



Seton Portage Affordable Rental Housing – Geotechnical Assessment Report

Presented To: **Tsal'ah Government
c/o David Nairne + Associates Ltd.**

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Ecora's General Conditions are provided in Appendix A of this report.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation
ASTM	ASTM International (formerly American Society for Testing and Materials)
BC	(Province of) British Columbia
BCBC	British Columbia Building Code
BGC	BGC Engineering
bgl	below ground level
CBC	Crushed Base Course
CCIL	Canadian Council of Independent Laboratories
CFEM	Canadian Foundation Engineering Manual
CSA	Canadian Standards Association (Group)
Ecora	Ecora Engineering & Environmental Ltd.
EGBC	Engineers and Geoscientists of British Columbia
EIT	Engineer-in-Training
FCL	Flood Construction Level
GIT	Geoscientist-in-Training
NBCC	National Building Code of Canada
RP	Return Period
SGSB	Select Granular Sub-Base
SLRD	Squamish-Lillooet Regional District
SLS	Serviceability Limit State
SPMDD	Standard Proctor Maximum Dry Density
SPT	Standard Penetration Testing
TDC	Tsal'alh Development Corporation
ULS	Ultimate Limit State

1. Introduction

Ecora Engineering & Environmental Ltd. (Ecora) was retained by David Nairne + Associates Ltd. (David Nairne) on behalf of The Tsal'alh Government (Tsal'alh) to undertake a geotechnical assessment for a proposed development in Seton Portage, BC. The subject site includes lots 6, 7 and 8 at the intersection of Edward Road and Seton Portage Road. Tsal'alh is in the process of submitting a funding application to BC Housing to develop 16 units of affordable rental housing. The geotechnical findings, analysis, and recommendations within this report are intended to provide the necessary information to facilitate design, construction, and financial approval.

Ecora received approval to proceed from David Nairne + Associates Ltd. to complete the scope of work described in the project "RFP Geotechnical Engineering Services - Tsal'alh Government proposal" dated March 18, 2025. The scope of work includes the following tasks:

- Task 1 - Supplementary Geotechnical Investigation
- Task 2 - Preliminary Analysis, Design and Reporting
- Task 3 - Detailed Design and Tender Support
- Task 4 - Construction Geotechnical Services

2. Project Description

The proposed development entails the demolition of existing structures on the site to facilitate the construction of four new affordable rental multi-family dwellings. These structures are all intended to be fourplex buildings, collectively comprising sixteen units. The site plan prepared by David Nairne indicates that the development will include four two-bedroom units, nine three-bedroom units, and three four-bedroom units. An access road will be constructed extending northward from Seton Portage Road through the center of the site and terminating onto Edwards Road near the northern boundary of the property. On-site utilities developed as part of the project will include a water system located at the southeast corner and a septic field situated at the northeast corner of the site.

3. Site Description

The site consists of three lots situated within Seton Portage, BC, as shown in Figure 1.0. The site is bounded by Edward Road to the west, Seton Portage Road on the south, a parking area for Lil'tem' Mountain Hotel on the east, and the Seton Passing Track owned by CN Railway to the north. Seton River is located immediately north of the railway.

The three lots comprising the Site are previously developed residential properties. Lots 6 and 8 are aligned north south and represent the southwest and southeast portions of the Site, respectively. Lot 7 is aligned east-west, representing the northern portion of the Site. The combined surface area of all three lots is approximately 1.52 acres (approximately 6,150 m²). The Site's elevation ranges from 259 m above sea level (asl) to 265 m asl, peaking roughly in its center at the boundary of all 3 lots and sloping away in all directions.

4. Background Review

4.1 Existing Geotechnical Reports and Studies

4.1.1 Valley Geotechnical 2014 Report

Valley Geotechnical Engineering Services Ltd. conducted a geotechnical investigation for the site in 2014, consisting of eight test pits to depths of between 1.5 m and 2.1 m.

Soil conditions were described as “Loose, olive, silty SAND, mixes with gravel up to 0.45 m thick, over loose, dark grey, poorly graded GRAVEL mixed with sand and cobbles (colluvium) up to the depths explored”. They also noted boulders up to 0.6 m in diameter at 0.9 m below ground level in three test pits, and logs and rootlets in three test pits at 0.6 m below ground level. They encountered no groundwater or seepage during their investigation.

Shallow foundations were recommended with a minimum cover of 760 mm for frost protection. No mention of ground improvement other than general flood-proofing fill is made.

4.1.2 Existing Hotel 2014 Foundation Drawings

Ecora reviewed drawings named “Seton Portage Hotel – Foundation Details”, dated July 2014 and prepared by CanStruct Engineering Group.

Ecora understands that the current hotel exterior wall foundations consist of 457 mm wide strip footings buried approximately 1.2 m below ground level. Wall junction and floor junction strip footings are 711 mm wide. It appears from a review of architectural drawings that a crawl space was constructed such that the floor slab is a suspended timber structure spanning between footings rather than slab-on-grade.

4.1.3 BGC 2018 Report

BGC Engineering (“BGC”) completed a risk assessment for debris flow hazards through Bear Creek, Whitecap Creek and Spider Creek, which are near Seton Portage. They presented this assessment in a report named “Seton Portage Area Integrated Hydrogeomorphic Risk Assessment” and dated April 6, 2018.

As part of their assessment, they completed 22 test pits across Seton Portage to depths of between 3 m and 15 m. The test pits were generally conducted on the south side of Seton Portage, on or near Bear Creek Fan.

The main finding from their report of relevance to the subject site is the identification of the potential for debris flows and debris floods from Bear and Pete’s creeks. Run-out maps indicate that following the 300-year return period event, debris could reach the subject property.

4.1.4 Ecora 2023 Hydrotechnical Report

The Tsa’alh Government engaged Ecora in 2023 to undertake conceptual design of a berm to protect Seton Portage from the debris flow and debris flood events that were identified by BGC in 2018. Hydrotechnical modelling was undertaken for several berm alignment options. The preferred berm will extend from the edge of Cresta Road to Spyder Creek Road, at the bend in Seton River, where the outlet structure will be located. It will deflect flows from Bear and Pete’s Creek around the core of Seton Portage so that they discharge into Seton River downstream from the subject site.

Ecora's conceptual berm design is outlined in the report entitled "Preliminary Design Report: Seton Portage Flood Hazard Mitigation Planning – Bear/Pete's Creek" dated October 2023. Detailed design and construction of the berm are awaiting funding application approvals.

4.1.5 Ecora 2023 Geotechnical Report

The Tsai'ah Development Corporation (TDC) hired Ecora to perform a geotechnical assessment for Seton Portage, BC. The 2023 project area included the Site for this 2025 assessment, as well as three additional lots to the east, measuring about 130 by 200 m in total. The proposed development plan involved demolishing the existing structures to build parking, residential units, a park, and a community center. Ecora's scope of work included a desktop study, an intrusive investigation, analysis, and geotechnical reporting.

Ecora's desktop study reviewed geology, water well data, aerial photos, reports, and foundation plans. The historical air photos showed that the site was previously developed, indicating the subsurface soils would be partially comprised of disturbed fill.

Ecora's intrusive investigation included one borehole drilled to a termination depth of 30.2 m below ground level (bgl), and six test pits to 3 m bgl. The subsurface includes gravel fill at 0.3- 0.45 m bgl, over cobbly sandy gravel and sand to 23.8 m bgl, and gravelly sand to 30.2 m bgl. Groundwater was found at a depth of 5.5 m bgl, with seasonal fluctuations anticipated depending on the levels of the adjacent lake and water availability.

Ecora completed a liquefaction assessment using Standard Penetration Testing (SPT) and shear wave data to estimate the potential free-field displacements of 60 mm and lateral spreading of less than 15 mm. The report noted that although liquefaction could occur, surface impacts were unlikely.

Based on Ecora's analysis of the background information and encountered site conditions, the following geotechnical recommendations were provided for the proposed site development:

- No ground improvements were advised if structures were designed as proposed at that time.
- Shallow foundations were recommended, with an Ultimate Limit State (ULS) bearing capacity of 300 kPa and Serviceability Limit State (SLS) of 200 kPa.
- Frost depth was required to be 760 mm to adhere to the local bylaws.
- Floors were required to be at or above flood construction level (FCL) as outlined in the hydrotechnical assessment. However, Ecora noted that the elevation of the FCL for the design depended on whether the mitigation measures provided in the hydrotechnical report were installed.
- Site preparation required removing topsoil and unsuitable materials to a minimum depth of 0.15 m bgl.
- The Site was recommended to be graded away from structures to prevent surface ponding near foundations.

4.1.6 Ecora 2024 Hydrotechnical Report – Flood Construction Levels

TDC requested Ecora to undertake a hydrotechnical assessment to determine FCL for new development areas in Seton Portage, BC, and to prepare flood maps to indicate flood hazards in the study area. The work was completed under a Community Emergency Preparedness Fund grant from the Union of BC Municipalities for 'Disaster Risk Reduction - Climate Adaptation'.

Details of the results and analysis are in Ecora's report entitled "Hydrotechnical Report – Seton Portage Flood Construction Levels and Mapping" dated May 2024.

4.2 Publicly Available Data

4.2.1 Published Surficial Geology

Based on the “Surficial geology, Vancouver Island and adjacent mainland, British Columbia, map” (Clague, Fulton, & Ryder, 1982) the site is situated within an area of rock mixed with discontinuous colluvium and till. The full description of the surficial geology unit is defined as:

Rock with discontinuous colluvium and till -- alpine mountains:

Major rock landforms consist of aretes, cirques, glaciated valleys and various other alpine glacial forms. A discontinuous mantle of colluvial rubble is present on most slopes and aprons and cones of colluvial debris occur at the toes of many slopes. A till veneer (dMv sMv) is present on lower parts of valley walls with thicker till occurring locally in valley bottoms and thin discontinuous till present at higher elevations. Colluvium and till are generally <2 m thick. Valleys are generally occupied by complexes of colluvial debris, channel sediments, overbank deposits and low gravel terraces (Fx) which locally may be as much as 10 m thick but are too small to map at this scale.

4.2.2 Published Bedrock Geology

The geology of the area surrounding the Bridge River was described in “Geology and Mineral Occurrences of the Taseko - Bridge River Area” (Schiarizza, Gaba, Glover, Garver, & Umhoefer, 1997). The Site lies within the Bridge River Complex and is comprised of a combination of marine sedimentary and volcanic rocks. The rock types included in the bedrock unit include ribbon chert, argillite and pillowed to massive basalt, with lesser amounts of limestone, gabbro, diabase, serpentinite, siltstone, sandstone, pebble conglomerate, slate, phyllite and quartz phyllite.

4.2.3 Water Well Database

IMapBC (Government of British Columbia, 2025) identified two water wells located on site, and two located on immediately neighbouring lots with drilling logs. A summary of the subsurface lithology encountered during water well installation is detailed in the tables below.

Well #50957 is located on the southern side of Lot 8. A summary of the ground conditions encountered is presented in Table 4-1 below.

Table 4-1 Well #50957 Summary

Depth From (m)	Depth To (m)	Driller's Description
0.0	3.0	“sand, gravel and boulders”
3.0	6.4	“silt, till, gravel and boulders”
6.4	8.5	“sand and gravel”
8.5	15.2	“water-bearing sand and gravel”

Well #47098 is located on the south extent of Lot 6. A summary of the ground conditions encountered is presented in Table 4-2 below.

Table 4-2 Well #47098 Summary

Depth From (m)	Depth To (m)	Driller's Description
0.0	6.1	“Sources of water, gravel and boulders ”
6.1	10.7	“silty sand and gravel”

Depth From (m)	Depth To (m)	Driller's Description
10.7	13.7	<i>"wet silty sand and gravel"</i>
13.7	17.7	<i>"coarse, water-bearing gravel"</i>

Well #66918 is located on the central portion of the neighboring property, Lot 9. A summary of the ground conditions encountered is presented in Table 4-3 below.

Table 4-3 Well #66918 Summary

Depth From (m)	Depth To (m)	Driller's Description
0.0	4.9	<i>"existing well"</i>
4.9	11.6	<i>"wet silty sand & gravel"</i>
11.6	17.7	<i>"water-bearing sand and gravel"</i>

Well #50958 is located on the neighboring lot across the street south of Lot 8. A summary of the ground conditions encountered is presented in Table 4-4 below.

Table 4-4 Well #50958 Summary

Depth From (m)	Depth To (m)	Driller's Description
0.0	3.4	<i>"dry sand, gravel and boulders"</i>
3.4	7.3	<i>"silty till, gravel and boulders"</i>
7.3	9.1	<i>"wet, silty sand and gravel"</i>
9.1	15.2	<i>"water-bearing sand and gravel"</i>

4.2.4 Historical Aerial Photograph Review

Ecora reviewed the following aerial imagery and made the observations below as part of the 2023 geotechnical project:

- The University of British Columbia air photos dated 1947, 1951, 1960, 1964, 1969, 1975, 1982, 1987, 1993, 1997 and 2005.
- Google Earth aerial imagery dated 2005, 2010, 2019 and 2021.
- Ecora drone imagery dated 2023.

In 1947, very few houses are present within the community. One row of tree clearing, most likely for electrical transmission lines, are clearly present running north of Seton Portage. Additionally, the railway is also present as well as small tree clearing within the town which are possibly fields or houses. Two steep slopes devoid of trees, which appeared to be historical landslides, are present north of Seton Portage, along Whitecap Creek. By 1960, two additional tree cleared areas, similar to the one present in 1947 are observed.

Between 1982 and 1987, multiple buildings are constructed within the town center, including a smaller building at the front of the parking lot for the current Lil'tem' Mountain Hotel. Since then, multiple buildings were built as well as removed, suggesting the possible existence of fill material with the area. Figure 1.1 through 1.4 attached presents the Seton Portage core in 1997, 2005, 2019 and 2021.

5. Intrusive Geotechnical Investigation

5.1 General

Ecora conducted a geotechnical site investigation on June 17, 2025, using a John Deere 35D Mini excavator operated by TDC and a sonic drill operated by Downrite Drilling. Sonic Drilling employs the use of high-frequency, resonant energy generated inside the sonic head to advance a core barrel or in this occasion, a casing. No water, air or drilling muds are introduced during sonic drilling resulting in minimal waste and faster production rate compared to conventional rotary methods.

The investigation comprised the excavation of four test pits to a maximum depth of approximately 1.7 m bgl and one sonic test hole to a maximum depth of approximately 20.4 m bgl. Test pits were terminated at 1.7m bgl to perform percolation tests and estimate the infiltration rates on site.

The site investigation was supervised by Ecora geotechnical personnel who logged the soil and collected representative soil samples for visual identification. The test hole and test pits were backfilled immediately upon completion. The subsurface conditions encountered are described in Section 5.2 and detailed logs are included in Appendix B.

The test hole and test pits are summarized in Table 5-1 below. The locations of the test locations are shown on the attached site plan in Figure 1.0. The detailed test pit logs are provided in Appendix B.

Table 5-1 Summary of Test Hole and Test Pits

Test No.	Easting	Northing	Test Pit Depth (m bgl)	Comments
TH25-01	550219.0	5617598.4	20.4	Target Depth
TP25-01	550255.3	5617626.1	1.7	Target Depth
TP25-02	550256.0	5617616.7	1.7	Target Depth
TP25-03	550244.2	5617609.9	1.7	Target Depth
TP25-04	550235.8	5617622.3	1.7	Target Depth

Samples retrieved from the test pits were returned to Ecora's laboratory for moisture content and grain size analysis tests. The test results from the analysis are summarized in Section 5.3 and the detailed test results are included in Appendix C.

5.2 Encountered Subsurface Conditions

5.2.1 Soil Conditions

The soil conditions described below were encountered during the site investigation in the following sequence:

Uncontrolled Fill:

Uncontrolled FILL was encountered in all test pits to the termination depth at 1.7m bgl, and in the *Test Hole (TH25-01)* to a maximum depth of 2.7m bgl. Uncontrolled fill was identified by the presence of occasional construction debris, including electrical conduits and broken concrete. The grain size consisted of SAND and GRAVEL, SAND with trace gravel, or GRAVEL with trace sand. Based on the grain size composition being similar to that of the surrounding native soils, the uncontrolled fill is inferred to be reworked material on site or locally sourced soils.

Alluvial Deposits:

Alluvial deposits were encountered from approximately 2.7m bgl to the termination depth of the test hole at 20.4 m bgl. The n-values derived from SPTs in TH25-01 ranged from 10 to 20, indicating that the native soils are compact. The dominant grain size was comprised of SAND and GRAVEL to 3.2 m bgl, GRAVEL to 5.4 m bgl, GRAVELLY SAND extending to 14.5 m bgl, and SAND to the termination depth of 20.4 m bgl. The grain size distribution was poorly graded (well sorted), with minimal fines. The gravel was primarily subrounded, with occasional subangular shapes indicating low to moderate wear by alluvial processes prior to deposition.

5.2.2 Groundwater Conditions

Groundwater was encountered at 4.13 m bgl during the drilling investigation. The static water level in TH25-01 was measured at 3.88 m bgl after the drilling investigation in a monitoring well installed during backfilling with a screen from 3.1 m bgl to 6.1 m bgl.

5.2.3 Percolation Testing Results

Ecora completed four percolation tests at 1.7 m bgl on the base of the test pits, above the static groundwater elevation. Percolation tests were performed as per the test procedures found in the BC Sewerage Practice Manual (2014). The testing procedure involved filling a 6" (150 mm) deep hole with water and recording how long it takes for the water level to drop to 5" (127 mm). The rate of infiltration stabilized after four to five 25 mm (1") drops in the water level. The percolation results measured on site are detailed in Table 5-2 below.

Table 5-2 Summary of Percolation Test Results

Test number	Depth of base of hole from surface (m)	Recorded Time (mins per inch for water to drop from 6" to 5" from base of hole)					Lowest rate (min per inch)
		Reading #1	Reading #2	Reading #3	Reading #4	Reading #5	
TP25-01	1.7	5.25	5.75	6.00	5.80		6 minutes
TP25-02	1.7	2.00	1.50	1.25	0.75	0.70	2 minutes
TP25-03	1.7	0.50	0.50	0.50	0.45		0.5 minutes (30 sec)
TP25-04	1.7	0.30	0.17	0.17	0.17		0.3 minutes (18 sec)
Notes:	TP25-01 - At 1.7 m bgl: Compact SAND, some Gravel, trace to some Fines, trace cobbles, dry. TP25-02 - At 1.7 m bgl: Compact SAND and GRAVEL, trace Fines, trace Cobbles, dry. TP25-03 - At 1.7 m bgl: Compact SAND and GRAVEL, some Cobbles, trace Fines, dry. TP25-04 - At 1.7 m bgl: Loose SAND and GRAVEL, trace Fines, trace Cobbles, moist.						

5.3 Laboratory Testing

Laboratory testing was conducted on select representative samples to confirm the field observations and geotechnical index properties of the subsurface soils. Testing was conducted in general conformance with the relevant ASTM Standards at Ecora's laboratory, certified by the Canadian Council of Independent Laboratories (CCIL). The following tests were performed:

- Grain Size Analysis (ASTM D6913)
- Moisture Content Testing (ASTM D2216)

Table 5-3 provide a summary of the laboratory testing results. Soil descriptions and classifications can be found within the logs attached in Appendix B, and the detailed laboratory test results are presented in Appendix C.

Table 5-3 Summary of Grain Size Analysis Laboratory Test Results

Test Pit No.	Sample Depth (m bgl)	Moisture Content (%)	Grain Size Distribution (%)		
			<i>Gravel</i>	<i>Sand</i>	<i>Fines</i>
TH25-01	3.0 – 3.6	10.5	43.5	50.6	5.9
	4.6 – 5.2	11.7	30.7	64.1	5.2
	6.1 – 6.7	12.2	30.3	67.1	2.6
	7.6 – 8.2	12.7	20.0	77.5	2.5
	12.2 – 12.8	6.4	29.2	67.7	3.1
	16.8 – 17.4	14.6	12.7	84.3	3.0
TP25-01	1.5 - 1.7	1.4	14.5	71.7	13.8

6. Seismic Considerations

For the seismic considerations and liquefaction triggering analyses, the following three sets of information were utilized:

- A downhole shear wave test (Cased test hole to a termination depth of 30.2m bgl) performed by Ecora during the 2023 geotechnical site investigation in close proximity to the subject Site, see Figure 6.1;
- SPT data obtained from the 2023 site investigation utilizing mud-rotary drilling technique to a termination depth of 30.4m bgl; and,
- SPT data obtained from this Study utilizing sonic drilling technique to a termination depth of 20.4m bgl;

The encountered subsurface conditions in the sonic test hole, in terms of lithology and layer thicknesses, were very similar to the conditions in the borehole from the 2023 investigation, however, the SPT blow counts obtained from the sonic drilling were consistently lower than the ones obtained from 2023 study using Mud-rotary drilling.

As noted in CFEM, 2023, due to vibrations and repeated cyclic loading during sonic drilling, soil samples are sometimes disturbed which we consider was the case in our current (2025) investigation program. As such, for the liquefaction triggering analyses, Ecora utilized the 2023 Vs and SPT data obtained from mud-rotary drilling technique with the static groundwater table measurement (3.88 mbgl) from our recent investigation program.

6.1 Liquefaction Triggering Assessment

A liquefaction triggering assessment was undertaken utilizing both SPT data and the Shear Wave Velocity readings from 2023 Ecora Report. The analysis was completed using LiqSVs by GeoLogismiki (v 2.3.2.9), a data-processing software for liquefaction analysis. The analysis was completed for the 2475-year return period earthquake. A surface PGA of 0.19g was used based on $V_{s30}=288$ m/s and the 6th Generation seismic hazard from the Earthquakes Canada online calculator.

The Cyclic Stress Ratio (CSR) was adjusted to a 6.35 magnitude event based on deaggregation plots from Earthquakes Canada. The Cyclic Resistance Ratio (CRR) was adjusted to account for the soil conditions based on the field descriptions and laboratory index testing.

A design groundwater depth of 3.88 m was utilized based on our monitoring well reading following completion of our investigation program.

The Boulanger and Idriss (2014) SPT triggering methodology was primarily relied upon however a shear wave velocity (V_s) approach was also utilized (Kayen et. al. (2013)) to account for potential impacts to SPT readings from larger particle sizes. A summary of the results is presented below:

- A 1.0 m thick layer of liquefiable material was identified extending from the design 4.5 m to a depth of 5.5 m. This was associated with the lower V_s reading in this interval of 129 m/s. SPT-readings within this material were in the order of $N=29$ and the SPT analysis indicated that this material was non-liquefiable.
- The SPT based analysis indicated liquefiable material (compact gravelly sand) between depths of 8 m – 12.5 m (4.5 m thick) and between depths of 19 m – 23.5 m (4.5 m thick) within the compact sand and gravel. The V_s based analysis indicated that these layers were not liquefiable.

6.2 Liquefaction Induced Displacements

Liquefaction induced (free field) displacements were estimated to be in the order of 60 mm noting that these estimates do not include shear-induced (i.e. building load) and ejecta-induced settlements. Once building dimensions have been determined, the total liquefaction induced settlements can be estimated.

Lateral spread displacements are estimated to be less than 15 mm, assuming no structure is closer to the river than the existing hotel.

6.3 Liquefaction Potential & Severity

Liquefaction triggering and seismically induced displacements are expected at the site as result of the design earthquake. However, the liquefiable layers are relatively thin and at significant depths. As such, surface manifestation and building damage will be mitigated by the “crust” of non-liquefiable material. Ecora considered several methods for assessing the surface manifestation and damage. A brief summary of the methods used is included below:

- H1-H2 method – Ishihara (1985) proposed an empirical relationship between the thickness of the “crust” (H1) and the extent of the liquefiable soils below (H2), and the manifestation of liquefaction at the surface. This method results in a “yes” or “no” answer with regards to manifestation of liquefaction at the surface.
- Liquefaction Potential Index (LPI method) – Initially developed by Iwasaki (1982), this method sums the shear strains calculated during the liquefaction triggering analysis, and normalizes them for depth. An LPI between 0 and 2 indicates a low liquefaction potential, between 2 and 5 a moderate potential, between 5 and 15 a high potential and higher than 15 for a very high potential.
- Liquefaction Severity Number (LSN method) – Initially developed by Tonkin and Taylor (2013) following the Christchurch earthquakes of 2010/2011, this method is similar to the LPI method, but accounts for a depth. LSNs between 0 and 20 indicate little to no expression of liquefaction at the surface, between 20 and 40 indicate some expression of liquefaction at the surface, and greater than 40 indicates severe expression of liquefaction at the surface and severe building damage.

Table 6-1 below summarizes our results:

Table 6-1 Liquefaction Impact at Surface Summary

Investigation Data	Analysis Method		
	H1-H2	LPI	LSN
SPT	No manifestation at the surface.	1.76	2.8
Vs	No manifestation at the surface.	1.22	9.9

The above assessment suggests that although liquefaction triggering may occur at the site, the potential for surface manifestation and building damage is unlikely.

Based on this, we do not consider the need for ground improvement provided that the structures can be designed to accommodate seismic ground movements (see Section 6.2) while meeting the life safety and serviceability requirements of the building code.

A key assumption of this assessment is the soil thickness between the relevant structure and the liquefiable layers at depth. Any fill placement would increase this thickness, therefore reducing the risk of manifestation, while buried structures or excavations would result in a reduced thickness, elevating the risk of manifestation.

6.4 Site Class

As noted above, liquefaction triggering is expected as a result of the 2475-year return period earthquake. As such, the site should be classified as “*Site Class F*”. If the fundamental period of the structure is determined to be at or above 0.5 seconds, a site response analysis will be required as per NBCC/BCBC building code requirements to determine the response spectra.

If the fundamental period of the structure is determined to be less than 0.5 seconds, the response spectra can be determined from the online Earthquakes Canada seismic hazard calculator utilizing $V_{s30}=288$ m/s.

7. Geotechnical Considerations

7.1 General

The following presents a summary of our findings and analysis:

- Seton Portage is located between two glacial lakes, and steep slopes. As such, the community is vulnerable to a variety of hydrogeomorphic hazards. Such hazards were investigated in part by BGC's 2018 assessment and further discussed briefly in the following Section below;
- The encountered subsurface condition at the site comprises of “Sand and Gravel” from the surface down to a depth of 4.6 m bgl, which overlays “Gravelly Sand” down to a depth of 14.5 m bgl, which in turn is over compact “Sand” to a depth of 20.4 m bgl (the end of the Test Hole);
- The subsurface conditions encountered across the subject site align similarly with the same conditions encountered in the 2023 Geotechnical Investigation;
- At the time of investigation, the groundwater table was encountered at approximately 3.88 m bgl;
- A seismic site classification of “Class F” is considered due to the presence of liquefiable soils discovered in the 2023 Geotechnical Investigation;

- Shallow foundation systems are considered appropriate for the proposed development due to the native sands and gravels with low fines content; and,
- The flood construction level is currently 251.3 m (geodetic), as determined by 2024 Ecora Hydrotechnical Report.

7.2 Hydrogeomorphic Geohazards

Seton Portage is located between two glacial lakes, and steep slopes. As such, the community is vulnerable to a variety of hydrogeomorphic hazards. Such hazards were investigated in part by BGC's 2018 assessment. A summary of these hazards is presented below:

- **Flooding:** Seton River connects Anderson Lake in the west with Seton Lake in the east. The river is approximately 2.8 km long, and generally 15 m to 45 m wide. River terraces have been identified by BGC, 2018, indicating a history of flooding. These flood events may be caused by large storm events, debris flows from the nearby creeks and landslide generated water displacement. Ecora is assessing the Flood Construction Level (FCL) for the core of Seton Portage in a separate report, and although final results are not available at the completion of this report, preliminary findings indicate that some level of flood proofing fill will be required.
- **Debris Floods and Flows:** Four active creeks are present within the community of Seton Portage: Bear and Pete's creeks, Spider creek and Whitecap creek. These creeks are subjected to debris flows and flood events, which all have a significant likelihood of reaching the project area. Ecora is currently designing a debris berm to protect the community from debris flows originating from Bear and Pete's creeks. **It should be noted that until it is installed, the current project area is at significant risk of being impacted by such events.** BGC's report should be consulted for further detail on the risks.

7.3 Flood Construction Level

In May 2024, Ecora issued a hydrotechnical report to Tsal'ah entitled "Hydrotechnical Report – Seton Portage Flood Construction Levels and Mapping". The report determined FCL's for new and proposed development areas in Seton Portage.

The location of the proposed affordable housing currently has a FCL of 251.3 m (geodetic).

The Hydrotechnical Report (2024) consisted of three phases: hydrological analysis, bathymetric surveying, and hydraulic analysis. The work was completed in accordance with Squamish-Lillooet Regional District (SLRD) bylaws and EGBC flood assessment and mapping guidelines. The design flood return period (RP) for FCL determination was taken as 200-years, and the design freeboard was selected as 0.6 m.

All living areas should be located above the FCL. No enclosed space shall be used for habitation or storage of goods that can be damaged by floodwaters below the FCL. The top of the floor slab (or bottom of wooden joist system) for any habitable space must be above the FCL. It is highly recommended that all mechanical and electrical equipment should be constructed and installed above the FCL.

Refer to the Hydrotechnical Report (2024) for further detail of the analysis and results.

7.4 Foundation Recommendations

7.4.1 Shallow Foundations

Provided that the seismic displacements can be accommodated, Ecora considers shallow foundations (pads and strip footings) or raft foundations as suitable for the proposed buildings without the need for ground improvement.

Ecora recommends a factored Ultimate Limit State bearing resistance of 250 kPa (factored ULS, using a resistance factor of 0.5), and a Serviceability Limit state resistance of 175 kPa (SLS) for strip and pad foundations. These recommendations are applicable to a maximum footing width of 750 mm and maximum pad dimensions of 2.4 m by 2.4 m extending to the frost burial depth recommended later in this report. It should be noted that this bearing resistance is preliminary and should be confirmed by Ecora once structural drawings are available to account for foundation shape, depth and any other factors which may affect the bearing capacity.

Prior to construction of the footings, the subgrade under the proposed footings should be compacted in-situ with a 1000 lb. plate compactor (or approved equivalent) for at least three passes to address any loose soils that may be present.

Provided the structure is designed to the above bearing resistance values, settlements are not likely to exceed 25 mm of total settlement and 1/250 of differential settlement under static conditions.

Foundation subgrade should be clear of any material larger than 75 mm in diameter, which may be likely based on the subsurface investigation.

7.4.2 Site Preparation

Ecora anticipates that some flood proofing fill will be required at the site.

Prior to the placement of flood proofing fill and any other structural fill, all areas should be stripped of vegetation, topsoil, and other deleterious material to expose native sand and gravels. Based on conditions encountered, we anticipate that stripping and sub-excavation depths required to remove the topsoil and expose competent subgrade will be approximately 0.3 m below current ground level. Greater excavation depths may be required in localized areas.

Additionally, when used as structural fill, the native soils should be removed of any material with a diameter greater than 75 mm. Structural fill in this report refers to permanent fill that will be located below foundations, slabs, pavements, and other settlement-sensitive features. The suitability of any soil proposed for use as structural fill should be confirmed by a Geotechnical Engineer prior to its use onsite.

Structural fill should be placed on a horizontal surface in maximum 300 mm thick loose lifts and uniformly compacted to a minimum 98% Standard Proctor Maximum Dry Density (SPMDD) within +/- 2% of optimum moisture content. Moisture conditioning, such as wetting or drying, may be required to achieve the specified compaction. A qualified technician or engineer shall conduct field density tests and review structural fill placement.

7.5 Structural Fill

Structural fill refers to permanent fill that may be required to reinstate grades below foundations, slabs, pavements, and other settlement sensitive features. Structural fill is defined as sand to sand and gravel with less than 5 % fines. The structural fill should be a granular material free of any deleterious, organic or otherwise unsuitable material and compacted to a minimum of 95% of a Modified Proctor maximum dry density (ASTM D1557), with a moisture content within 2% of optimum moisture content. Structural fill is to be placed in lifts not exceeding 300 mm in thickness. Structural fill materials should be well graded. In-situ soil density testing should be completed on all structural fill to confirm that adequate compaction is achieved.

Further geotechnical laboratory testing may be required at the time of construction to determine suitability of the in-situ materials or imported materials for use as structural fill. Subgrade soils should be reviewed by the geotechnical engineer prior to structural fill placement.

7.6 Re-use of On-site Material

Excavated material can be used as structural fill, at the discretion of the Geotechnical Engineer, and that native soils should be removed of any material with a diameter greater than 75 mm. Structural fill in this report refers to permanent fill that will be located below foundations, slabs, pavements, and other settlement-sensitive features. The suitability of any soil proposed for use as structural fill should be confirmed by a Geotechnical Engineer prior to its use onsite.

7.7 Earth Pressures on Foundation Walls

Earth pressure design parameters shall be calculated using the parameters provided in Table 7-1 below. Calculations for parameters based on section 20 of the CFEM (2023), and the earthquake-induced earth pressure was approximated using the Mononobe and Matsuo (1929) and Okabe (1926) equations.

Table 7-1 Earth Pressure Coefficient Design Parameters

Material	γ (kN/m ³)	Φ' (°)	K_a	K_o	K_p	K_{ae}
Native gravelly Sand	19.5	33	0.29	0.46	3.39	0.42

The earth pressures given assume that the perimeter drainage systems are adequately installed and function so as to be fully drained and not allow any hydrostatic pressure to build up against the foundation wall.

7.7.1 Slab On-Grade Floors

A 150 mm layer of structural fill compacted to 98% SPMDD should be placed immediately below floor slabs over approved sub-grade.

Slab-on-grade floors should be designed in accordance with BCBC/NBCC with regards to damp-proofing, waterproofing and soil gas control.

7.7.2 Frost Depth

The underside of the foundations should extend to a depth of at least 760 mm as recommended by the Squamish-Lillooet Regional District (SLRD).

7.7.3 Site Drainage

Surfaces within 2 m of the perimeter of any buildings should be sloped to drain water away from the building at a minimum gradient of 2%. Site grading should be designed in such a manner so as to prevent the ponding of surface water near foundation walls and paved areas.

Roof downspouts should be connected to non-perforated drain pipes and be conveyed to an on-site storm water disposal system such as an infiltration pit. If an infiltration pit is to be constructed, it is recommended to be constructed as per building code requirements in a location downslope of any structures and 5 m from any building foundation.

7.8 Pavement Design Considerations

It should be noted that the SLRD has no bylaws regarding pavement design or structure for local roads or parking areas. The pavement structure is determined by the subgrade support quality, generally a twenty-year design life

and traffic loading and designed in accordance with the methodologies presented in “AASHTO Guide for design of pavement Structures” (1993).

Based on the results of the field investigation, and the anticipated low-volume use (no through traffic), the following minimum pavement structure material thickness is recommended in Table 7-2 and Table 7-3 for Asphalt and gravel roads respectively.

Table 7-2 Asphalt Pavement Structure Design

Pavement Structure Type	Minimum Thickness (mm)
Asphalt	50
Crushed Base Course (CBC)	150
75 mm Select Granular Sub-base (SGSB)	150

Table 7-3 Gravel Road Structure Design

Pavement Structure Type	Minimum Thickness (mm)
Graded Aggregate Seal or High Fines Gravel Surface	-
Crushed Base Course (CBC)	225
75 mm Select Granular Sub-base (SGSB)	150

WGB and SGSB should be placed in lifts not exceeding 150 mm, adequately moisture conditioned, and compacted to 100% SPMDD.

7.9 General Construction Considerations

Ecora has outlined below general construction related geotechnical considerations.

- Any temporary excavation work should be carried out in accordance with requirements specified by WorkSafe BC Occupational & Safety Regulations, Part 20 noting that the test pits started sloughing at depths as shallow as 1.0 m.
- Cobbles and boulders may be encountered during construction and due allowance should be made for handling these.

7.10 Design and Construction Review

Ecora should be given the opportunity to review details of the design and construction specifications related to all geotechnical aspects of this project, prior to construction.

All foundation design recommendations presented in this report are based on the assumption that an adequate level of monitoring will be provided during construction, and that construction will be carried out by a suitably qualified contractor, experienced in foundation and earthworks construction.

An adequate level of monitoring is considered to be:

- For shallow foundations, observation of all bearing surfaces prior to placement of structural fill and prior to concrete placement; and,
- For earthworks, full-time monitoring and compaction testing.

Suitably qualified persons, independent of the contractor, should carry out all such monitoring. It should be noted that failure to provide an adequate level of foundation monitoring might be in contravention of the building code.

One of the purposes of providing an adequate level of monitoring is to check that recommendations based on data obtained at discrete borehole and test pit locations are relevant to other areas of the site.

8. Closure

We trust this report meets your requirements. Please contact Ecora if you have any questions or comments.

References

American Association of State Highway and Transportation Officials, AASHTO. (1993). “AASHTO Guide for Design of Pavement Structures.”

BGC Engineering Inc. (2018) “Seton Portage Area Integrated Hydrogeomorphic Risk Assessment”.

British Columbia Building Code (BCBC). (2024). Office of Housing and Construction Standards

Canadian Geotechnical Society,” Canadian Foundation Engineering Manual, 5th Edition,” 2023.

Clague, Fulton, & Ryder, (1982). “Surficial Geology, Vancouver island and adjacent mainland, British Columbia, map”

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Ishihara, K.. “*Stability of natural deposits during earthquakes*”, 1985. Proceedings of the 11th International Conference on Soil Mechanics and Foundation Engineering.

Schiarizza, Gaba, Glover, Garver & Umhoefer, (1997). “Geology and Mineral Occurrences of the Taseko – Bridge River Area”

WorkSafe BC, (2008). “Occupational Health and Safety Regulations, Part 20”.

Figures

Figure 1.0	Site Plan
Figure 1.1	Seton Portage Core 1987
Figure 1.2	Seton Portage Core 1997
Figure 1.3	Seton Portage Core 2005
Figure 1.4	Seton Portage Core 2021
Figure 6.1	2023 Downhole Seismic Testing

SITE PLAN



AFFORDABLE RENTAL HOUSING
SETON PORTAGE, BC

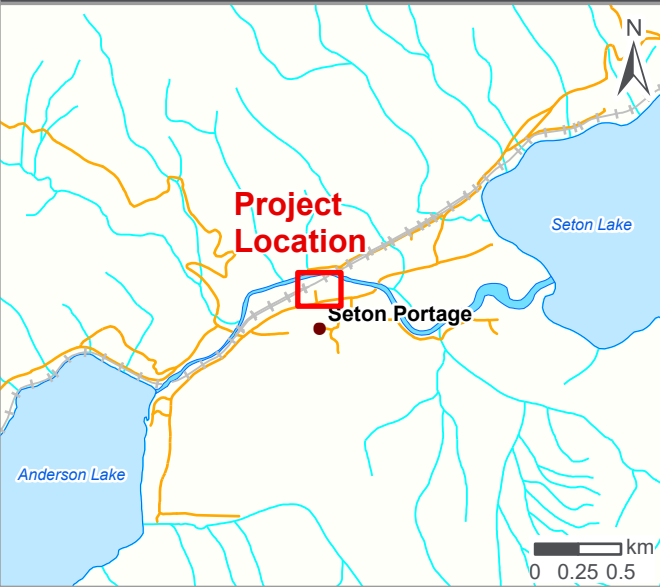
Legend

- Test Hole
- Test Pit
- 20m TRIM Contour Line
- Fresh Water Atlas Stream
- Railway
- Digital Atlas Road
- PMBC Legal Parcel
- Property Boundary

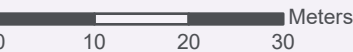
References

Aerial Imagery: Esri Basemap Maxar 7/2/2023

LOCATION MAP



1:800



Project No.: 2500150
Client: Tsal'ah Government

Date: 2025/07/28
Drawn: AS Check: MB

NAD 1983 UTM Zone 10N

Figure 1.0

Path: Z:\2025\2500150\geo\11_gis\plots\aprx\2500150_AffordableRentalSetonPortage.aprx



Notes:

Aerial Imagery taken from UBC Airphotos number BCC678-222.

Seton Portage Affordable Rental Housing Geotechnical Assessment

Seton Portage Core - 1987

Project No. 2500150
Client: Tsal'alh Government / David Nairne
Office: Kelowna
Scale: NTS
Date: July 28, 2025
DWN: DB CHK: MB

ecora

Figure 1.1



Notes:

Aerial Imagery taken from UBC Airphotos number BCC97218 -120

Seton Portage Affordable Rental Housing Geotechnical Assessment

Seton Portage Core - 1997

Project No. 2500150
 Client: Tsal'alh Government / David Nairne
 Office: Kelowna
 Scale: NTS
 Date: July 28, 2025
 DWN: DB CHK: MB

ecora

Figure 1.2



Notes:

Aerial Imagery taken from Google Earth dated 2005.

Seton Portage Affordable Rental Housing Geotechnical Assessment

Seton Portage Core - 2005

Project No. 2500150
 Client: Tsal'alh Government / David Nairne
 Office: Kelowna
 Scale: NTS
 Date: July 28, 2025
 DWN: DB CHK: MB

ecora

Figure 1.3



Notes:

Aerial Imagery taken from Google Earth dated 2021.

Seton Portage Affordable Rental Housing Geotechnical Assessment

Seton Portage Core - 2021

Project No. 2500150
 Client: Tsal'alh Government / David Nairne
 Office: Kelowna
 Scale: NTS
 Date: July 28, 2025
 DWN: DB CHK: MB

ecora

Figure 1.4

2023 DOWNHOLE SEISMIC TESTING



AFFORDABLE RENTAL HOUSING SETON PORTAGE, BC

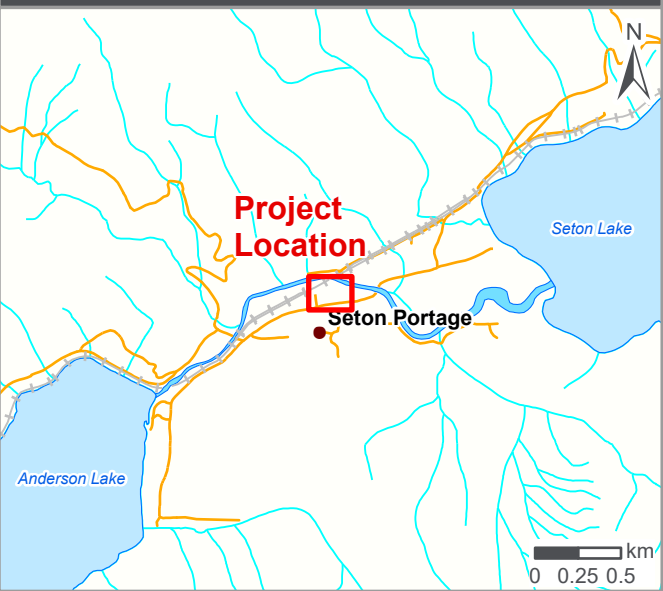
Legend

- Test Hole (2023)
- Test Hole (2025)
- Test Pit (2025)
- 20m TRIM Contour Line
- Fresh Water Atlas Stream
- Railway
- Digital Atlas Road
- PMBC Legal Parcel
- Property Boundary

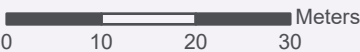
References

Aerial Imagery: Esri Basemap Maxar 7/2/2023

LOCATION MAP



1:800



Project No.: 2500150
Client: Tsal'ah Government

Date: 2025/07/30
Drawn: AS Check: MB

NAD 1983 UTM Zone 10N

Figure 1.0

Path: Z:\2025\2500150\geol\11_gis\plots\aprx\2500150_AffordableRentalSetonPortage.aprx

Appendix A

General Conditions

Standard of Care

Ecora Engineering & Environmental Ltd. (Ecora) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report

This report and the recommendations contained in it are intended for the sole use of Ecora's Client. Ecora does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Ecora's Client unless otherwise authorized in writing by Ecora. Any unauthorized use of the report is at the sole risk of the user. In order to properly understand the suggestions, recommendations and opinions expressed herein, reference must be made to the whole of the report. We cannot be responsible for use by any party of portions of the report without reference to the whole report.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Ecora. Additional copies of the report, if required, may be obtained upon request.

Alternate Report Format

Where Ecora submits both electronic file and hard copy versions of reports, drawings and other project-related documents, only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Ecora shall be deemed to be the original for the Project. Both electronic file and hard copy versions of Ecora's deliverables shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Ecora.

Soil, Rock and Groundwater Conditions

Classification and identification of soils, rocks and geological units have been based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Ecora does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities such as traffic, excavation, groundwater level lowering, pile driving, blasting on the site or on adjacent sites. Excavation may expose the soils to climatic elements such as freeze/thaw and wet/dry cycles and/or mechanical disturbance which can cause severe deterioration. Unless otherwise indicated the soil must be protected from these changes during construction.

Environmental and Regulatory Issues

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Sample Disposal

Ecora will dispose all soil and rock samples for 30 days following issue of this report. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

Construction Services

During construction, Ecora should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Ecora's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Ecora's report. Adequate field review, observation and testing during construction are necessary for Ecora to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Ecora's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Job Site Safety

Ecora is responsible only for the activities of our employees on the jobsite. The presence of Ecora's personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that Ecora never occupy a position of control of the site. The Client undertakes to inform Ecora of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general.

Changed Conditions and Drainage

Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Ecora be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Ecora be employed to visit the site with sufficient frequency to detect if conditions have changed significantly. Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Ecora takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

Services of Sub consultants and Contractors

The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. Ecora may arrange the hiring of these services as a convenience to our Clients. As these services are for the Client's benefit, the Client agrees to hold the Company harmless and to indemnify and defend Ecora from and against all claims arising through such hiring's to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

Appendix B

Borehole Logs

BOREHOLE: TH25-01

Project: Affordable Rental Housing Seton Portage

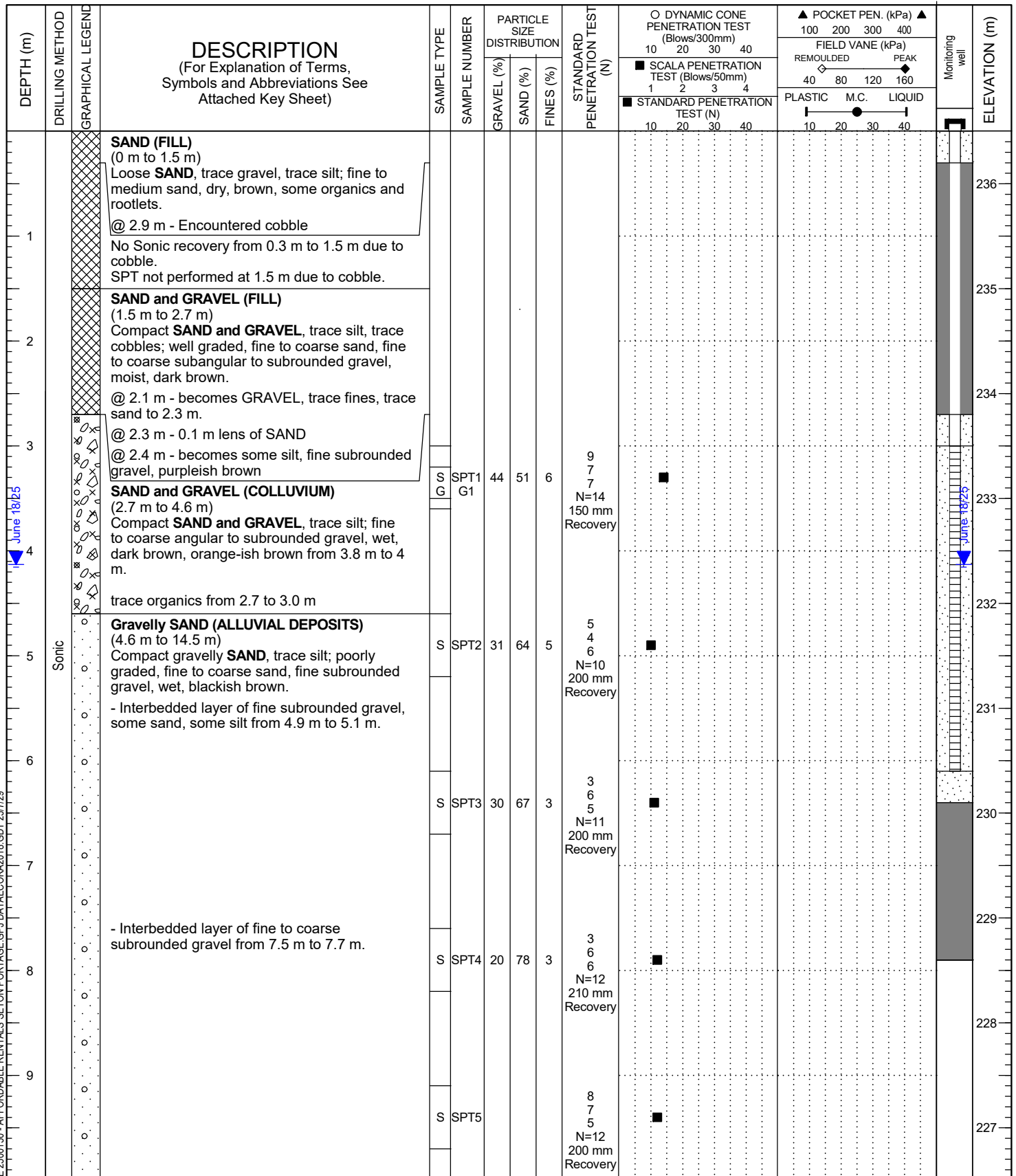
Project No: 2500150

Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Client: Tsal'ah Government

Zone: 10 Northing: 5617598.4 m Easting: 550219 m

Elevation: 236.5 m



Contractor: Downrite Drilling

Logged By: AD

Started: 2025-06-17

Hole Inclination: -90°

Completion Depth: 20.4m

Drilling Rig: CompactRotoSONIC17-8

Reviewed By: ST

Completed: 2025-06-17

Hole Orientation: 90°

Page 1 of 3

BOREHOLE: TH25-01

Project: Affordable Rental Housing Seton Portage

Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Zone: 10 Northing: 5617598.4 m Easting: 550219 m

Project No: 2500150

Client: Tsal'ah Government

Elevation: 236.5 m



DEPTH (m)	DRILLING METHOD	GRAPHICAL LEGEND	DESCRIPTION (For Explanation of Terms, Symbols and Abbreviations See Attached Key Sheet)	SAMPLE TYPE	SAMPLE NUMBER	PARTICLE SIZE DISTRIBUTION			STANDARD PENETRATION TEST (N)	O DYNAMIC CONE PENETRATION TEST (Blows/300mm)				▲ POCKET PEN. (kPa) ▲				TH25-01	ELEVATION (m)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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11	Sonic		- No sonic recovery from 10.7 m to 12.2 m.	S	SPT6				4 6 5 N=11 210 mm Recovery																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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15				SAND (ALLUVIAL DEPOSITS) (14.5 m to 20.4 m) Compact SAND, some gravel, trace silt; poorly graded, fine to coarse sand, fine to coarse subrounded gravel, wet, blackish brown.	S				SPT8				7 11 9 N=20 200 mm Recovery																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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2018 - BOREHOLE 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ DATAECORA2018.GDT 25/7/29



Contractor: Downrite Drilling	Logged By: AD	Started: 2025-06-17	Hole Inclination: -90°	Completion Depth: 20.4m
Drilling Rig: CompactRotoSONIC17-0	Reviewed By: ST	Completed: 2025-06-17	Hole Orientation: 90°	Page 3 of 3

TEST PIT: TP25-01

Project: Affordable Rental Housing Seton Portage

Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Zone: 10 Northing: 5617626.1m Easting: 550255.3m

Project No: 2500150

Client: Tsali'ah Government

Elevation: 236.7 m



DEPTH (m)	GRAPHICAL LEGEND	DESCRIPTION (For Explanation of Terms, Symbols and Abbreviations See Attached Key Sheet)	SAMPLE TYPE	SAMPLE NUMBER	PARTICLE SIZE DISTRIBUTION			CLASSIFICATION TESTS			IN-SITU SHEAR VANE TEST		ELEVATION (m)
					GRAVEL (%)	SAND (%)	FINES (%)	PLASTIC	M.C.	LIQUID	REMOULDED (kPa)	PEAK (kPa)	
		SAND (FILL) (0 m to 0.3 m) Loose SAND, trace Gravel, trace Fines; fine to medium sand, dry, brown, some organics and rootlets.											
		SAND and GRAVEL (FILL) (0.3 m to 1.3 m) Compact SAND and GRAVEL, some Cobbles, trace Fines; fine to coarse sand, fine to coarse subrounded gravel, dry, brown, trace organics and rootlets.											
1		- Becomes Gravelly SAND below 0.9 m. - Encountered electrical conduit construction debris at 1 m.											
		SAND (FILL) (1.3 m to 1.7 m) Compact SAND, some Gravel, some Fines, trace cobble; fine to coarse sand, fine to coarse subrounded gravel, dry, non-plastic, brown, trace organics and rootlets.	G	G1	15	72	14						236
		END OF HOLE at 1.7 m. Notes: 1) Test pit terminated due to target depth reached. 2) Test pit excavated to 1.5 m depth, hand dug 36 mm dia. percolation test hole to 1.7 m. 3) No groundwater encountered. 4) Percolation test performed at 1.7 m: Lowest rate (min per inch) = 6 min. 5) Test pit backfilled and tracked.											235

PHOTOGRAPH



2018 - TEST PIT LOG 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ DATAECOR42018.GDT 7/11/25

Contractor: TDC

Excavator Type: John Deere 35D Mini

Logged By: AD

Reviewed By: ST

Started: 2025-06-17

Completed: 2025-06-17

Completion Depth: 1.7m

Page 1 of 1

PHOTOGRAPH



TEST PIT: TP25-03

Project: Affordable Rental Housing Seton Portage

Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

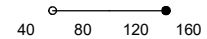
Zone: 10 Northing: 5617609.9m Easting: 550244.2m

Project No: 2500150

Client: Tsal'ah Government

Elevation: 237.0 m



DEPTH (m)	GRAPHICAL LEGEND	DESCRIPTION (For Explanation of Terms, Symbols and Abbreviations See Attached Key Sheet)	PARTICLE SIZE DISTRIBUTION			CLASSIFICATION TESTS		IN-SITU SHEAR VANE TEST		ELEVATION (m)
			GRAVEL (%)	SAND (%)	FINES (%)			REMOULDED (kPa)	PEAK (kPa)	
										

PHOTOGRAPH



2018 - TEST PIT LOG 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ DATA ECORA2018.GDT 7/11/25

Contractor: TDC

Excavator Type: John Deere 35D Mini

Logged By: AD

Reviewed By: ST

Started: 2025-06-17

Completed: 2025-06-17

Completion Depth: 1.7m

Page 1 of 1

TEST PIT: TP25-04

Project: Affordable Rental Housing Seton Portage

Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Zone: 10 Northing: 5617622.3m Easting: 550235.8m

Project No: 2500150

Client: Ts'al'ah Government

Elevation: 237.3 m



DEPTH (m)	GRAPHICAL LEGEND	DESCRIPTION (For Explanation of Terms, Symbols and Abbreviations See Attached Key Sheet)	PARTICLE SIZE DISTRIBUTION			CLASSIFICATION TESTS		IN-SITU SHEAR VANE TEST		ELEVATION (m)
			GRAVEL (%)	SAND (%)	FINES (%)			REMOULDED (kPa)	PEAK (kPa)	

PHOTOGRAPH



2018 - TEST PIT LOG 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ DATA ECORA2018.GDT 7/11/25

Contractor: TDC

Excavator Type: John Deere 35D Mini

Logged By: AD

Reviewed By: ST

Started: 2025-06-17

Completed: 2025-06-17

Completion Depth: 1.7m

Page 1 of 1

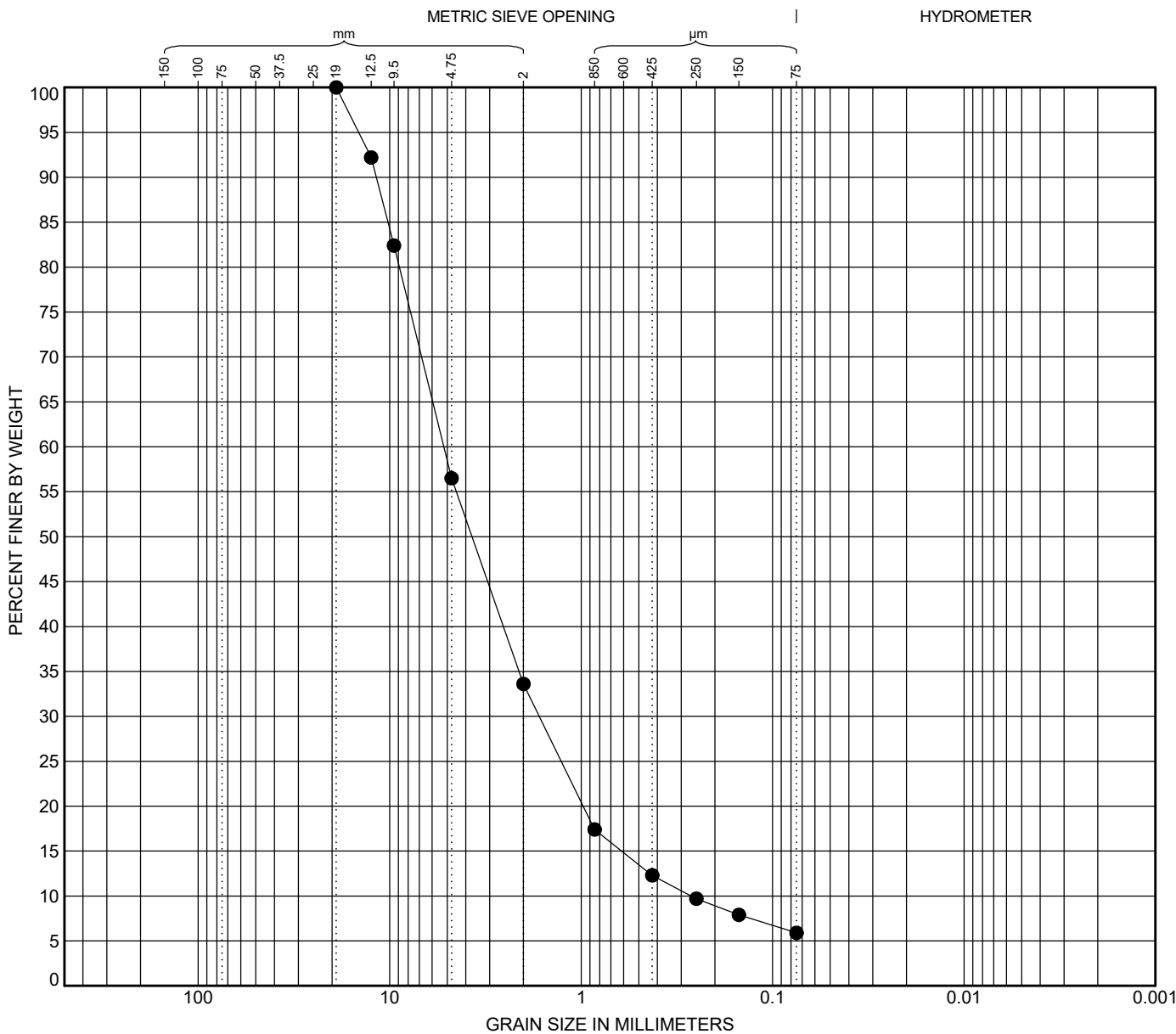
Appendix C

Laboratory Test Results

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213
Source: TH25-01, SPT 1

Project No: 2500150
Client: Tsal'ah Government
Depth: 3.00 m to 3.60 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
19	10.2	5.22	1.65	0.613	0.266	1.97	19.63	43.5	50.6	5.9	

Description: SAND and GRAVEL, trace fines
Natural Moisture Content: 10.5 %
Comments: N/A

Lab Sample Number: K25-199
Date Tested: 2025-07-08
Tested By: AT

Checked By: 

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage

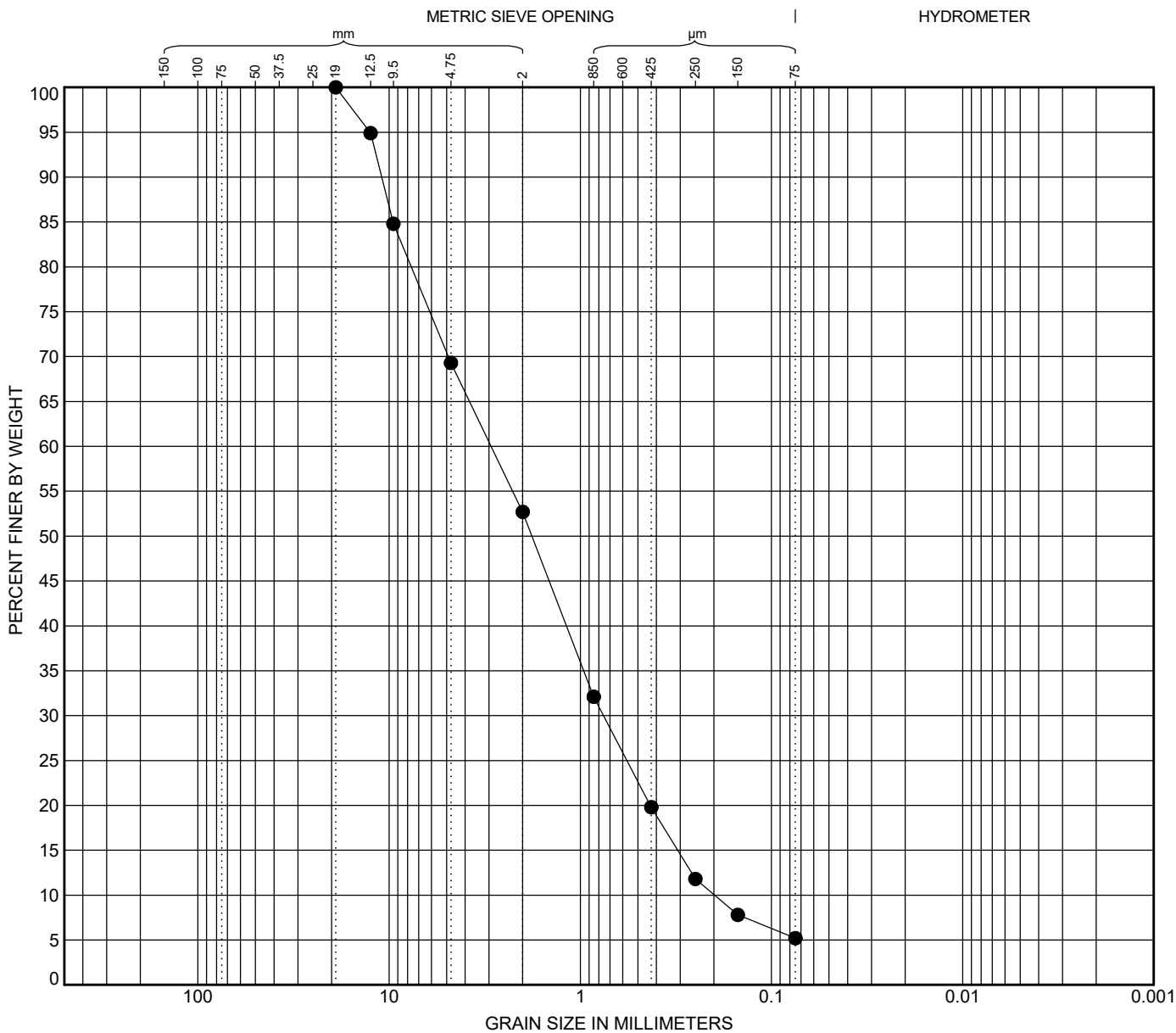
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Source: TH25-01, SPT 2

Project No: 2500150

Client: Tsal'ah Government

Depth: 4.60 m to 5.20 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
19	9.55	2.93	0.755	0.309	0.199	0.98	14.73	30.7	64.1	5.2	

Description: Gravelly SAND, trace fines
Natural Moisture Content: 11.7 %
Comments: N/A

Lab Sample Number: K25-200
Date Tested: 2025-07-08
Tested By: AT

Checked By: Steve

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage

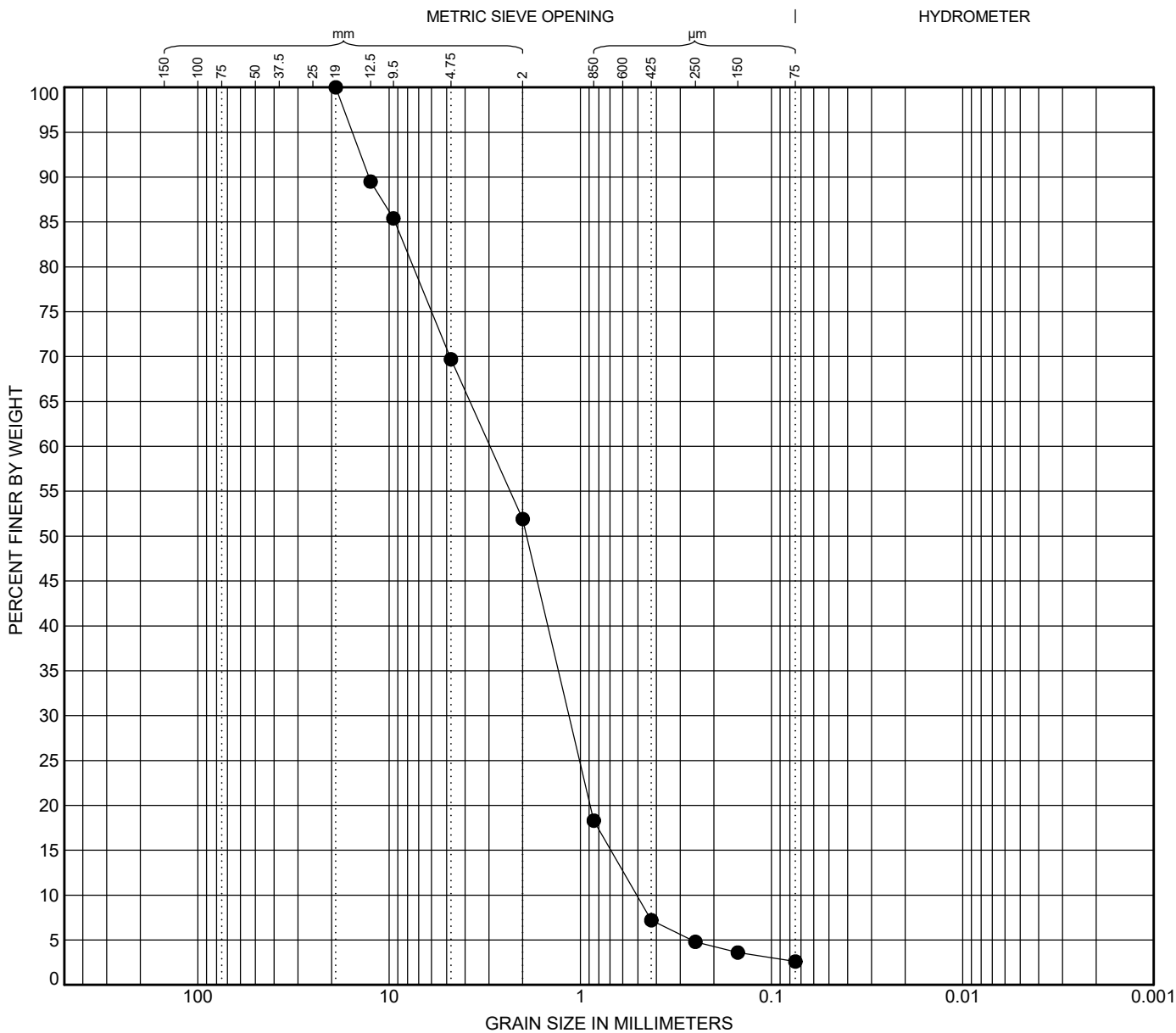
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Source: TH25-01, SPT 3

Project No: 2500150

Client: Tsal'ah Government

Depth: 6.10 m to 6.70 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
19	9.33	2.96	1.15	0.692	0.506	0.87	5.86	30.3	67.1	2.6	

Description: Gravelly SAND, trace fines
Natural Moisture Content: 12.2 %
Comments: N/A

Lab Sample Number: k25-201
Date Tested: 2025-07-08
Tested By: AT

Checked By:

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage

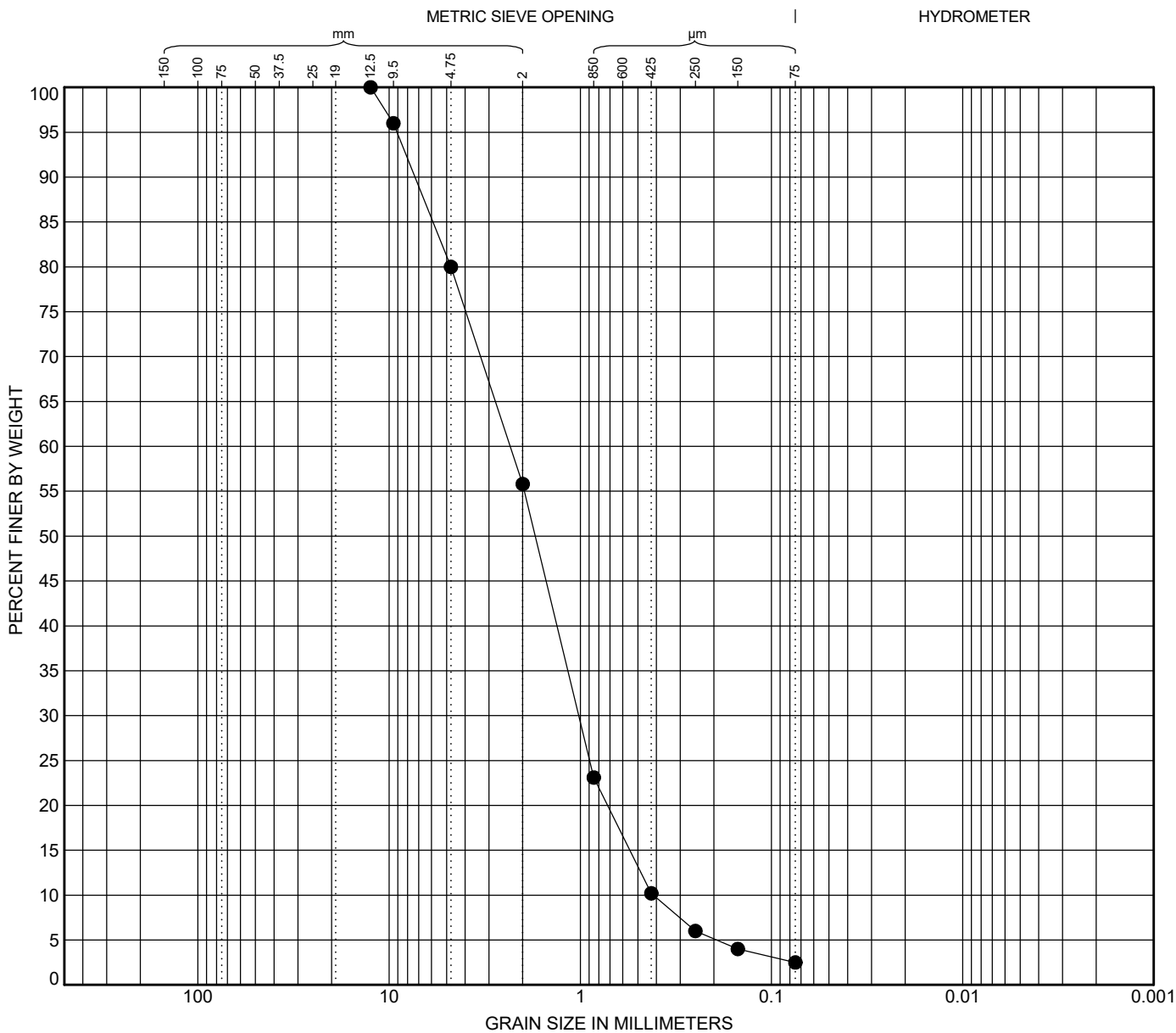
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Source: TH25-01, SPT 4

Project No: 2500150

Client: Tsal'ah Government

Depth: 7.60 m to 8.20 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
12.5	5.90	2.32	1.02	0.550	0.414	1.08	5.61	20.0	77.5	2.5	

Description: Gravelly SAND, trace fines
Natural Moisture Content: 12.7 %
Comments: N/A

Lab Sample Number: K25-202
Date Tested: 2025-07-08
Tested By: AT

Checked By: 

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage

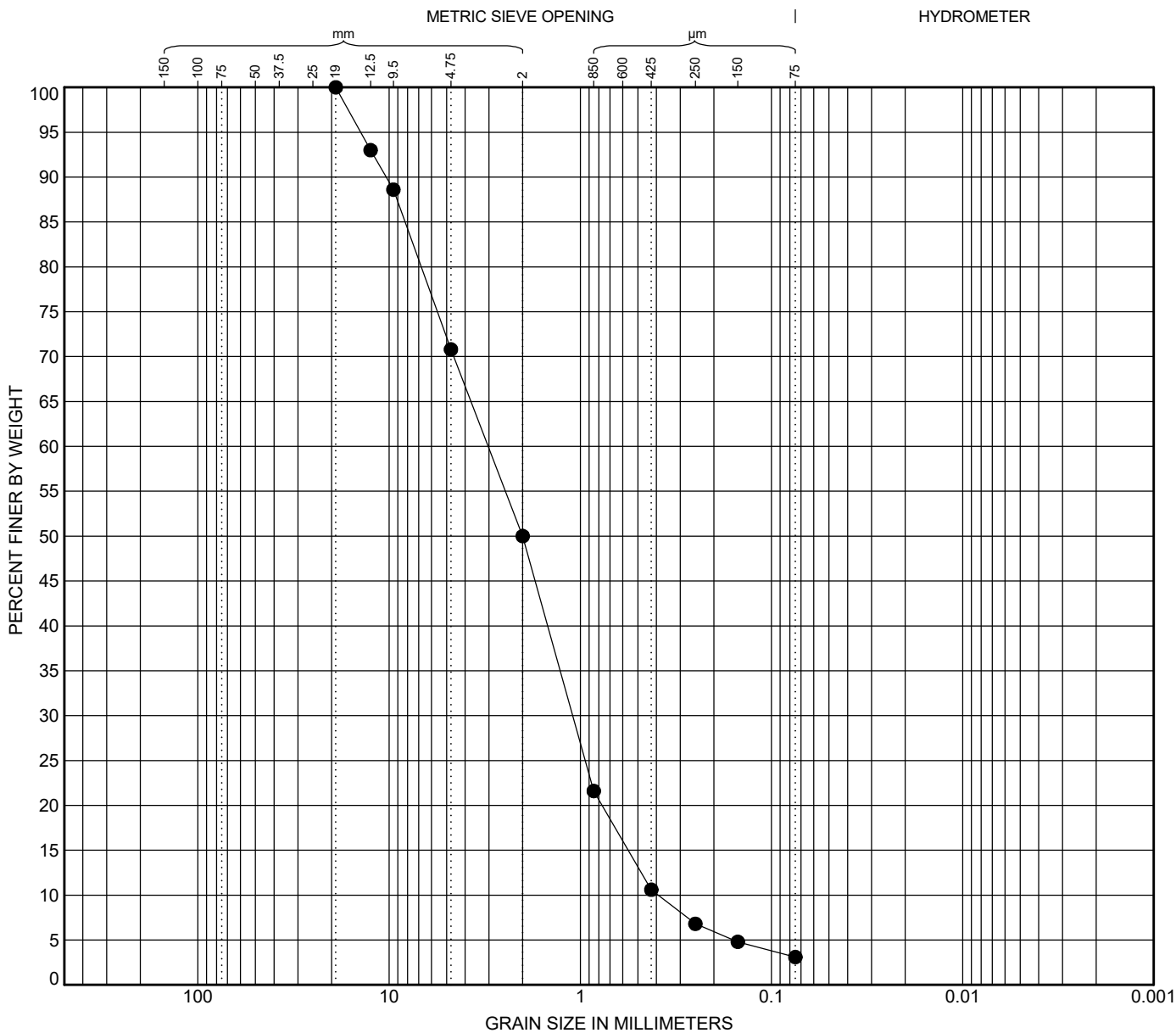
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Source: TH25-01, SPT 7

Project No: 2500150

Client: Tsal'ah Government

Depth: 12.20 m to 12.80 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
19	8.26	3.03	1.09	0.561	0.391	1.01	7.76	29.2	67.7	3.1	

Description: Gravelly SAND, trace fines
Natural Moisture Content: 6.4 %
Comments: N/A

Lab Sample Number: K25-203
Date Tested: 2025-07-08
Tested By: AT

Checked By: 

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage

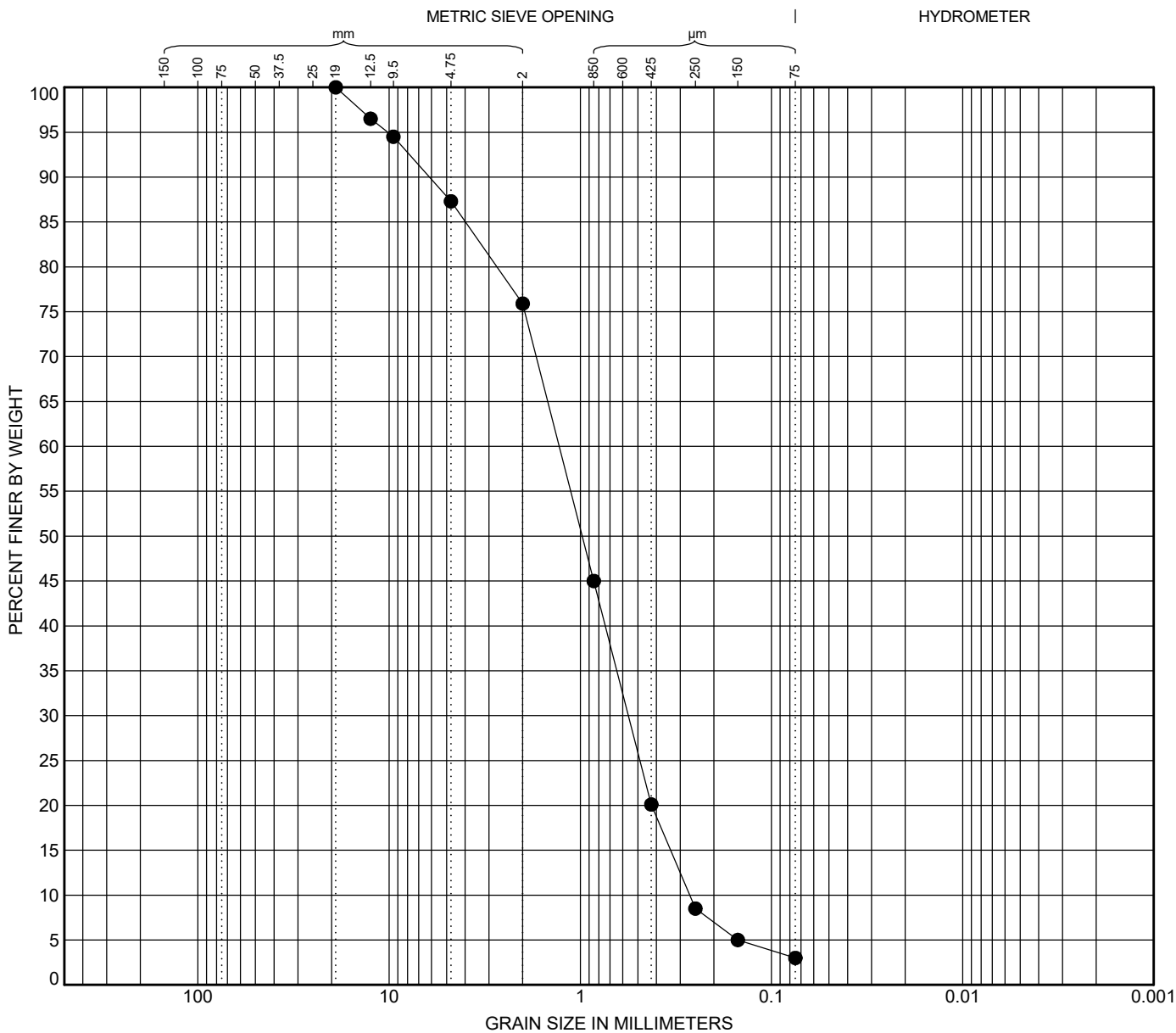
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Source: TH25-01, SPT 10

Project No: 2500150

Client: Tsal'ah Government

Depth: 16.80 m to 17.40 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
19	3.99	1.29	0.560	0.337	0.268	0.91	4.81	12.7	84.3	3.0	

Description: SAND, some gravel, trace fines
Natural Moisture Content: 14.6 %
Comments: N/A

Lab Sample Number: K25-204
Date Tested: 2025-07-08
Tested By: AT

Checked By: 

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

GRAIN SIZE DISTRIBUTION ASTM D6913

Project: Affordable Rental Housing Seton Portage

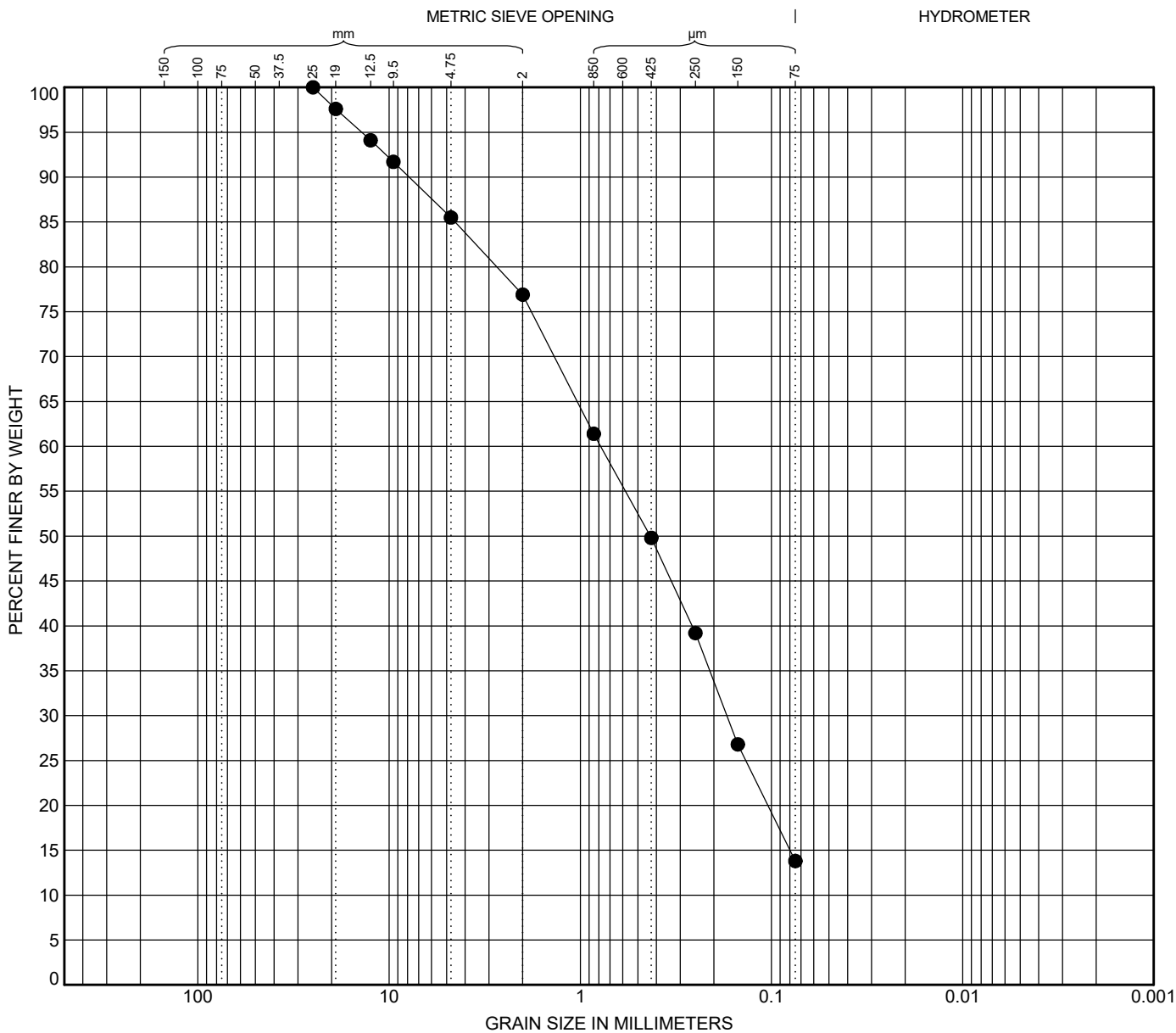
Location: Lot 7 District Lot 1596 Lillooet District Plan 17213

Source: TP25-01, G1

Project No: 2500150

Client: Tsal'ah Government

Depth: 1.50 m to 1.70 m



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

D ₁₀₀	D ₈₅	D ₆₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u	%Gravel	%Sand	%Silt	%Clay
25	4.52	0.782	0.171	0.0800				14.5	71.7	13.8	

Description: SAND, some gravel, some fines
Natural Moisture Content: 1.4 %
Comments: N/A

Lab Sample Number: K25-205
Date Tested: 2025-07-08
Tested By: AT

Checked By: Steve

GRAIN SIZE DISTRIBUTION 2500150 - AFFORDABLE RENTALS SETON PORTAGE.GPJ.DAT.AECORA2018.GDT 7/10/25

Appendix D

Liquefaction Analysis Report

V_s BASED LIQUEFACTION ANALYSIS REPORT

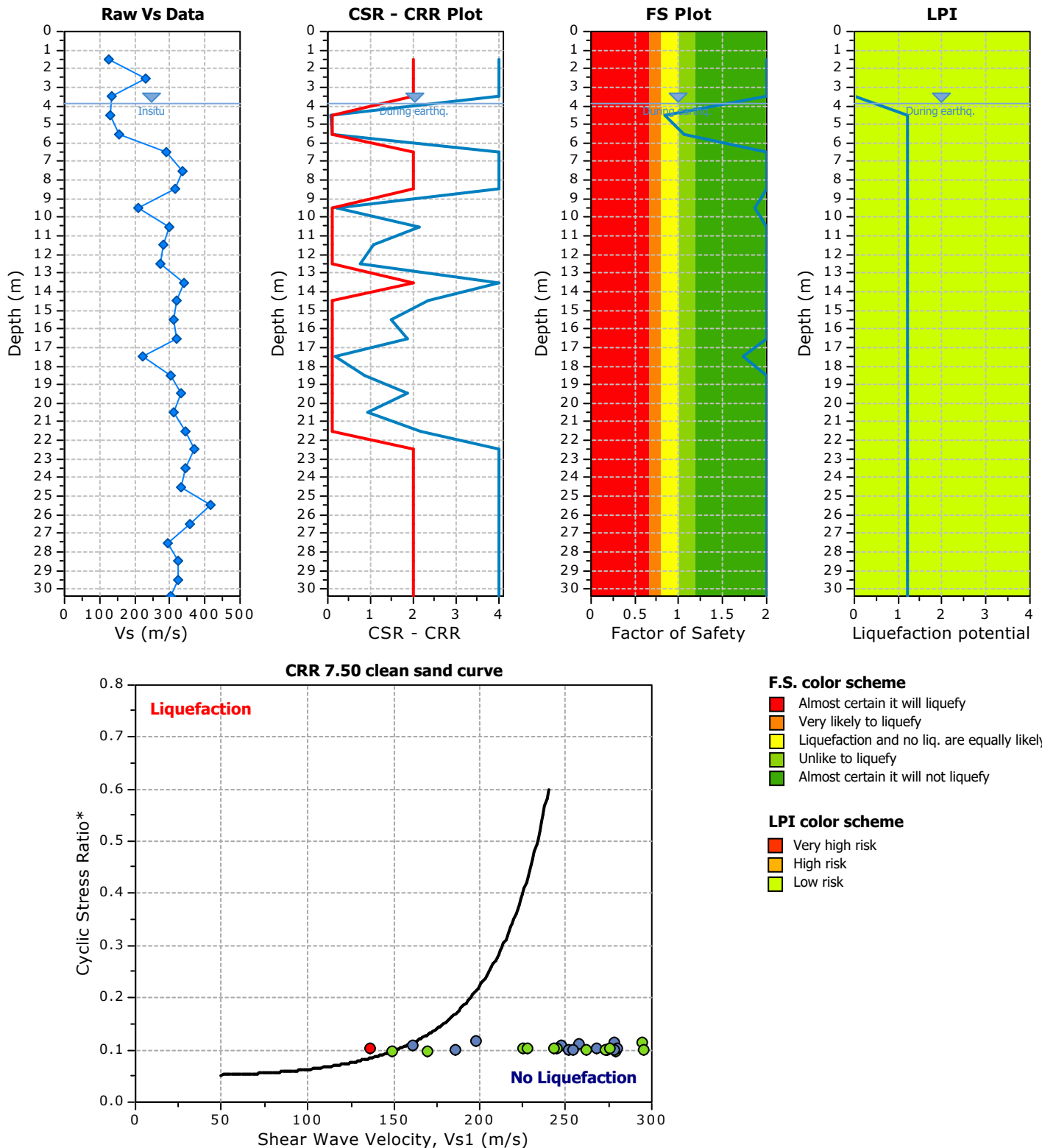
Project title :

V_s Name: BH23-01 - Vs

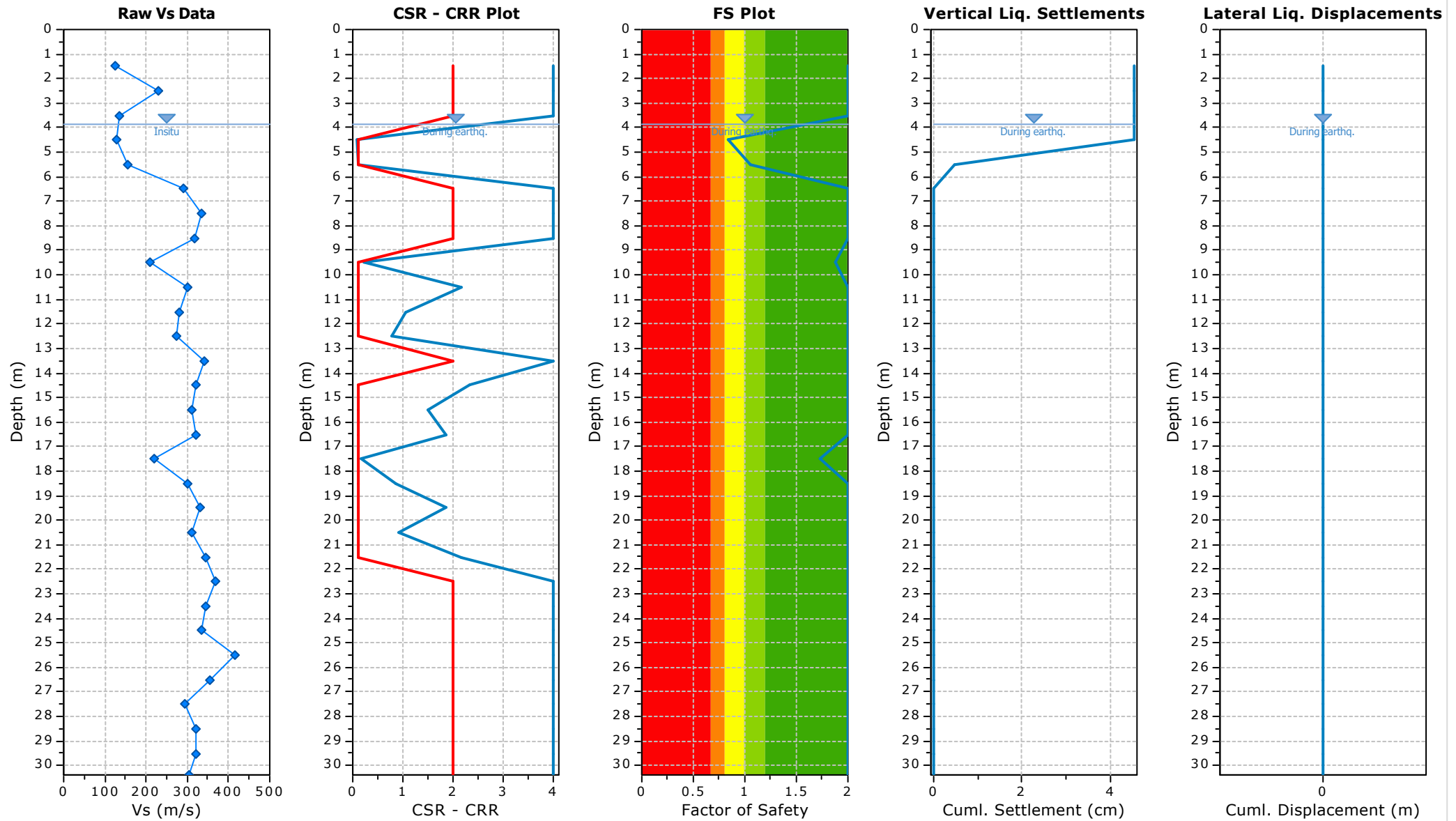
Location :

:: Input parameters and analysis properties ::

Analysis method: Kayen et al. 2013
G.W.T. (in-situ): 3.88 m
G.W.T. (earthq.): 3.88 m
Earthquake magnitude M_w : 6.34
Peak ground acceleration: 0.19 g
Eq. external load: 0.00 kPa



:: Overall Liquefaction Assessment Analysis Plots ::



SPT BASED LIQUEFACTION ANALYSIS REPORT

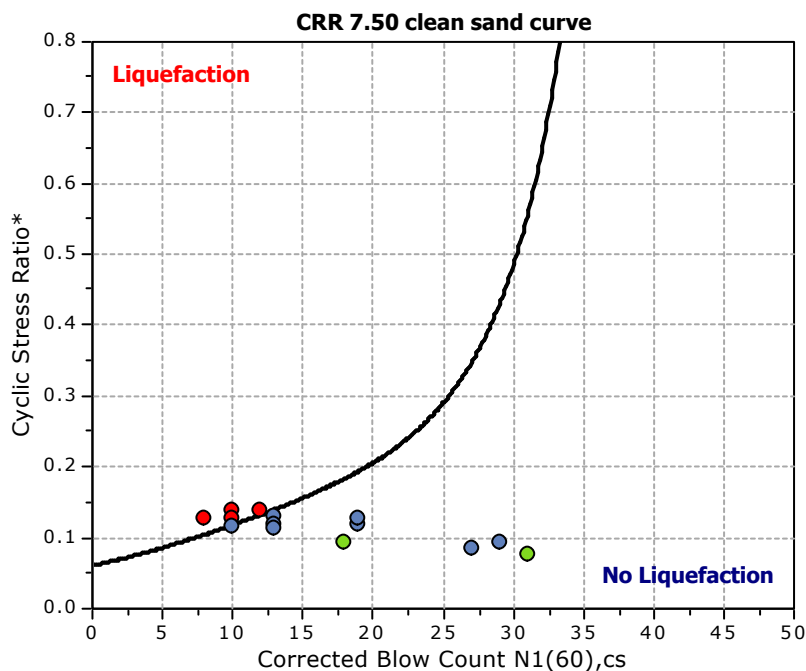
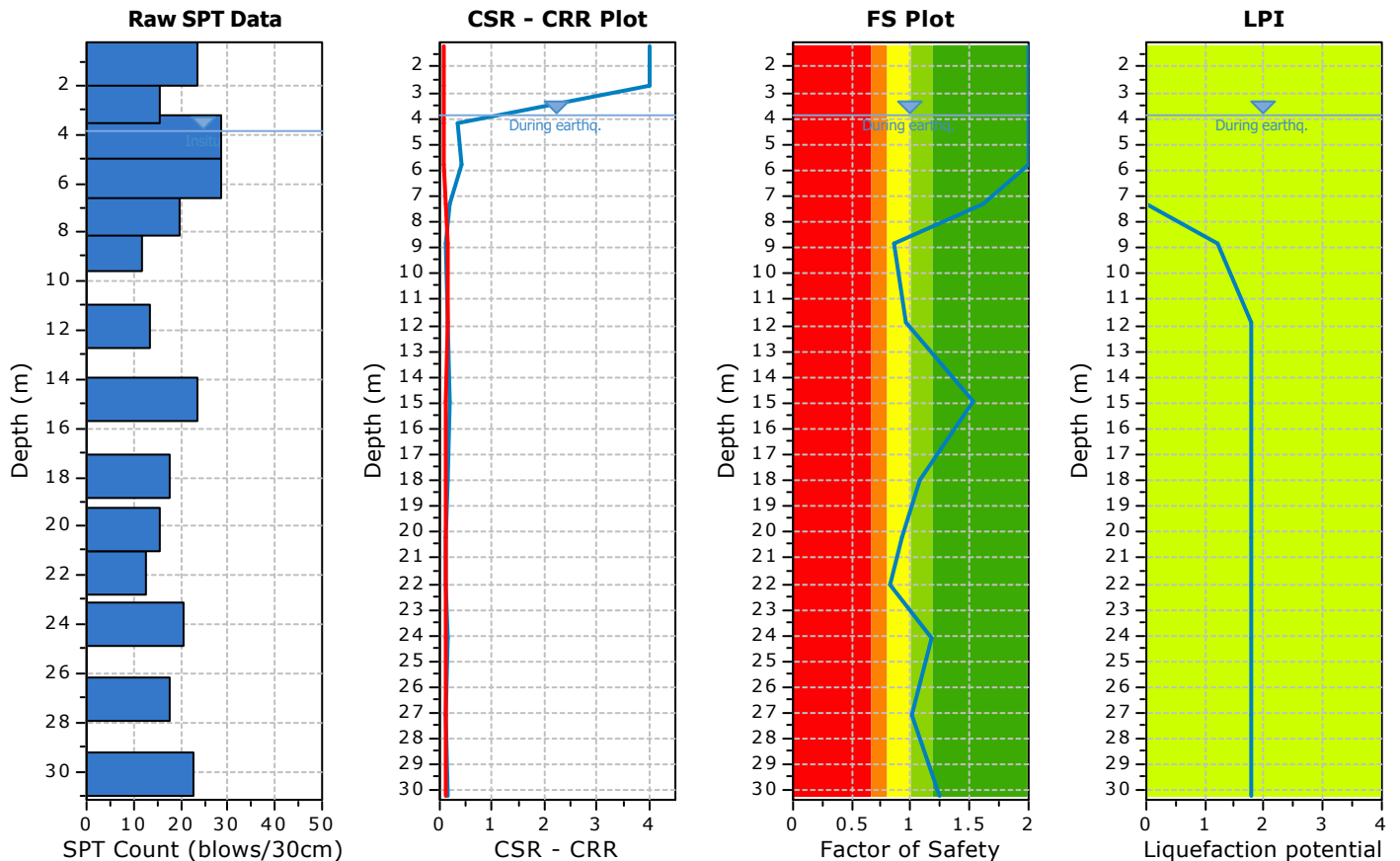
Project title :

SPT Name: BH23-01 - SPT

Location :

:: Input parameters and analysis properties ::

Analysis method:	Boulanger & Idriss, 2014	G.W.T. (in-situ):	3.88 m
Fines correction method:	Boulanger & Idriss, 2014	G.W.T. (earthq.):	3.88 m
Sampling method:	Standard Sampler	Earthquake magnitude M_w :	6.35
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.19 g
Rod length:	1.00 m	Eq. external load:	0.00 kPa
Hammer energy ratio:	1.00		



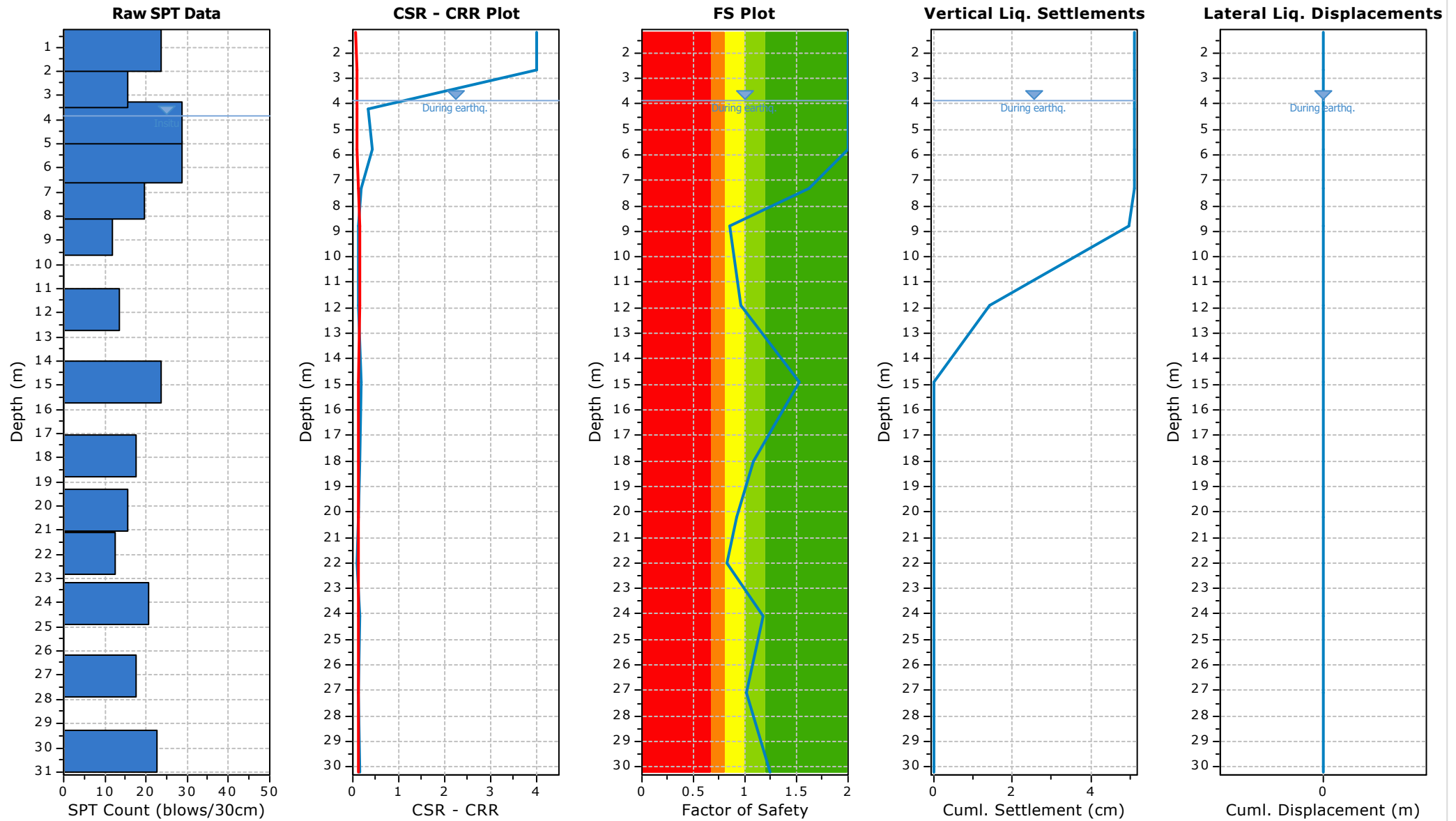
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::

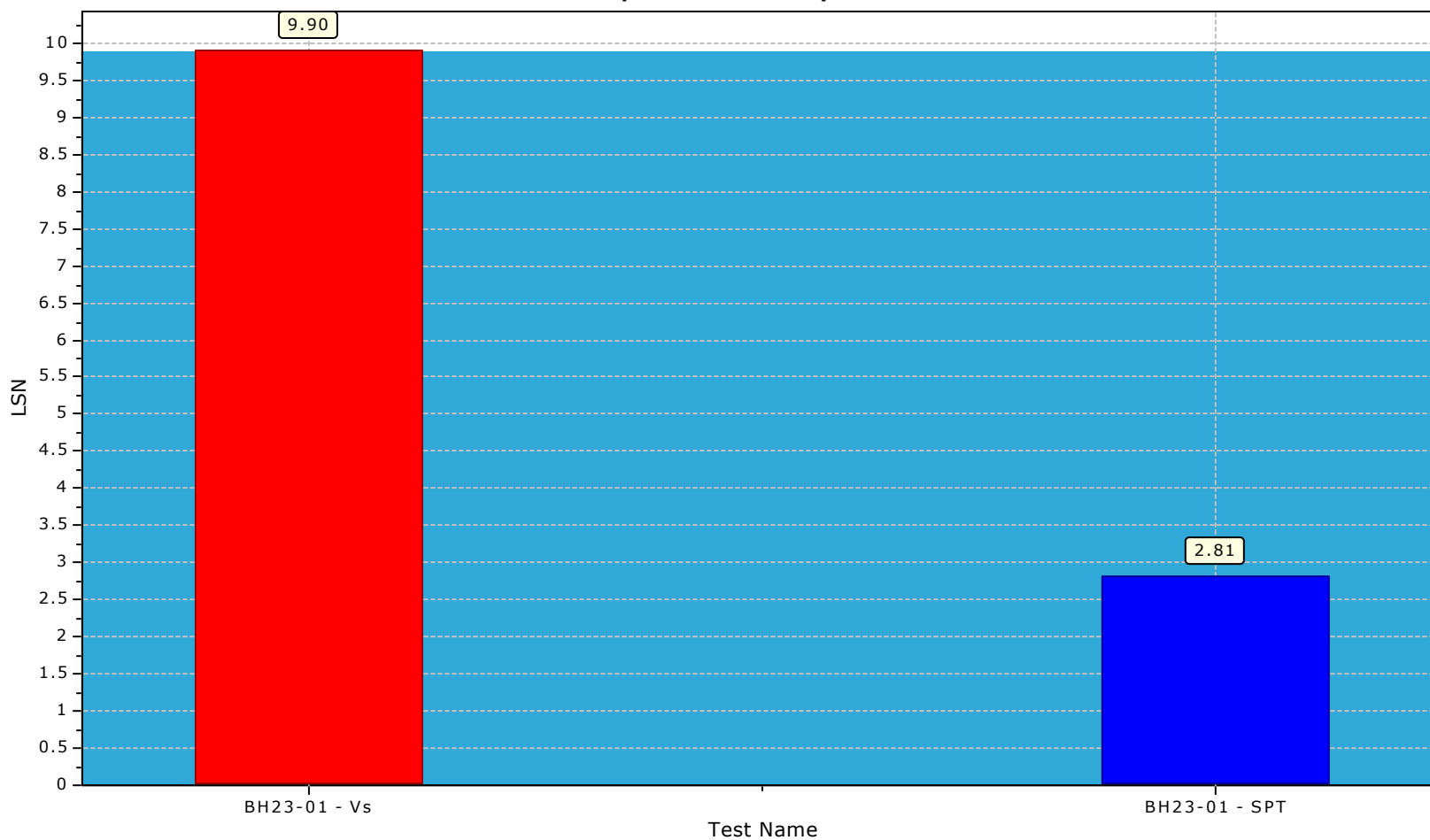


SUMMARY CALCULATION REPORT

Project title :

Location :

Liquefaction Sevirity Number



LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

SUMMARY CALCULATION REPORT

Project title :

Location :

Liquefaction Potential Index

