mm filled with clay gouge. Clay is generally described in terms of soil properties.
CV	Clay veneers	Joints contain clay coating whose maximum thickness does not exceed 1 mm. Note: Describe clay in terms of soil properties.
PL	Penetrative limonite	Joint traces are marked in terms of well defined zones of slightly to moderately weathered ferruginised rock-substance within the adjacent rock.
FeSt	Limonite stained	Joint surfaces are stained or coated with limonite, although the rock substance immediately adjacent to the joints is fresh.
CT, SC	Coated	Joints exhibit coatings other than clay or limonite, e.g. Carbonate (CT) or Silica (SC).
CL, CS, CC	Cemented	Joints are cemented with limonite (CL), Silica (CS), or Carbonates (CC).
CN	Clean	Joint surface show no trace of clay, limonite, or other coatings.

Spacing

Term	Spacing
Very wide	> 2 m
Wide	0.6 - 2 m
Moderately wide	200 - 600 mm
Close	60 - 200 mm
Very close	20 - 60 mm
Extremely close	> 20 mm

Excavator penetration

Easy	1
Moderate	2
Difficult	3

RQD: Rock Quality Designation - percentage of core run consisting of sound rock longer than 10 cm.

Appendix C August 2022 movement areas

- **Table C.1 – Damage area observations.**

Table C.1: Damage area observations

Damage area	Observations
	The shallow landslide has occurred on a steep slope resembling an abandoned sea-cliff, displacing downslope in the order of 1 to 2 m. properties were affected by the shallow landslide, covering an area of approximately 700 m2 along Rocks Rd at the TS.
	have been affected by landslide movement of in situ material along the headscarp of the TS. Approximately 1/3 of main scarp area has evacuated due to instability. were affected by headscarp regression, properties were affected by debris inundation.
	The 12,000 m2 shallow earth slide-flow is comprised of saturated high plasticity soil. Covers majority of the broad gully forming the northern margin of the TS (the 'Northern Gully'). Lateral displacements of 1 to 2 m from the event measured at Generated a slow-moving debris flow at base of gully which inundated Structures exhibited significant damage due to the magnitude of horizontal displacement. affected.
	An area of earth slide instability downslope affected by shallow landslide movement between the southern portion of covering an area of approximately 9,000 m2. Broadly in the same location as the shallow movement recorded in 1929. Displacements in order of 200-400 (horizontal) and 200 mm (vertical) occurred along Toe breakout at the rear of cut platforms on . Tension cracks widespread within this area indicating a degree of differential movement. Structures with shallow foundations display differential movement structural damage and racking. Newer structures with deeper piles (>5 m bgl) show little structural damage. Extensive damage to underground services.
	Covers a 5,000 m2 area of gently inclined land Up to 250 mm horizontal displacement and vertical displacement along central axis, with landslide displacements reducing rapidly at margins. Shows a significantly greater level of horizontal and vertical displacement than background TS movement. Upslope margin of zone defined by a 130 m long arcuate zone of tension cracks. Arcuate tension cracks mirroring pattern of upper tension crack present within landslide. Shallow landslide on the steep slope forms downslope margin. Dwellings/structures within this zone were subjected to structural damage and racking. Multiple tension cracks within area indicating differential movement within landslide. Tilting of the ground and structures towards the central axis of landslide observed. Pattern of displacements indicate that landslide movement is rotational and likely deep-seated. Breakages in, and loss of fall of underground services observed (due to ground tilting). affected.
	Downslope displacement in the order of 50 mm as a result of the event focussed in the area upslope and the TS showing little detectible movement or property damage. Linear tension cracks typical of deep-seated instability.

Damage area	Observations
	Area of compression in [redacted] that showed movement in July 1962 and December 2011 event, showed evidence of significant further deformation due to the event. Observations of services trenches excavations expose a zone of sheared siltstone underling the compression feature. Vertical displacement dominates at the top of the landslide and changes to predominantly horizontal downslope [redacted] Significantly lower levels of property damage than shallow movement areas. Some localized breakages in underground services [redacted] (outside of areas noted above attributed to deep-seated movement).

Appendix D Monitoring results to April 2023

- Post December 2011 [redacted] survey monitoring.
- Inclinometer monitoring results [redacted]
- Table D.1 – Summary of piezometer installations.
- Figure D.1 - Manual groundwater readings from [redacted] between February 2012 to July 2015.
- Post August 2022 NCC survey results.
- GNS continuous-GPS monitoring results.

The following page has been withheld in its entirety.

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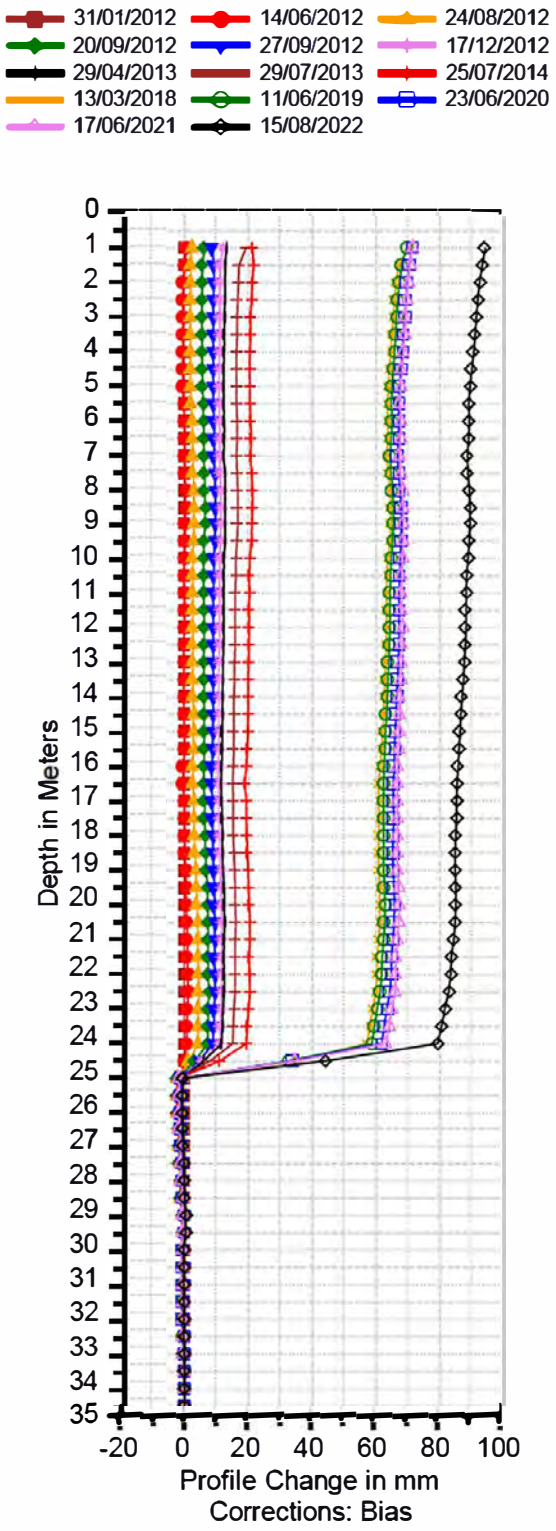

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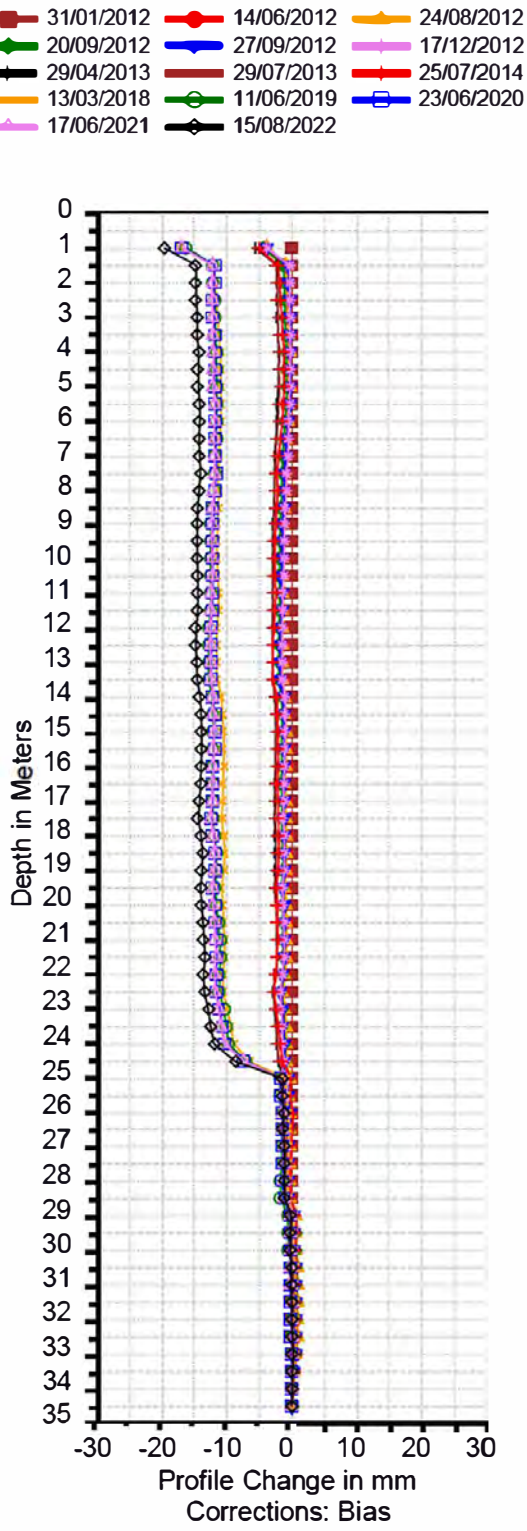
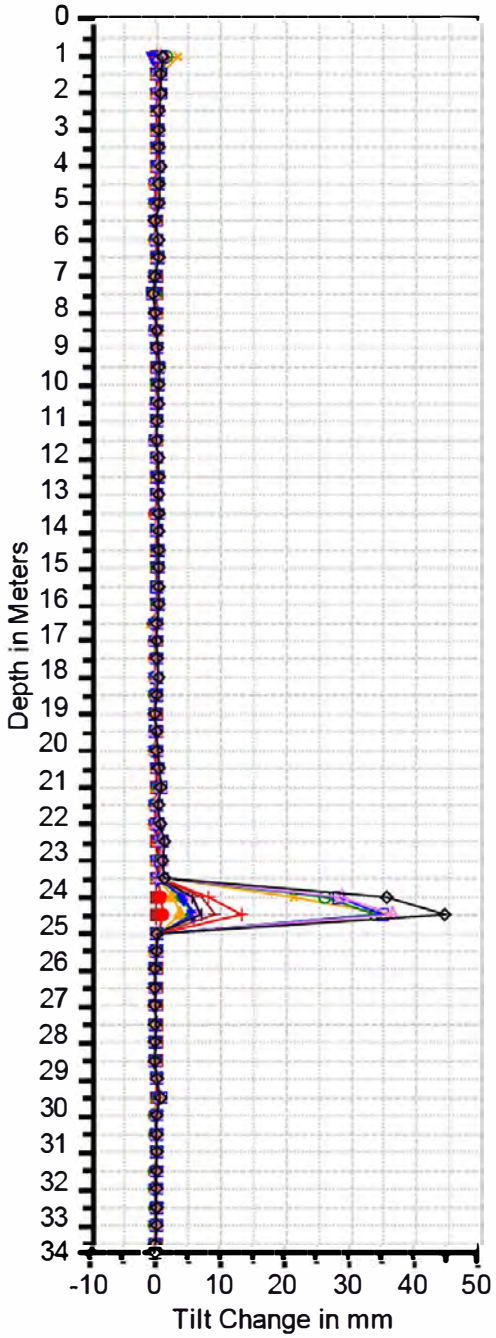


GEOTECHNICS

Area: Grenville Terrace
[redacted] Profile Change Plots
Ao Axis: Towards down slope direction.
Baseline reading: 31/01/2012
NB: Inclinometer summed/plotted from the bottom up.
Job number: 1006192.1000.0.0

[redacted] = 310°

31/01/2012 14/06/2012 24/08/2012
20/09/2012 27/09/2012 17/12/2012
29/04/2013 29/07/2013 25/07/2014
13/03/2018 11/06/2019 23/06/2020
17/06/2021 15/08/2022



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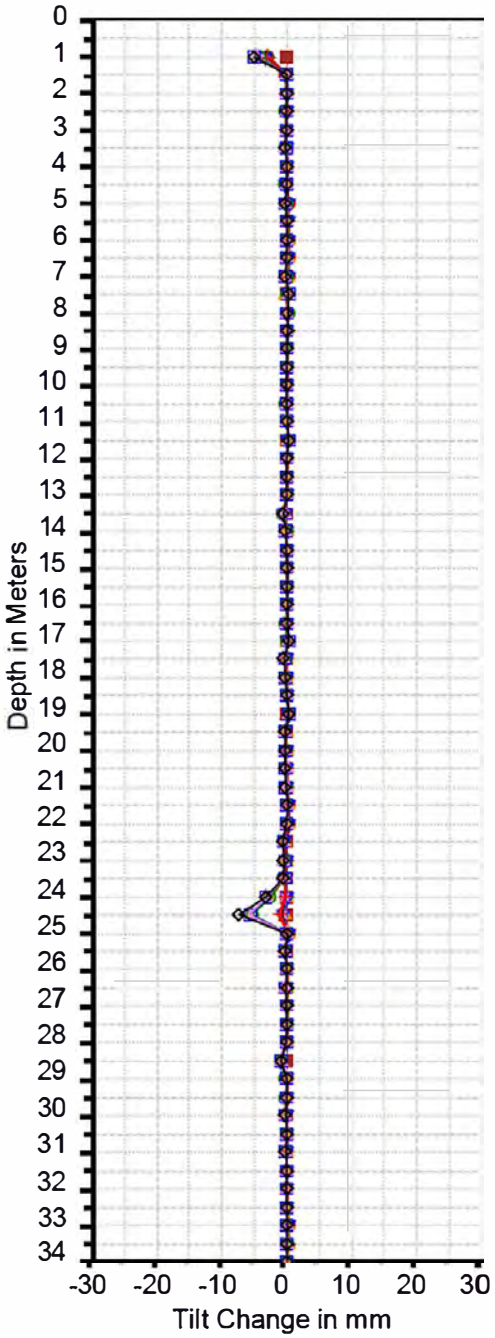
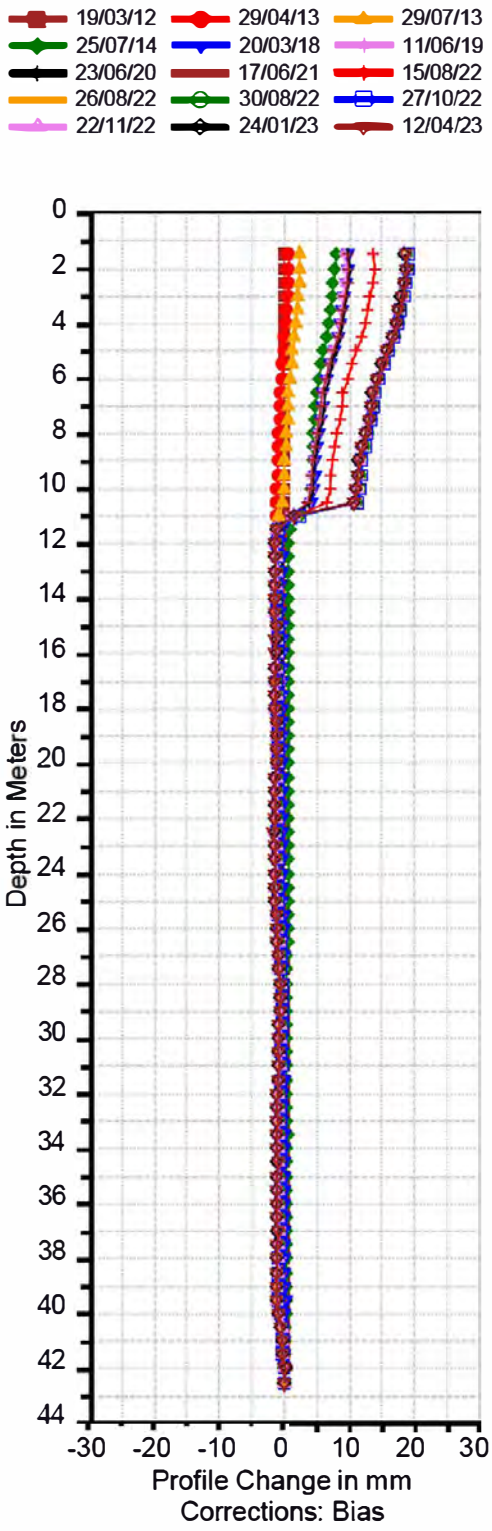
31/01/2012 14/06/2012 24/08/2012
20/09/2012 27/09/2012 17/12/2012
29/04/2013 29/07/2013 25/07/2014
13/03/2018 11/06/2019 23/06/2020
17/06/2021 15/08/2022



GEOTECHNICS

Tilt Change Plots for [redacted]
Area: [redacted]
[redacted] Tilt Change Plots
Ao Axis: Towards down slope direction.
Baseline reading: 31/01/2012
Job number: 1006192.1000.0.0

[redacted] = 300°



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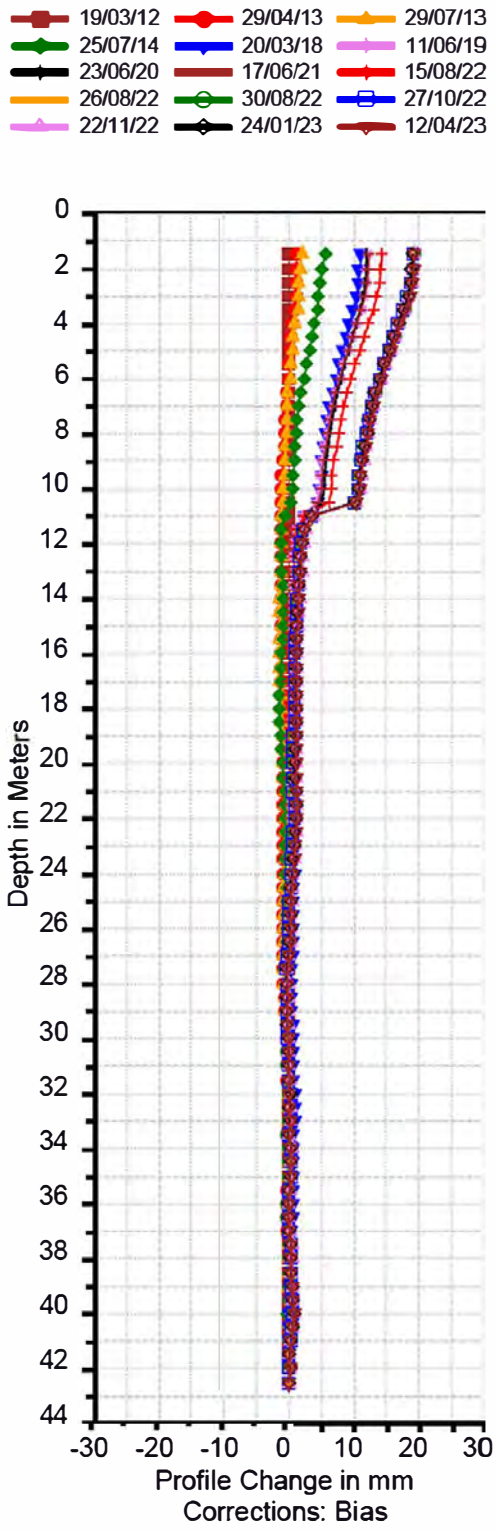
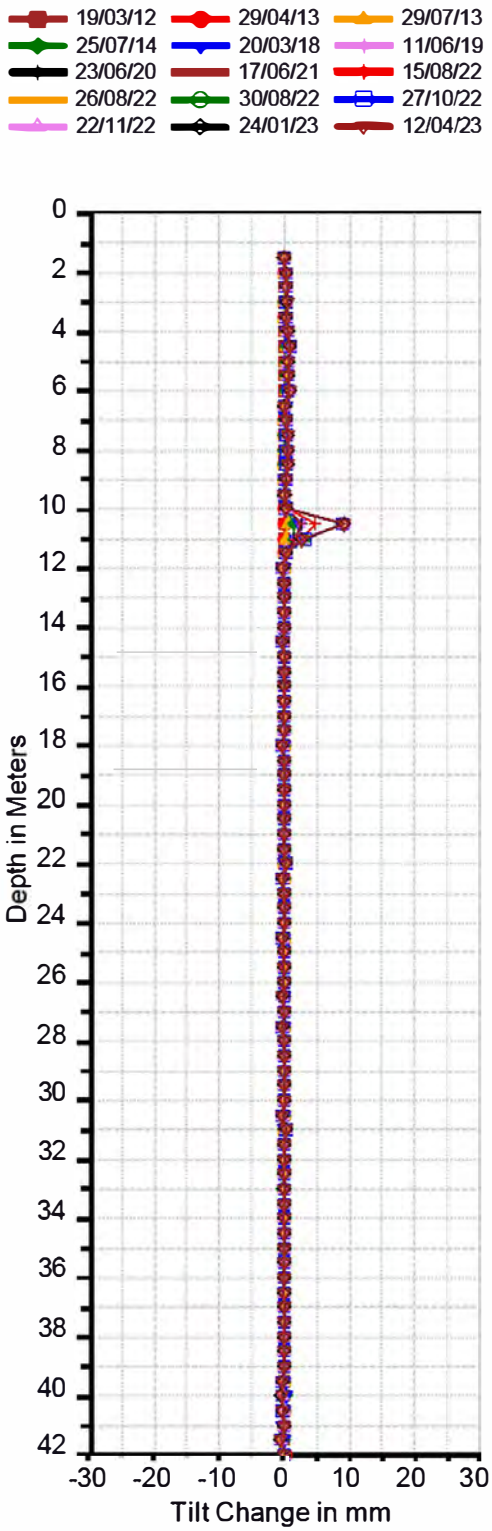


GEOTECHNICS

Tahunanui Slump Inclinometere
[redacted] Profile Change Plots
[redacted] Nelson [redacted]
Baseline reading: 19/03/2012
Job number: 1006192.2000.0.0

[redacted] = 300°



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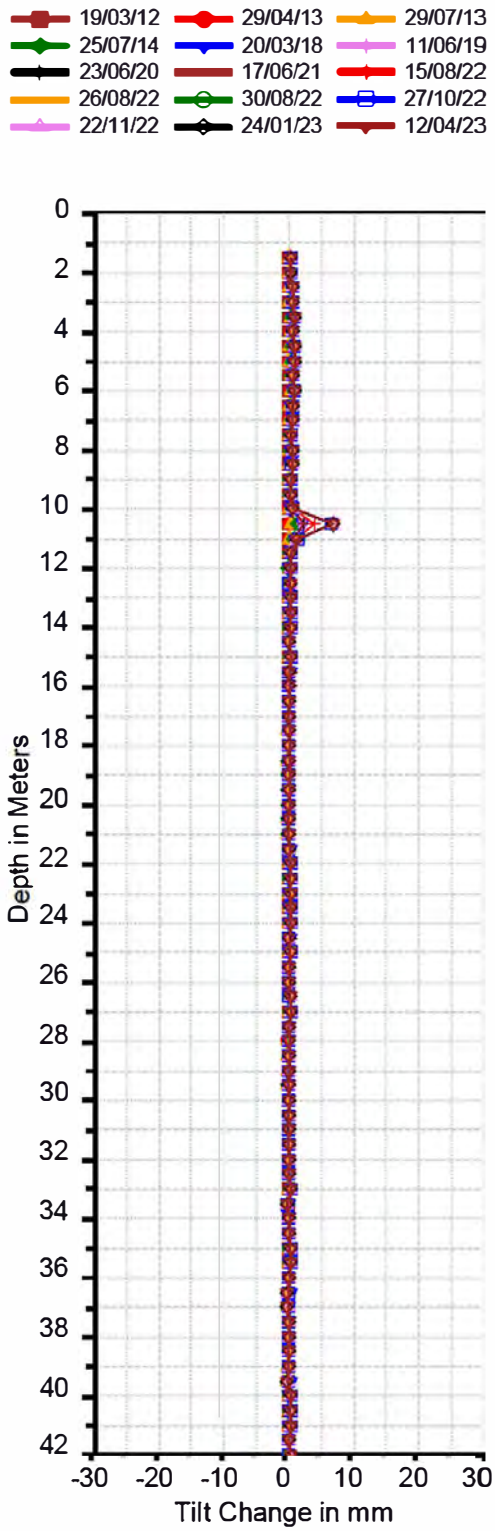

GEOTECHNICS

Tahunanui Slump Inclinometers

[redacted] Tilt Change Plots

[redacted] Nelson [redacted]

Baseline reading: 19/03/2012

Job number: 1006192.2000.0.0

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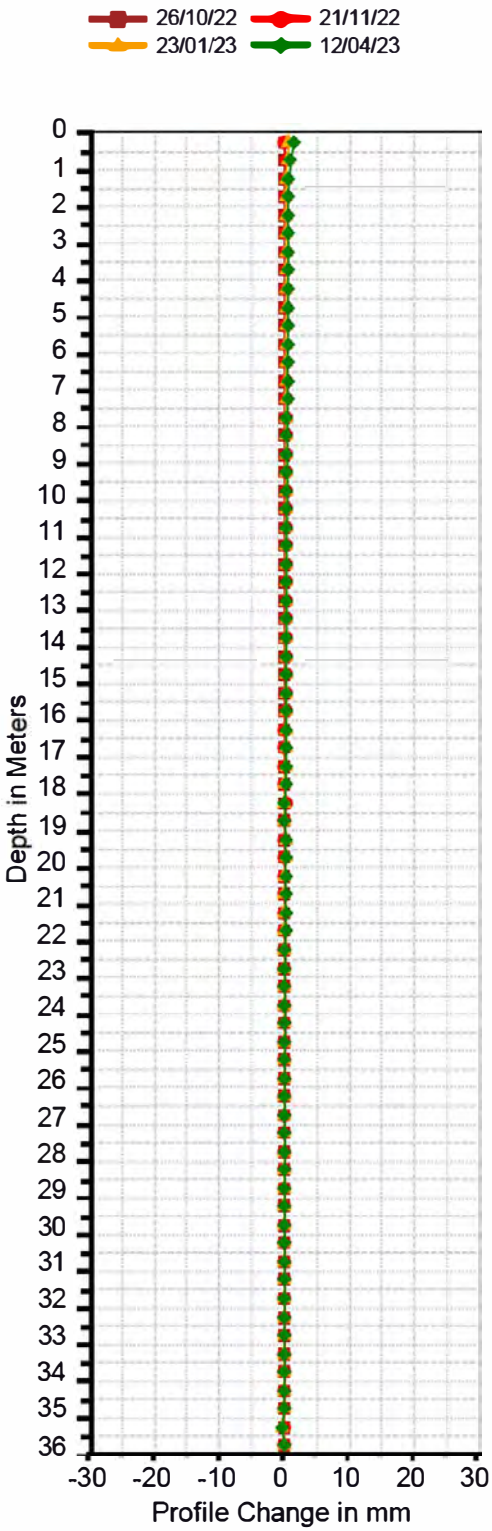

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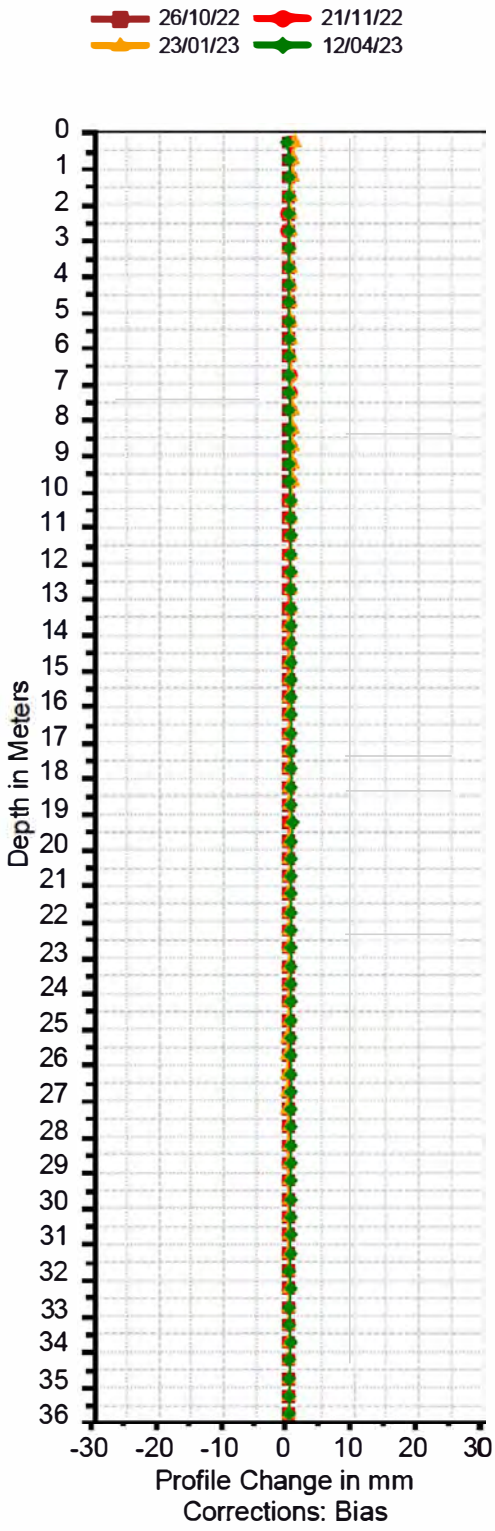

Tahunanui Slump Inclinometers
[redacted] Profile Change Plots
[redacted] Nelson
Baseline Reading: 26/10/2022
Job Number: 1006192.2000.0.0

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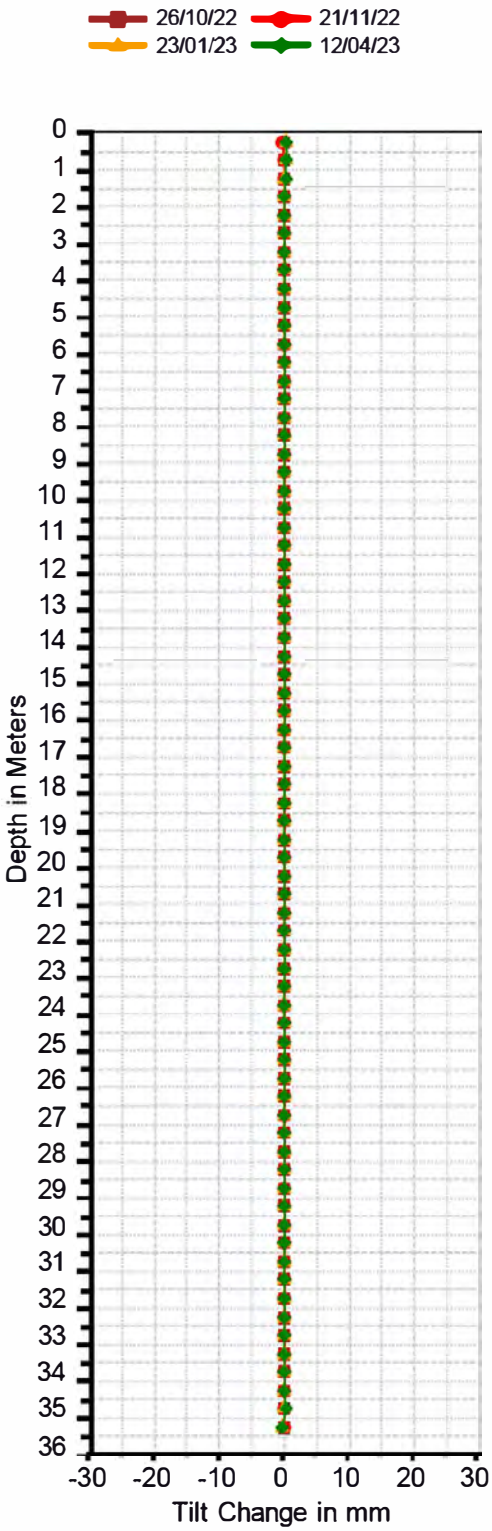

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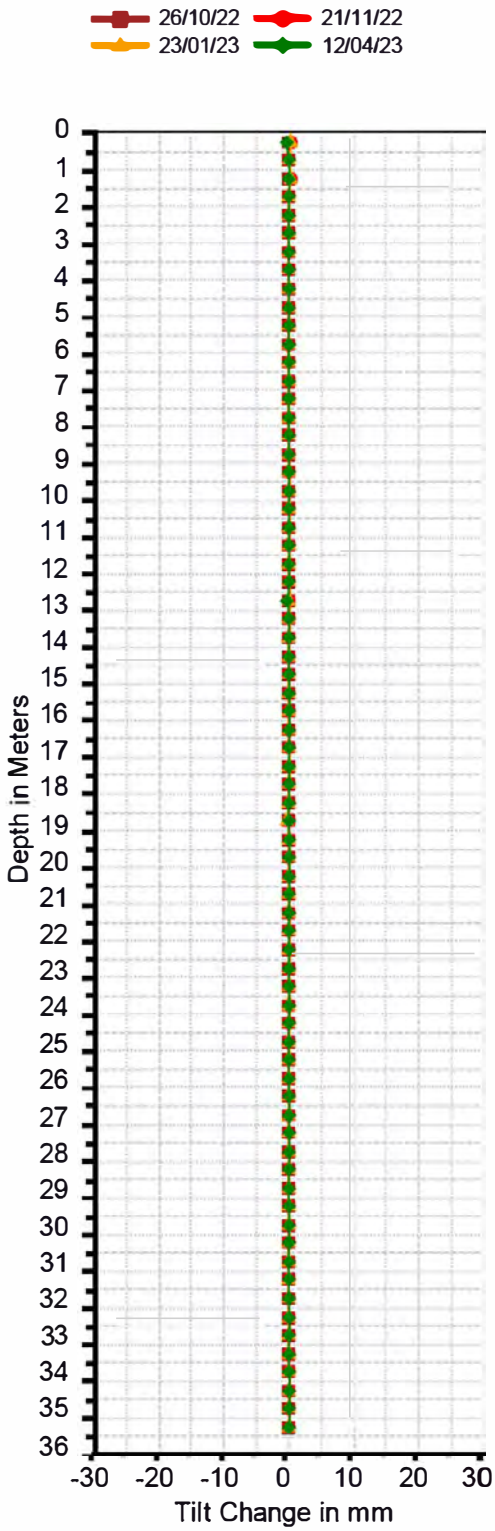
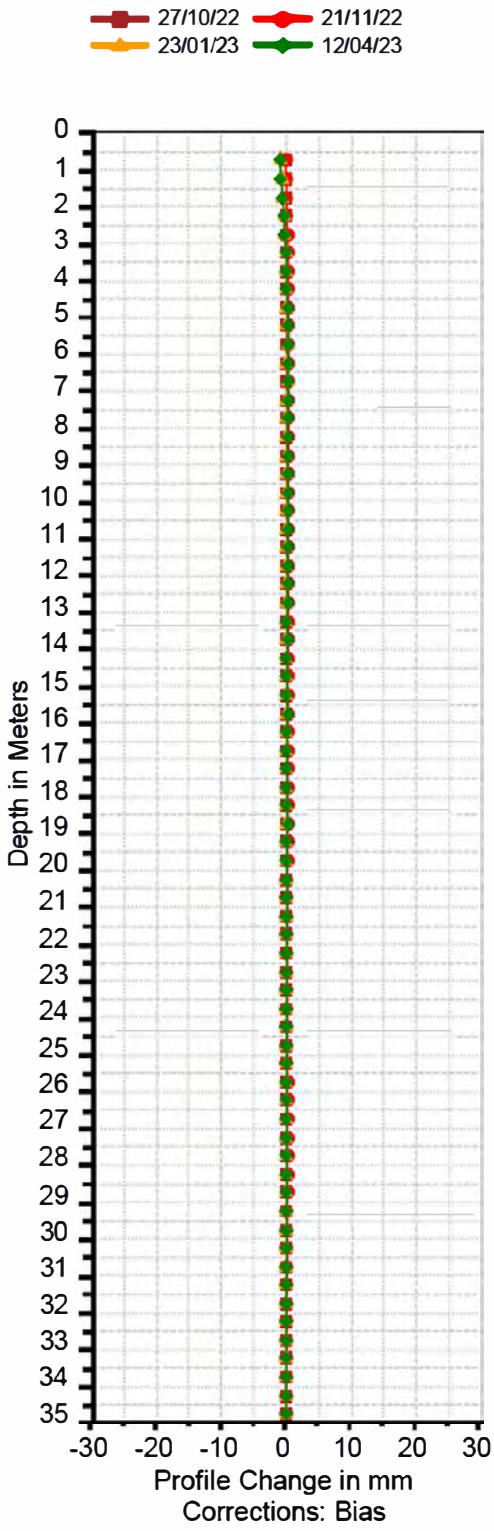


Tahunanui Slump Inclinometers
[redacted] Tilt Change Plots
[redacted] Nelson
Baseline Reading: 26/10/2022
Job Number: 1006192.2000.0.0

[redacted] = 300°



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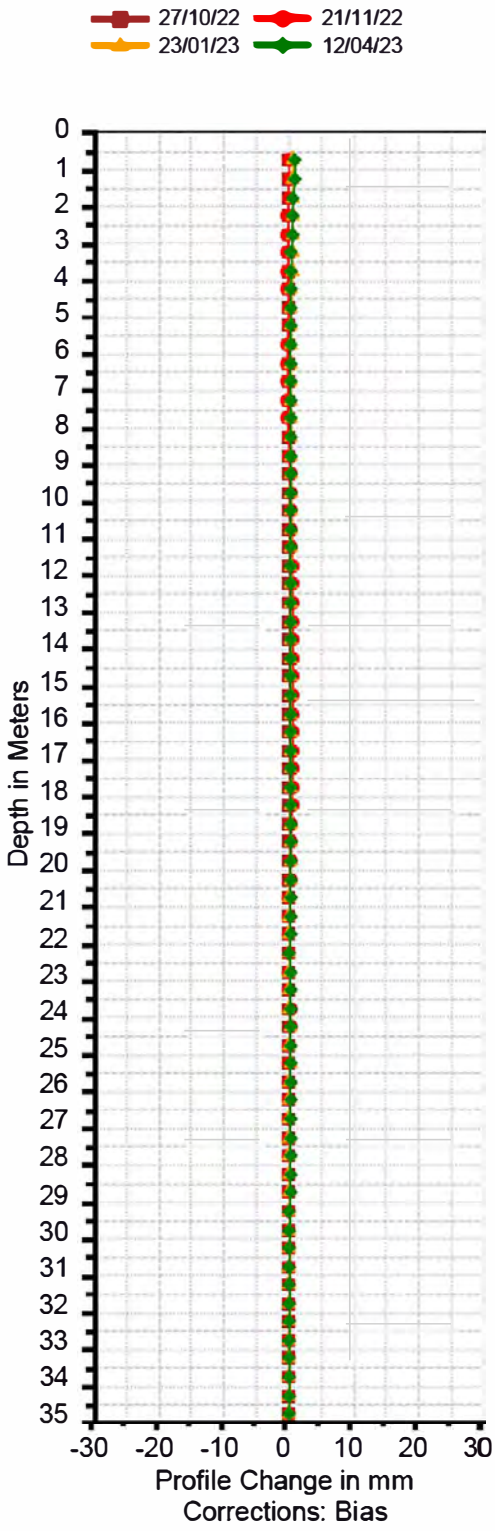
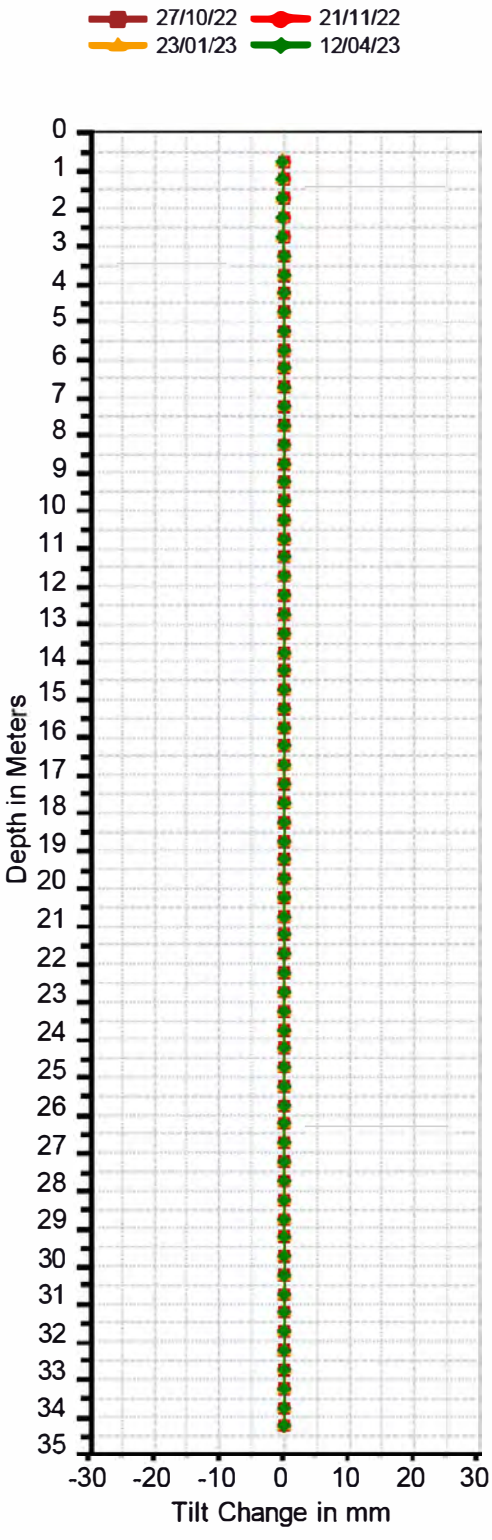


Tahunanui Slump Inclinometers
[redacted] Profile Change Plots
[redacted] Nelson [redacted]
Baseline Read: 27/10/2022
Job Number: 1006192.2000.0.0

[redacted] = 300°



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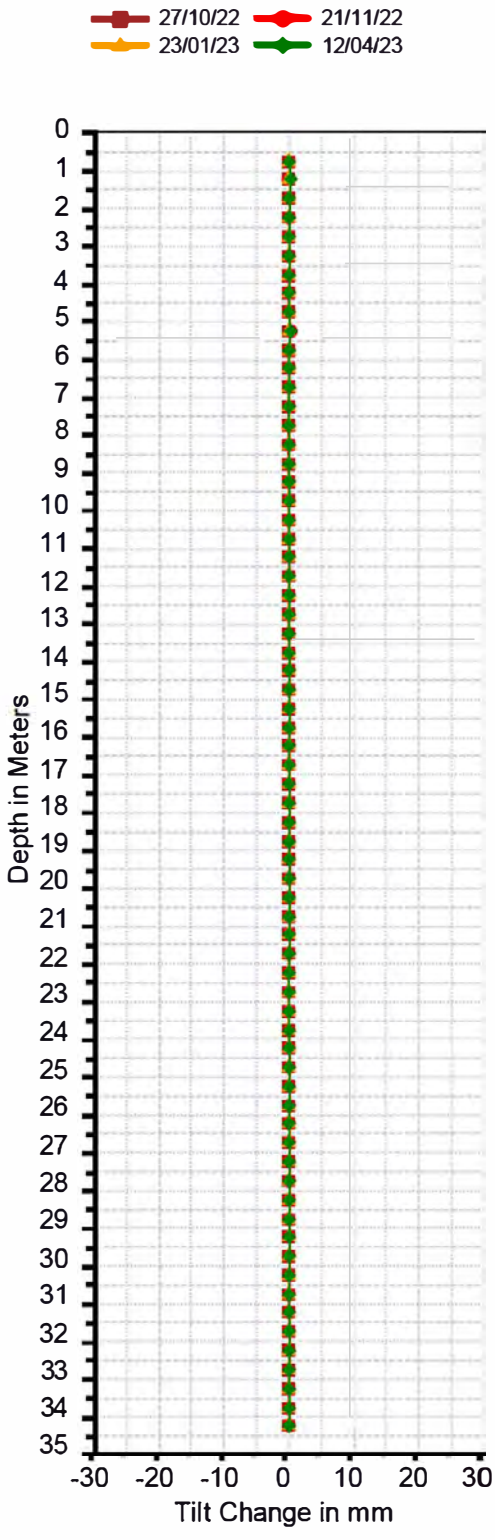

Tahunanui Slump Inclinometers
[redacted] Tilt Change Plots [redacted] Nelson [redacted]
Basline Read: 27/10/2022
Job Number: 1006192.2000.0.0

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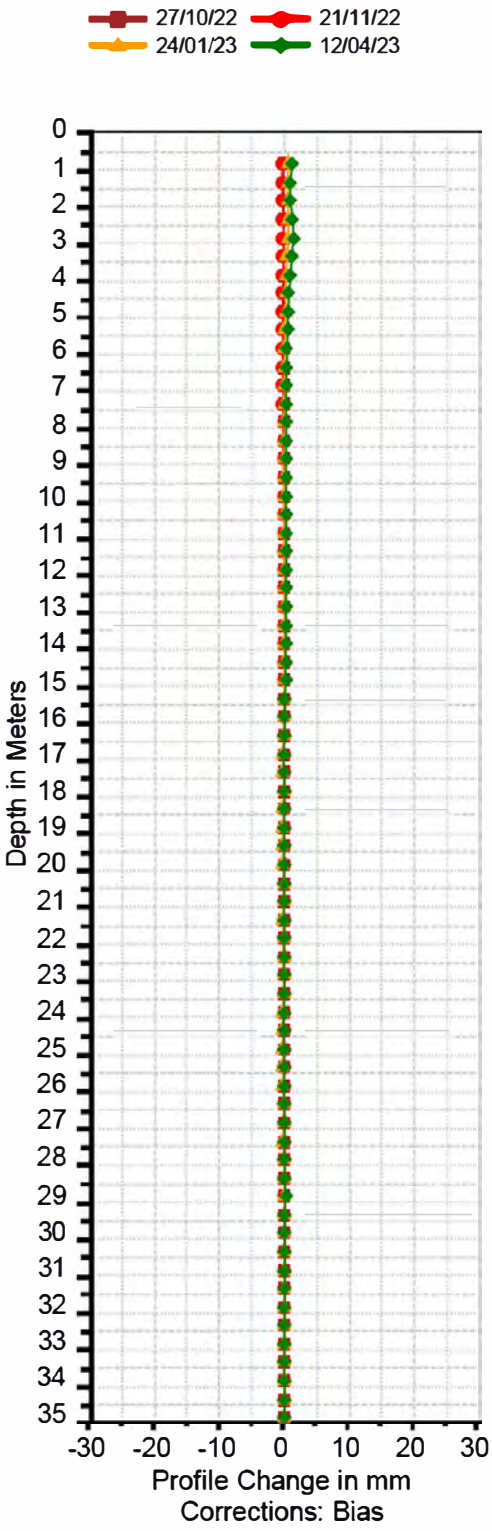

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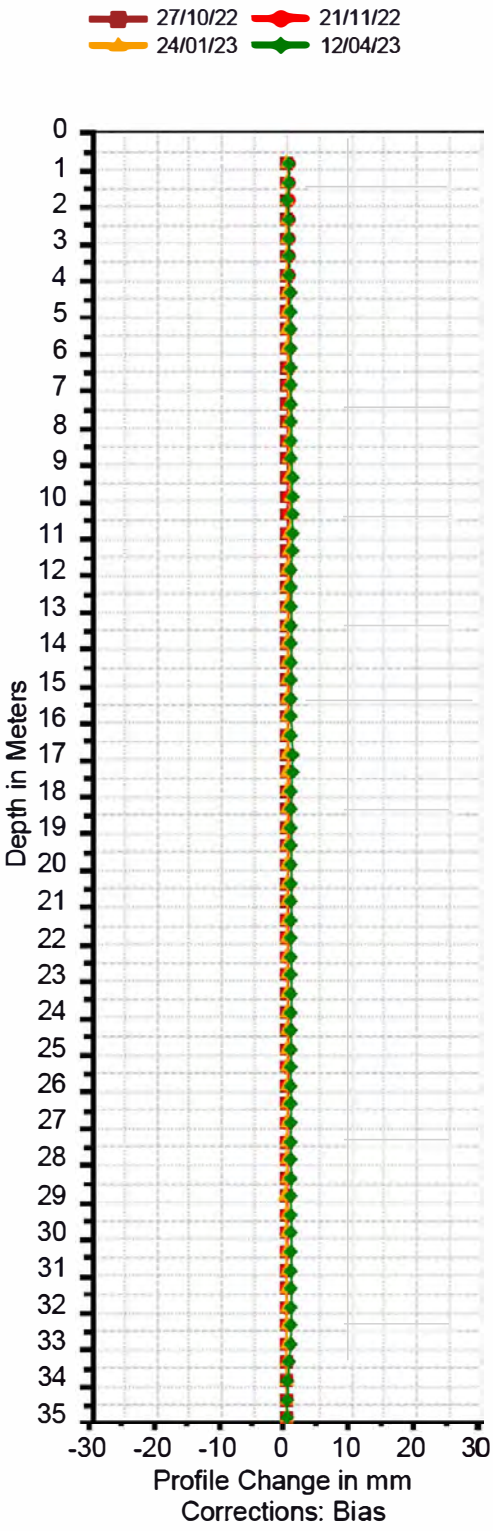
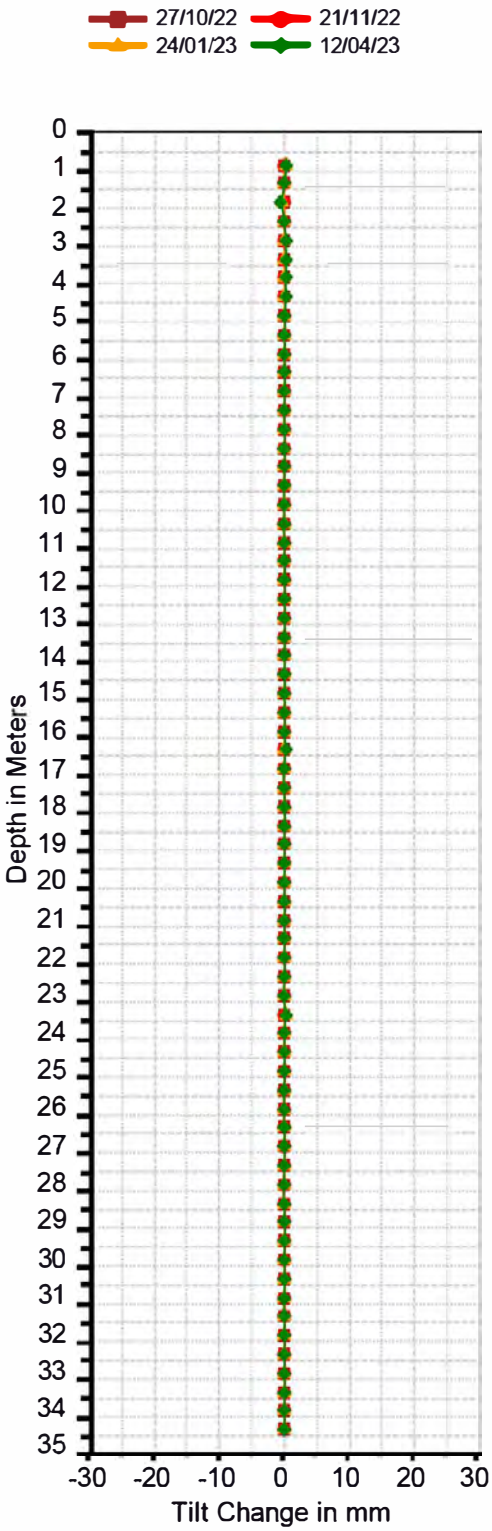


Tahunanui Slump Inclinometers
[redacted] - Profile Change Plots
[redacted] Nelson (on the road)
Base Read: 27/10/2022
Job Number: 1006192.2000.0.0

[redacted] = 300°



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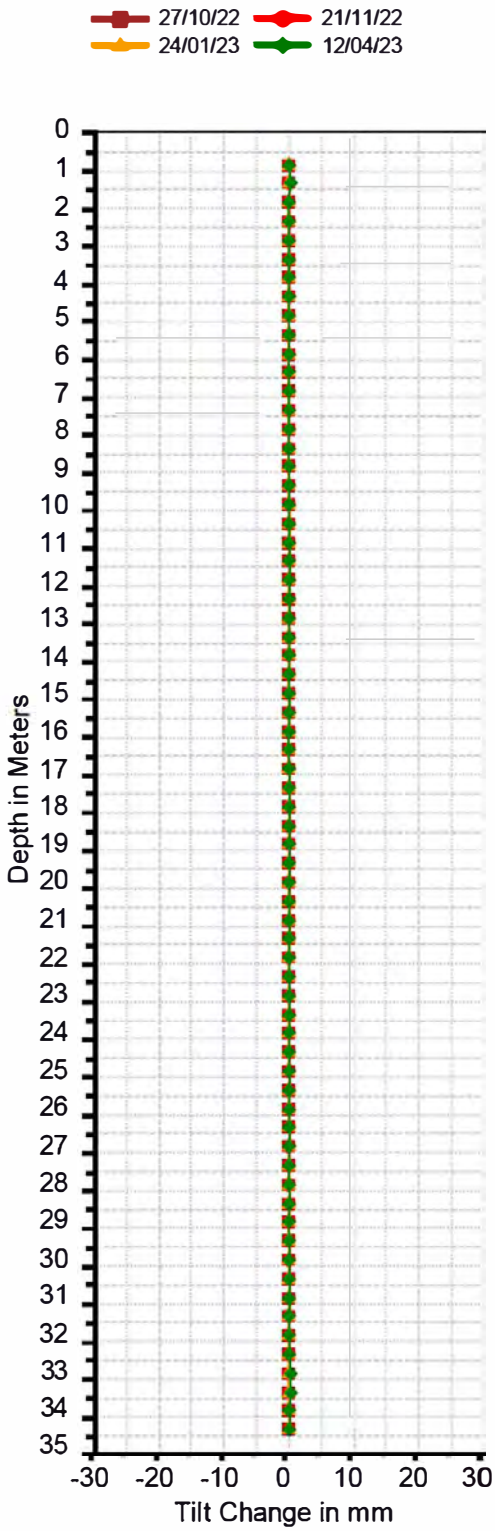

Tahunanui Slump Inclinometers

[redacted] - Tilt Change Plots [redacted] Nelson (on the road)

Base Read: 27/10/2022

Job Number: 1006192.2000.0.0

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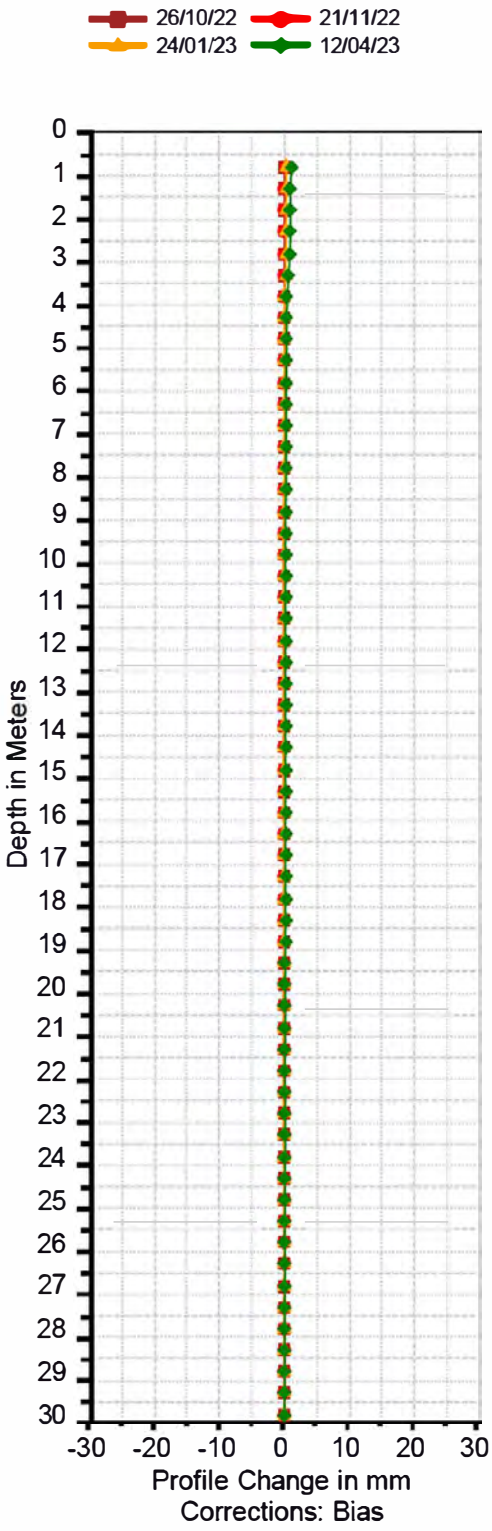

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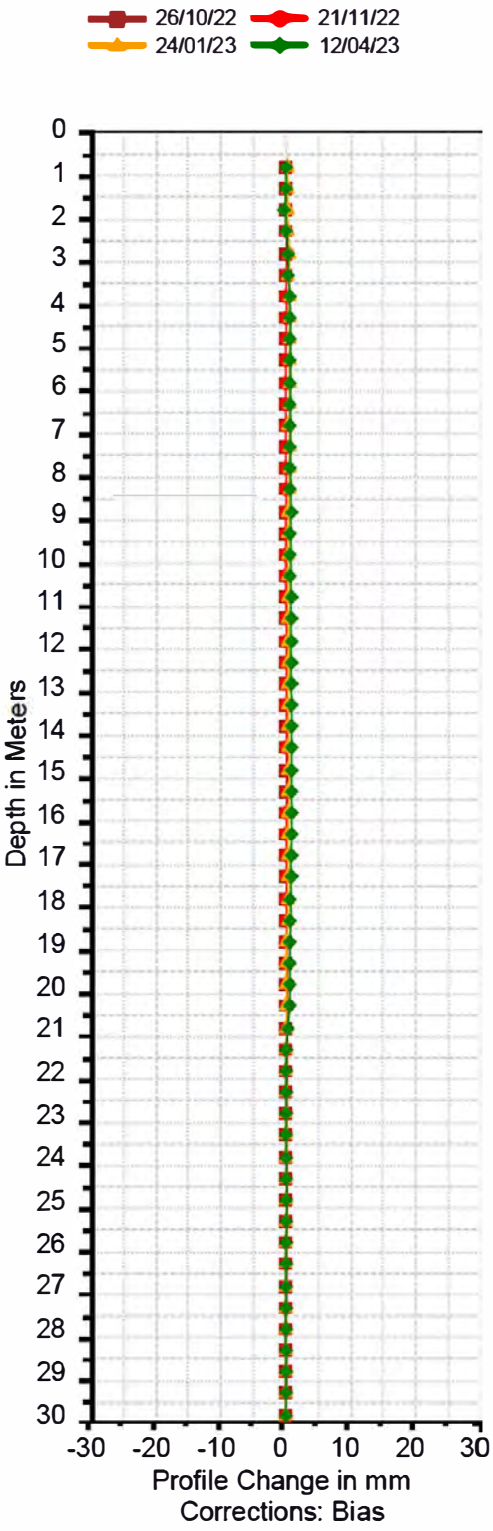
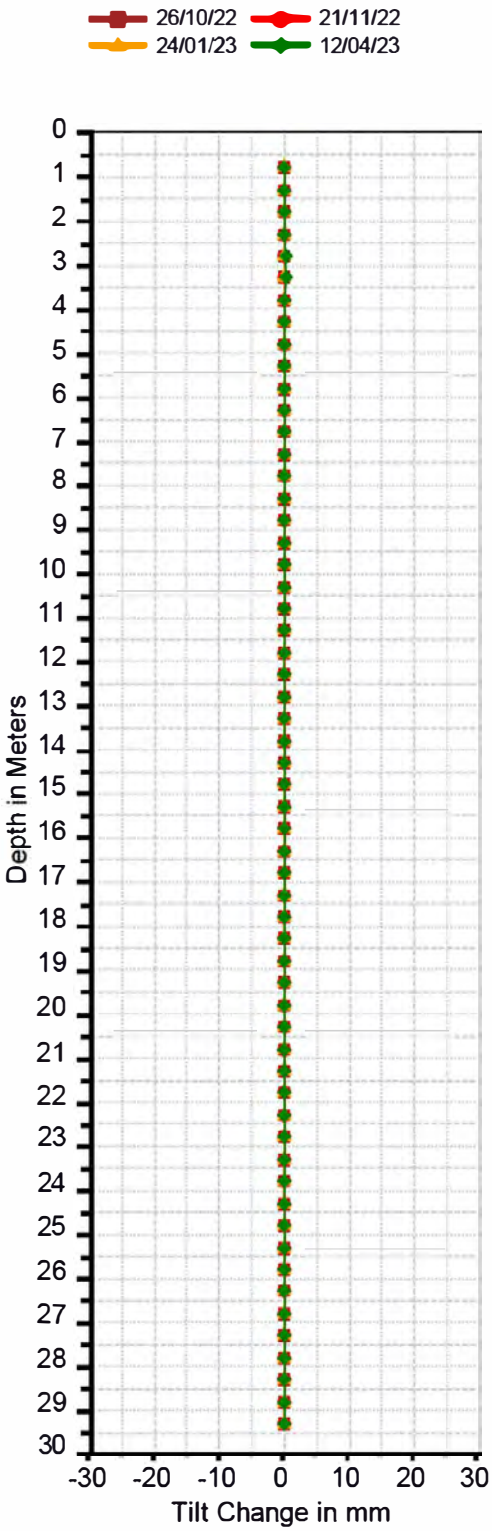
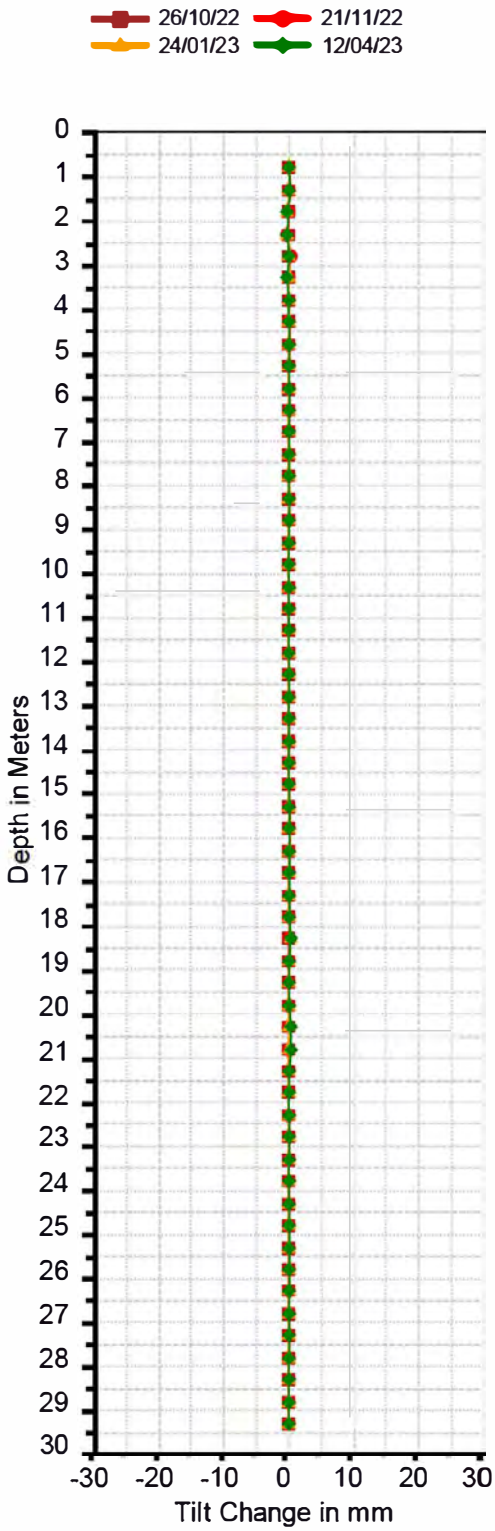


Tahunanui Slump Inclinometers
[redacted] - Profile Change Change Plots
[redacted] Nelson [redacted]
Base Read: 26/10/2022
Job Number: 1006192.0000.0.0

[redacted] = 020°



[redacted] = 110°



Tahunanui Slump Inclinometers
[redacted] Tilt Change Plots
[redacted] Nelson [redacted]
Base Read: 26/10/2022
Job Number: 1006192.0000.0.0

Table D.1: Summary of piezometer installations

Piezometer ID	Ground surface elevation (NZVD2016)	Piezometer tip / screen depth (m)	Geological unit
	89.1	2.5 – 9	Conglomerate-derived landslide debris
	89.1	40 – 44.5	Inferred basal shear zone
	48.4	28.75	Port Hills Gravel Formation – Mudstone
	48.4	23.55	Inferred basal shear zone
	79.3	17.6	Inferred basal shear zone
	53.3	8.1	Port Hills Gravel Formation – Mudstone
	48.5	34.0	Port Hills Gravel Formation – Conglomerate
	48.5	16.5	Inferred basal shear zone
	31.4	12.33	Port Hills Gravel Formation – Mudstone
	31.4	4.93	Inferred basal shear zone

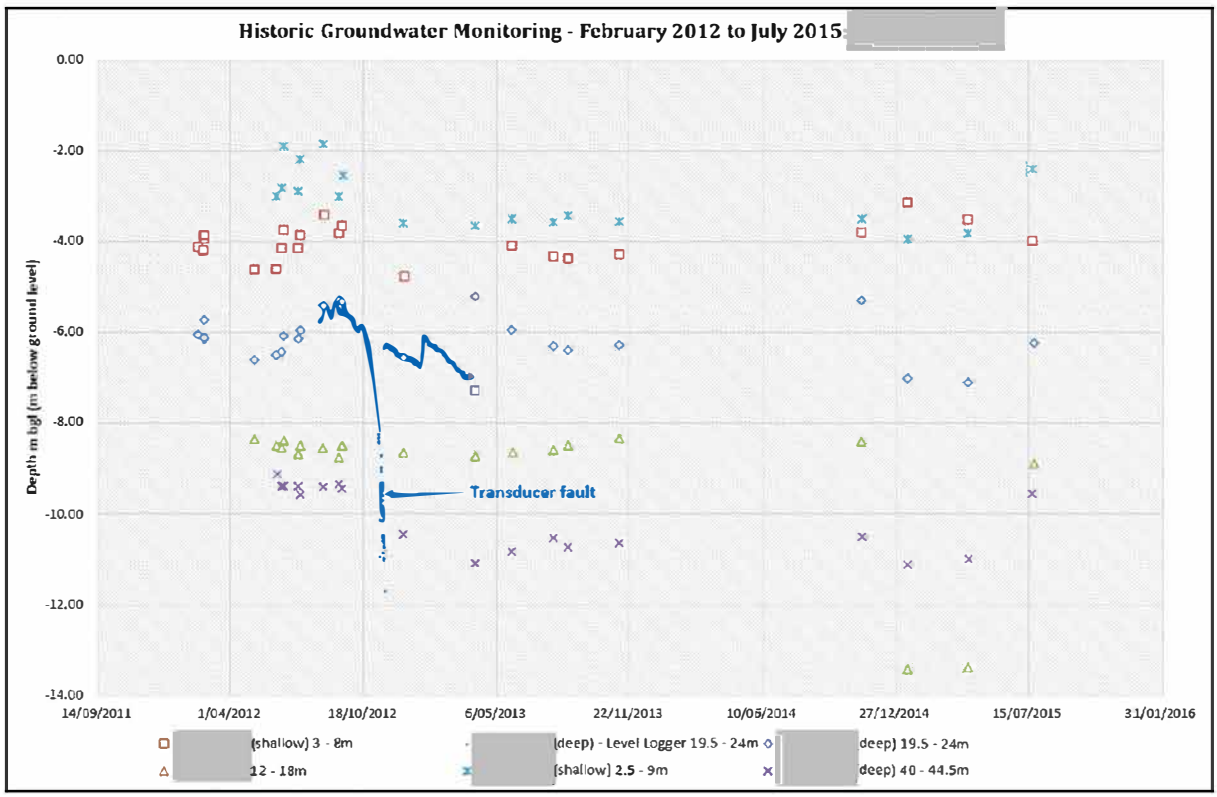
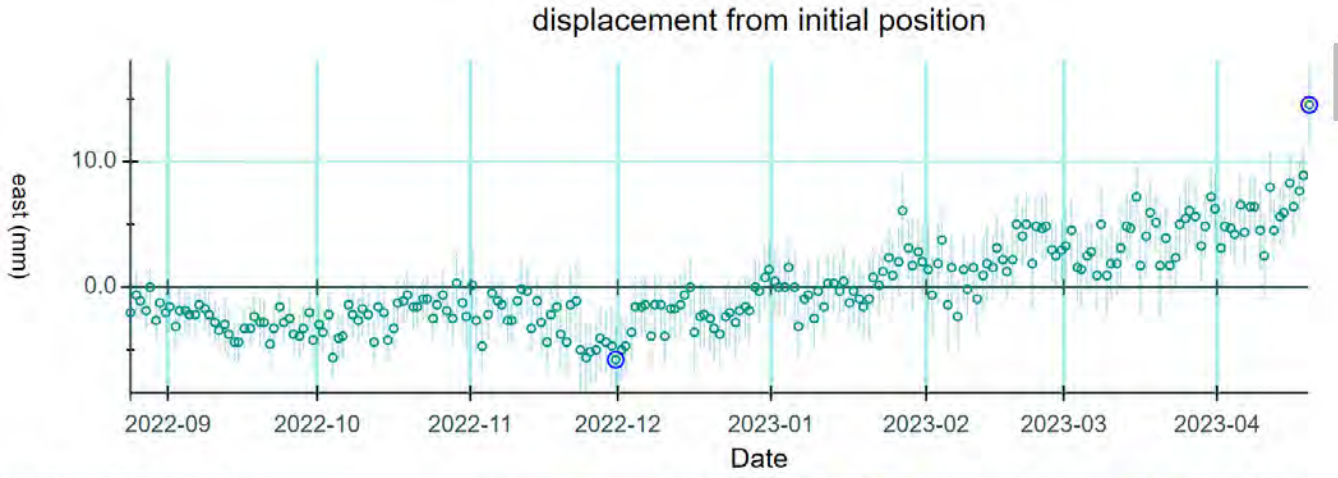


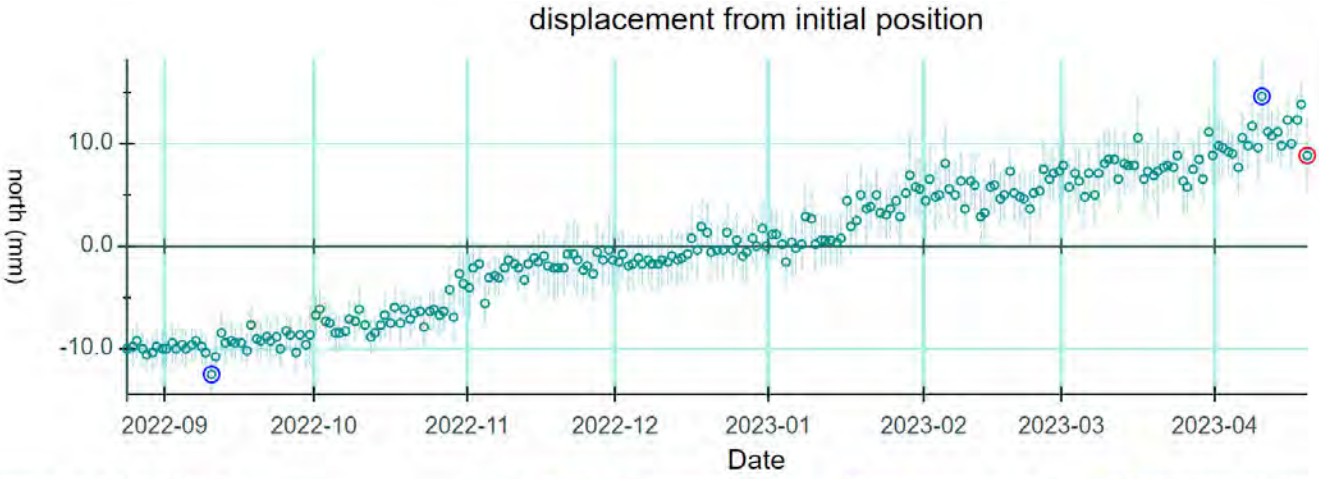
Figure D.1: Manual groundwater readings from [redacted] between February 2012 to July 2015.

GNS Continuous GPS - [redacted]



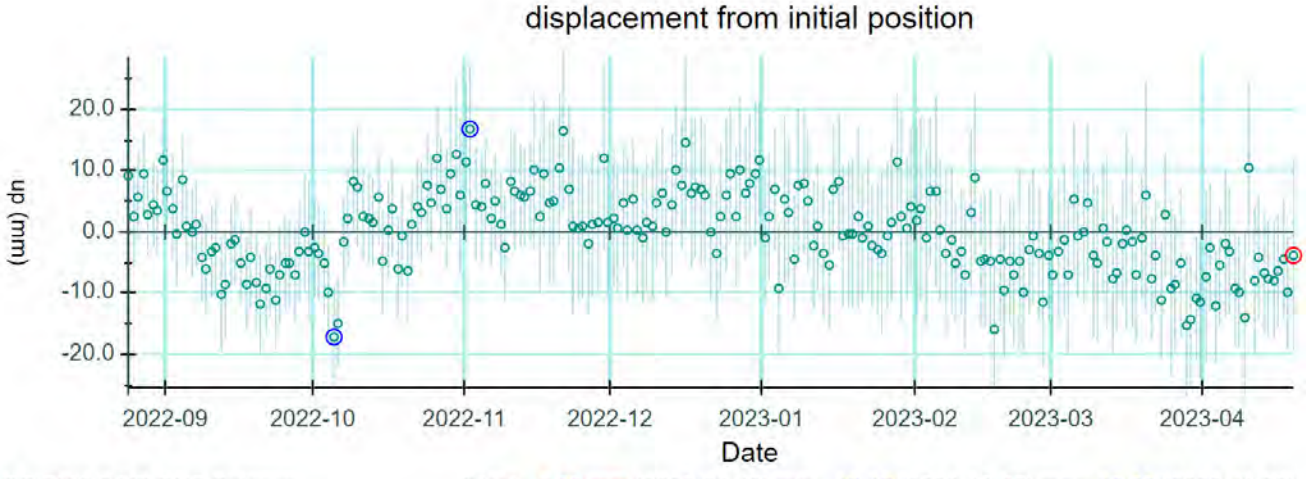
CC BY 3.0 NZ GNS Science

latest: 14.61 mm (2023-04-19) min: -5.70 (2022-11-30) max: 14.61 (2023-04-19)



CC BY 3.0 NZ GNS Science

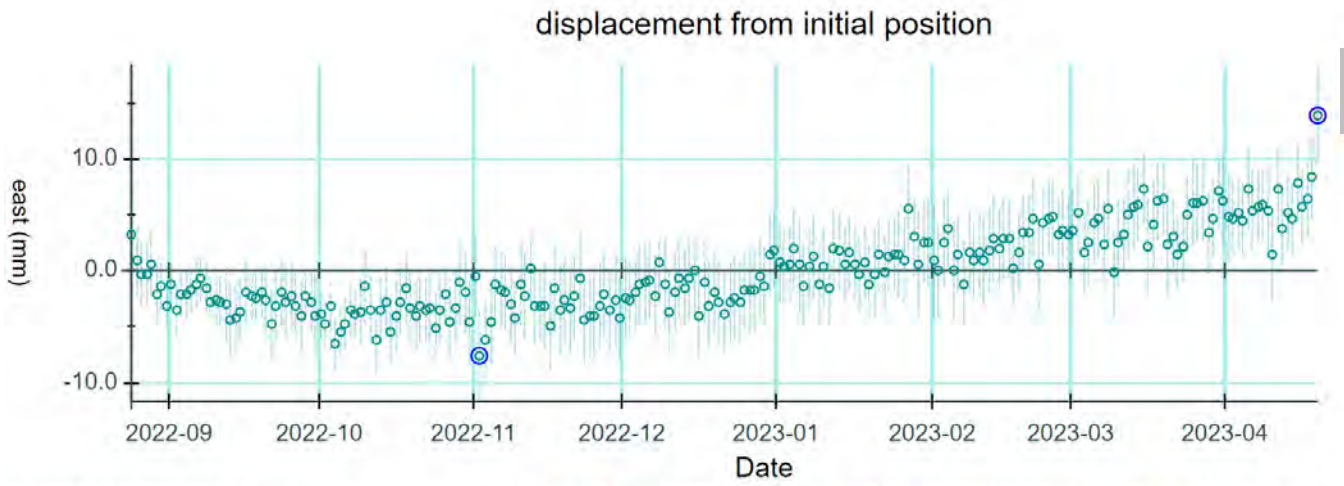
latest: 8.80 mm (2023-04-19) min: -12.57 (2022-09-10) max: 14.50 (2023-04-10)



CC BY 3.0 NZ GNS Science

latest: -3.99 mm (2023-04-19) min: -17.17 (2022-10-05) max: 16.68 (2022-11-02)

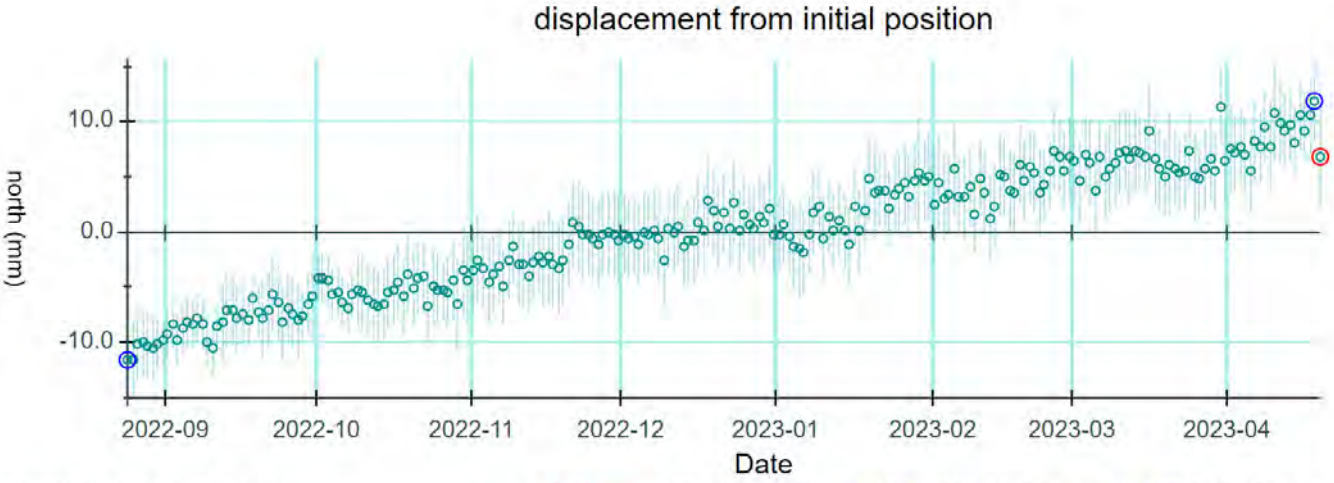
GNS Continuous-GPS - [redacted]



[redacted]

CC BY 3.0 NZ GNS Science

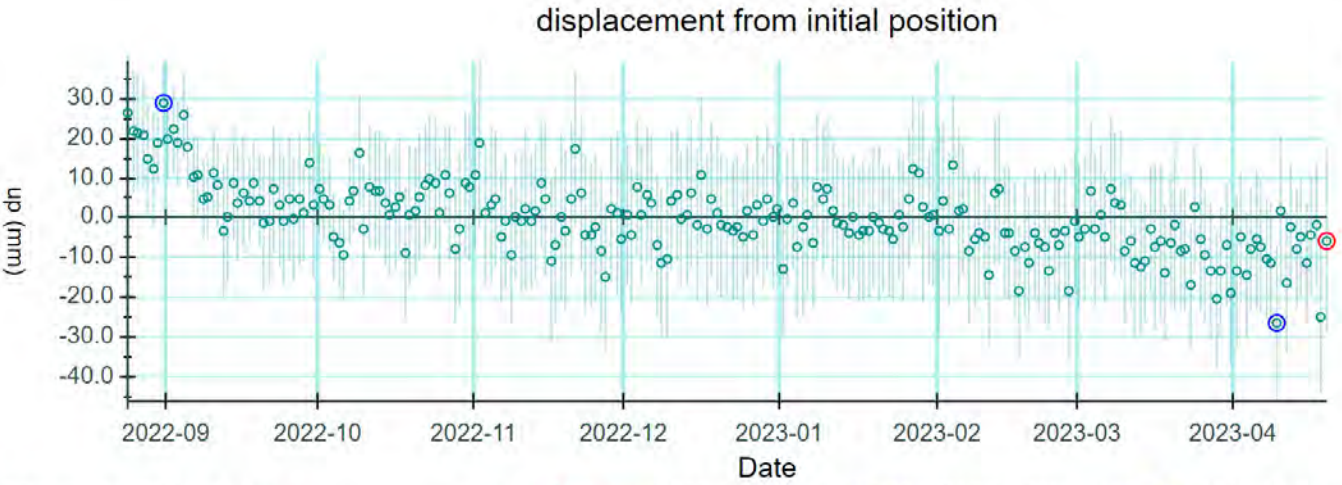
latest: 13.88 mm (2023-04-19) min: -7.56 (2022-11-02) max: 13.88 (2023-04-19)



[redacted]

CC BY 3.0 NZ GNS Science

latest: 6.70 mm (2023-04-19) min: -11.64 (2022-08-24) max: 11.85 (2023-04-18)



[redacted]

CC BY 3.0 NZ GNS Science

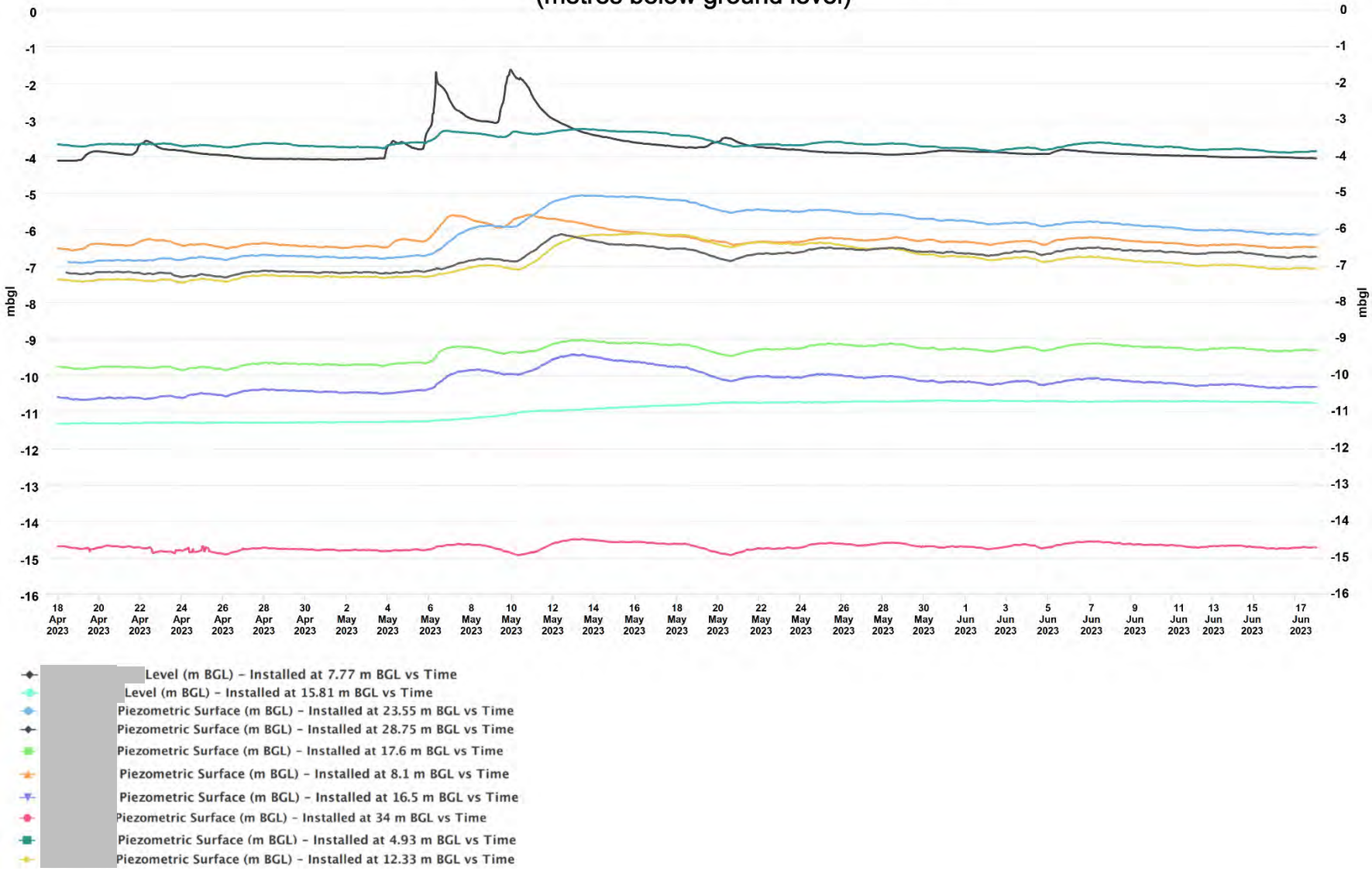
latest: -6.03 mm (2023-04-19) min: -26.28 (2023-04-09) max: 28.77 (2022-08-31)

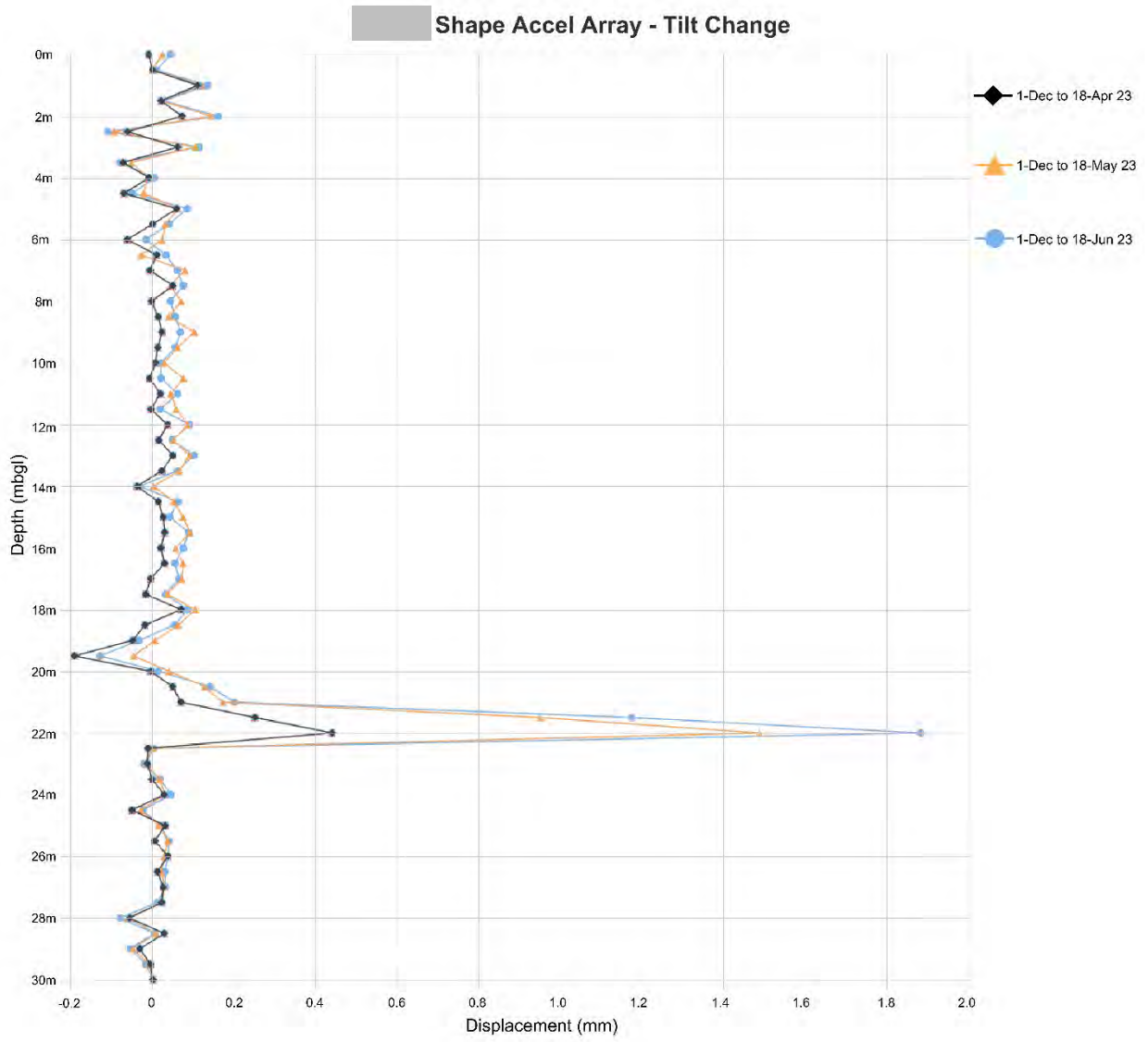
The preceding page was withheld in its entirety.

Appendix E Post April 2023 monitoring

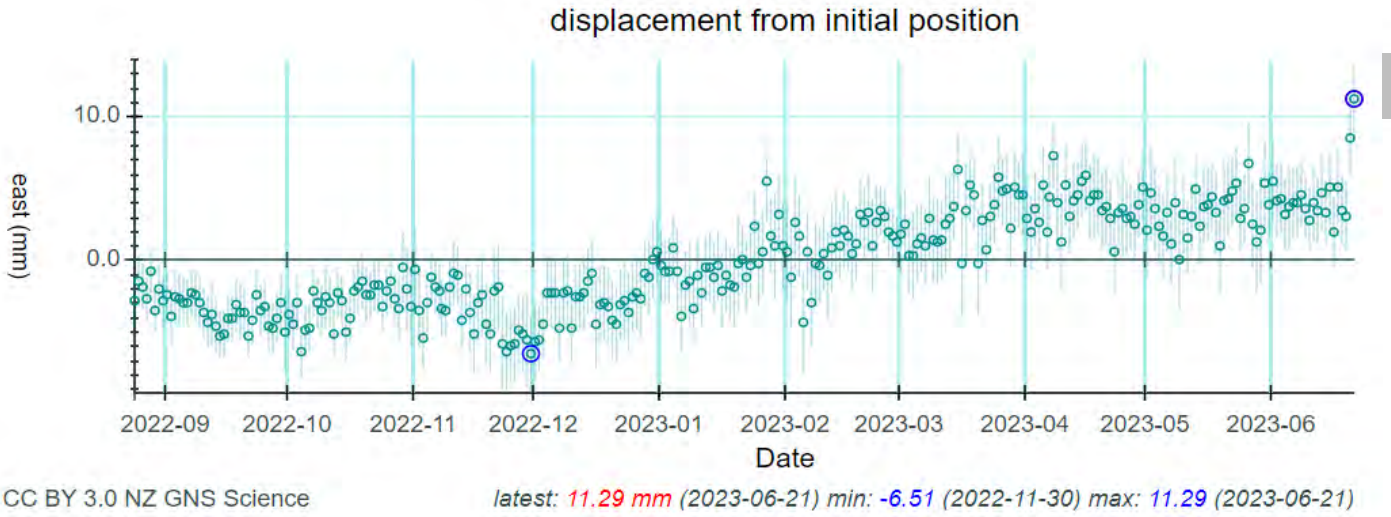
- **Groundwater monitoring data (post 19 April 2023).**
- **ShapeAccelArray data (post 18 April 2023).**
- **GNS continuous-GPS monitoring results (post 19 April 2023).**

Tahuanui Slump - Groundwater monitoring
(metres below ground level)

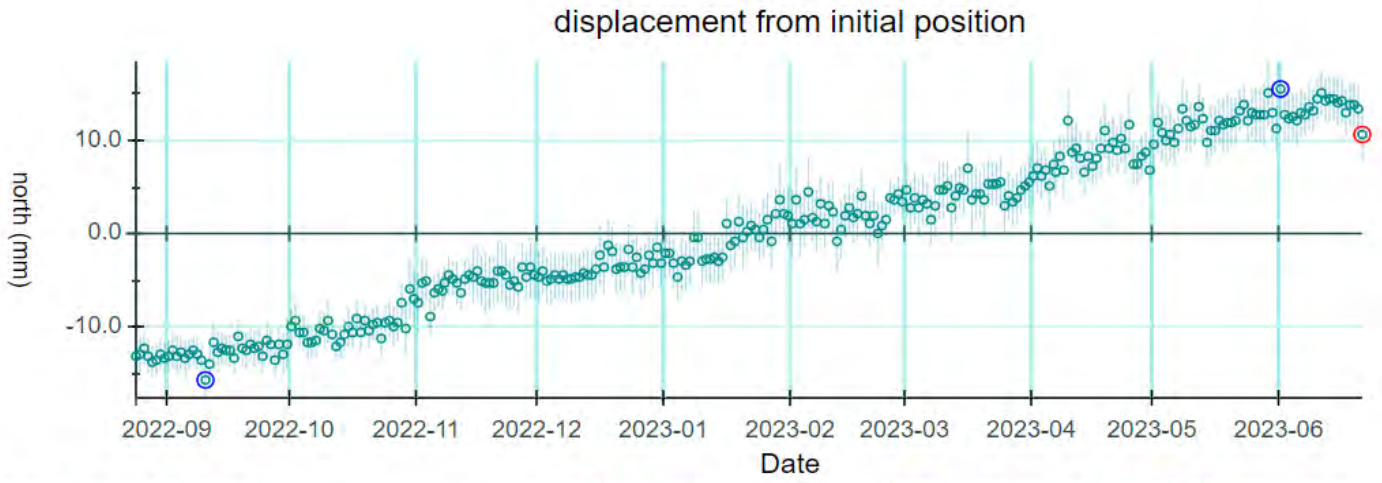



Shape Accel Array - Tilt Change
1-Dec to 18-Apr 23
1-Dec to 18-May 23
1-Dec to 18-Jun 23
Depth (mbgl)
0m
2m
4m
6m
8m
10m
12m
14m
16m
18m
20m
22m
24m
26m
28m
30m
-0.2
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Displacement (mm)

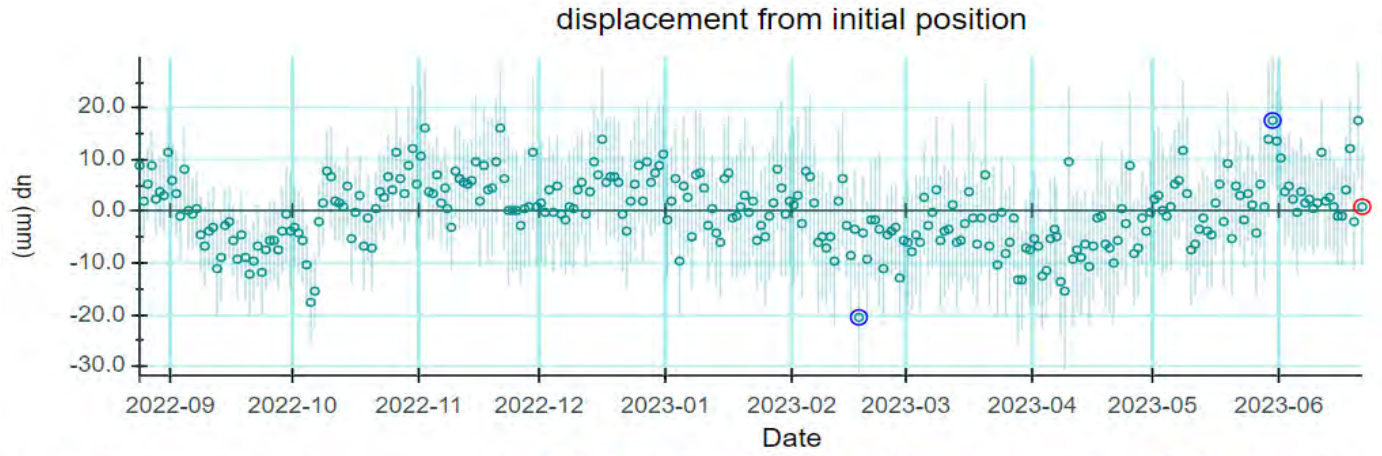
GNS Continuous GPS - NLS3 (1 Moncrieff Avenue) to 23 June 2023



latest: 11.29 mm (2023-06-21) min: -6.51 (2022-11-30) max: 11.29 (2023-06-21)

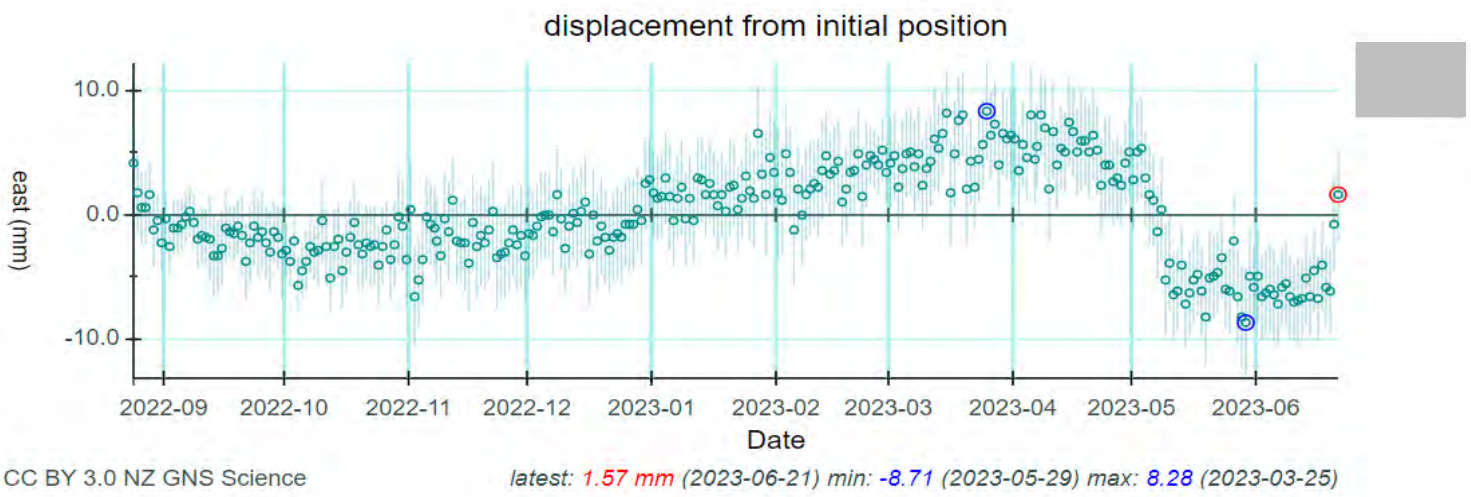


latest: 10.74 mm (2023-06-21) min: -15.70 (2022-09-10) max: 15.50 (2023-06-01)



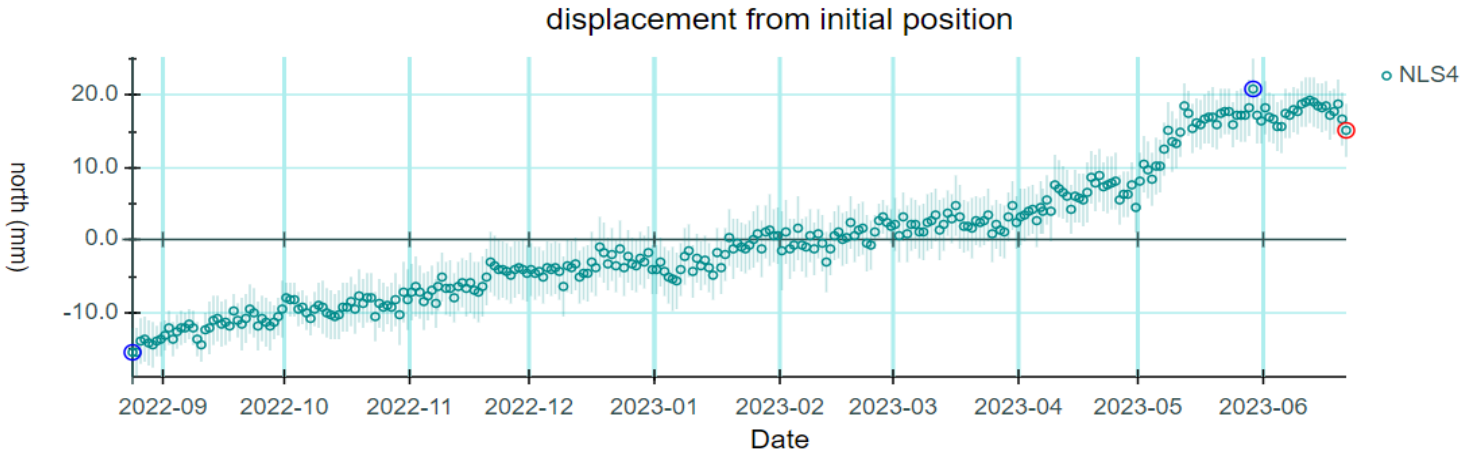
latest: 0.79 mm (2023-06-21) min: -20.59 (2023-02-17) max: 17.55 (2023-05-30)

GNS Continuous-GPS - [redacted] to 23 June 2023



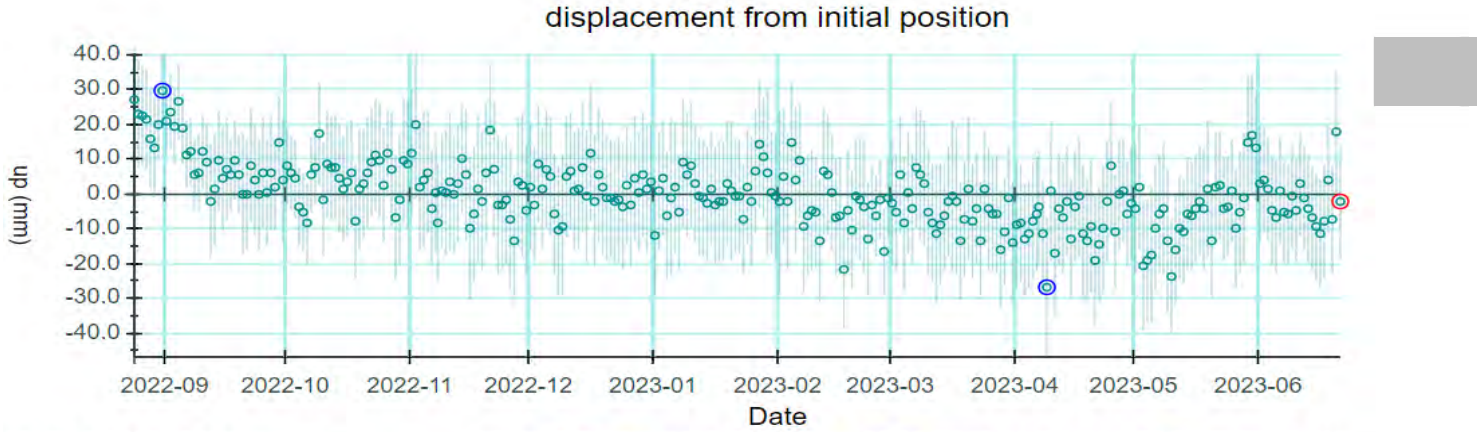
CC BY 3.0 NZ GNS Science

latest: 1.57 mm (2023-06-21) min: -8.71 (2023-05-29) max: 8.28 (2023-03-25)



CC BY 3.0 NZ GNS Science

latest: 15.21 mm (2023-06-21) min: -15.46 (2022-08-24) max: 20.87 (2023-05-29)



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latest: -2.07 mm (2023-06-21) min: -26.68 (2023-04-09) max: 29.81 (2022-08-31)

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