



Michelle Ouellette
Canmore Community Housing Corp.
600 9th Street, Unit 203
Canmore, AB T1W 3L9

September 13, 2023

Project Number: 2023-091

**RE: DRAFT – Geotechnical Investigation for Canmore Public Housing Project
100 Palliser Trail, Canmore AB**

Dear Ms. Michelle Ouellette,

As requested, Taylor Geotechnical Ltd. (Taylor) has conducted a geotechnical investigation for the proposed development of 100 Palliser Trail in Canmore, AB. The purpose of the investigation was to identify the subsurface soil and groundwater conditions at site. Based on our interpretation of this information, comments and recommendations pertaining to the geotechnical aspects of design and construction for proposed developments are provided herein.

The scope of work for this project was provided in the proposal letter (quote number 1386), dated August 1, 2023. Authorization to proceed was given by the client on August 1, 2023.

It should be noted that the scope of this report is limited to the geotechnical assessment of the proposed development. It does not include any investigation, analytical testing, or assessment of possible groundwater contamination, archeological or biological considerations, or sediment control measures. This report should be read in conjunction with the Disclaimer and Limitations which are appended following the text of this letter. The reader's attention is specifically drawn to this information as it is essential for the proper use and interpretation of this report.

1.0 PROJECT UNDERSTANDING

It is understood the project includes development of the 100 Palliser Trail property in Canmore, AB, consisting of multi-family units. The units are anticipated to be a maximum of 6 above ground levels, with underground parking.

The site has a footprint of approximately 8,407 square metres and is generally flat lying. The site is currently used as a dog run, consisting of a grass area with chain-link fenced. Palliser Trail borders the site to the south, and Palliser Lane borders to the site to the north, east, and west. The site is located in the Stoneworks Creek Steep Creek Hazard Zone.

The purpose of the geotechnical investigation is to provide a factual report of the bearing conditions of the in-situ materials, and to provide recommendations for the design and construction of the proposed building and associated infrastructure.



2.0 FIELD AND LABORATORY WORK

Taylor's geotechnical investigation was carried out on August 22, 2023. At this time, four (4) boreholes (BH-01 to BH-04) were advanced at the site to determine subsurface soil and groundwater conditions, and to collect representative soil samples for laboratory testing. See Figure 1 and 2 for reference. Boreholes were advanced using a track-based sonic drill owned and operated by Taylor.

BH-01 was advanced to 13.7 metres below ground surface (mbgs), and BH-02 to BH-04 were advanced to 4.88 mbgs. Representative soil samples were collected at selected depths for detailed examination.

Upon completion, 25 mm PVC standpipe piezometers were installed in BH-01 and BH-02. The piezometers were backfilled with sand and excavation spoils, plugged with bentonite chips and nominally compacted. A follow up site visit was conducted on August 29, 2023, for the purpose of groundwater monitoring.

Laboratory testing completed by Taylor included moisture content determinations, gradation analysis, and Atterberg limits. Chemical analysis of soil for sulphate resistivity was undertaken by KaizenLab in Calgary. All laboratory results are presented in Appendix A.

3.0 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

The following section summarizes the observed subsurface soil and groundwater conditions at the time of the investigation. Generalized stratigraphy is presented below in order of increasing depth. Borehole logs with piezometer installation details are provided within Appendix A of this report. Please note, subsurface conditions were found to vary with depth and between boreholes. It is anticipated that similar or greater variation may exist in areas beyond the boreholes.

- **Topsoil** – Topsoil was encountered at ground surface of boreholes. The topsoil was typically comprised of silt and contained organics. The material extended between 0.3 to 1.2 mbgs in BH-01 through BH-04.
- **Silt and Silty Sand**– Brown to light brown, soft to compact, silt with trace sand to silty sand, containing trace clay, was encountered in all boreholes. The moisture content ranged from 10.3 to 43.7%. The silt to silty sand extended to 7.5 mbgs in BH-01, and to the terminus of the borehole at 4.88 mbgs in BH-02 to BH-04.
- **Clayey Silt** – A mottled brown clayey silt layer, with trace to some sand and trace gravel, was encountered within the silt and silty sand in all boreholes. The moisture content ranged from 22.7 to 28.2%. The layer had a thickness of 0.3 to 0.7 m. The material was encountered at 7.5 mbgs in BH-01, 2.1 mbgs in BH-02, and 3.5 mbgs in BH-03 and BH-04. In BH-03, the material contained organics.
- **Sand and Gravel** – Compact to dense sand and gravel was encountered beneath the clayey silt in BH-01. The material had a moisture content of 7.9%. BH-01 was terminated in the sand and gravel at 13.7 mbgs.

Groundwater was encountered at the time of the investigation and during the follow-up visit, as summarized in Table 1 below. Please note, groundwater levels are subject to seasonal variation with the highest water levels likely to occur during the late-spring and summer months.



Table 1: Groundwater Monitoring Summary

Piezometer	Depth to Groundwater (mbgs)	
	August 22, 2023	August 29, 2023
BH-01	7.62	7.27
BH-02	Dry	Dry

4.0 GEOTECHNICAL COMMENTS AND RECOMMENDATIONS

Based on the results of the investigation, it is Taylor's opinion that the site is suitable for construction of the proposed development provided the comments and recommendations presented herein are adhered to. The following points summarize the pertinent geotechnical findings which are likely to influence the detailed design and construction of the development.

- Groundwater was encountered at a depth of 7.27 to 7.62 mbgs in BH-01. Groundwater is subject to seasonal variation. Depending on the design elevation and construction method, groundwater may need to be considered throughout design and construction.
- Sand and silts were observed across site. Sand and silts are frost susceptible and may be prone to excessive heave if exposed to freezing conditions. Heave ultimately causes settlement and significant reduction in bearing capacity when thaw occurs. The risk of frost heave and subsequent settlement increases significantly with the presence of available moisture from the groundwater table.
- To eliminate the risk of potential settlement and subsequent infrastructure distress from construction on frost susceptible materials, Taylor recommends either of the below options:
 1. Construction of strip and spread footings with bearing depth below the depth of frost penetration. Use of a shallow foundation system is contingent upon outstanding laboratory results. Outstanding laboratory tests include the determination of the organic content within an isolated organic layer observed at depth at the time of the subsurface investigation.
 2. Use of a deep foundation system consisting of driven piles or cast-in-place concrete piles, end bearing in the in-situ sand and gravel material.
- The property is located in the lower reaches of Stoneworks Creek and is within the Stoneworks Creek Steep Creek Hazard Zone. Risks associated with the steep creek must be considered throughout design.

Please note, development details such as building footprint and design elevations were not available at the time of developing this report. The following recommendations must be confirmed by Taylor following document review of the design drawings.



4.1 ALBERTA BUILDING CODE

In accordance with the Alberta Building Code, the design of foundations is governed by the use of limit states design. The Alberta Building Code incorporates both Ultimate Limit State (ULS, described as the point of structural failure of the designed element) and Serviceability Limit States (SLS, described as the point of the structure or element no longer being usable) into the scope of foundation design.

4.2 FOUNDATION DESIGN

Based on Taylor's review, use of traditional shallow foundation system consisting of spread footings or a deep foundation system consisting of driven pipe piles is considered a feasible option for design and construction of the proposed structure. The optimal foundation system will be dependent on the building loads, design elevations, and likely excavation and possible dewatering requirements. The following sections presents the recommendations for both the shallow and deep foundation system options.

4.2.1 Shallow Foundation

It is anticipated that the proposed structure can be supported by conventional strip and spread footings founded on the in-situ silt to silty sand materials, or on compacted granular fill. However, the use of a shallow foundation system is contingent on pending laboratory tests to determine the organic content within an isolated layer in BH-03. Rootlets were observed at 3.5 mbgs in BH-03 within the clayey silt layer at the time of the borehole investigation. Depending on the laboratory findings, use of a shallow foundation system may not be permissible due to the presence of organic-rich materials. Laboratory findings, and confirmation for the use of a shallow foundation, are to be provided in a subsequent version of this report.

Pending the laboratory results, a shallow foundation system may be permissible provided the following comments and recommendations are considered through design and construction.

Guidance for geotechnical resistance factors for shallow footings is listed in Table 2. These resistance factor values have been based on the information provided by the Canadian Foundation Engineering Manual (4th Edition, 2006).

Table 2: Geotechnical Resistance Factors

Case	Resistance factor
Vertical resistance by semi-empirical analysis and in-situ test data	0.5
Sliding based on friction	0.8

Table 3 presents a summary of the unfactored and factored bearing resistance at Ultimate Limit State and Allowable Bearing Capacity for the anticipated site conditions. The values in Table 3 considered a vertical loading (footing) scenario with strip footing up to 1.0 m wide or a square pad footing up to 1.2 m wide. Design elevations were unknown at the time of developing this report; as such, it is assumed that the underside of footing is situated approximately 2.1 mbgs.

Stricter settlement tolerances, footings larger than specified, or alternative depth to underside of footing, will require additional review. Please take note of recommendations in section 4.10 below, as these bearing resistances are conditional on adequate site preparation.



Table 3: Summary of Bearing Resistance and Capacity

Soil Conditions	Ultimate Bearing Resistance (kPa)	Factored Bearing Resistance (kPa)	Allowable Bearing Resistance (kPa)
In situ Silt to Silty Sand	300	150	100

Alternatively, footings can be constructed on compacted engineered fills placed on the in-situ materials. Bearing capacity values for fill material are anticipated to be higher than those provided for site soils. However, detailed analysis of the soils and footing conditions is required. Taylor can provide input upon request.

Serviceability was considered for the factored bearing resistance given. Provided that the foundation materials are not loosened or disturbed, it is anticipated that foundations designed for these bearing pressure will be subject to settlements less than 25 mm. It is recommended that Taylor review footings with dimensions considering the actual factored loads to determine if settlement tolerances may be exceeded.

The above bearing resistance values listed for fill are considered suitable provided that the fill materials are in accordance with the recommendations given in section 4.10.5.

The seismic response classification for this site is class "E". This site class may be used in the design of building to resist seismic events using the Alberta Building Code, including the determination of Foundation Factors F_v and F_a .

Minimum required footing depths based on frost protection requirements are presented in section 4.3.

Foundation elements shall be constructed on adequately prepared site soils that are free of organics and deleterious materials, as well as standing or ponding water. Working surface shall be kept reasonably dry throughout foundation construction. If construction proceeds during cold weather conditions, all exposed footings and slabs must be protected from freezing. Under no circumstances should footings or slabs be placed on frozen material or materials that are allowed to freeze. Subgrade soils are not permitted to freeze throughout building construction.

4.2.2 Deep Foundation System

Taylor recommends consideration of the use of piles due to the presence of frost susceptible soils and local groundwater conditions. Based on the observed soil conditions it is anticipated that driven open-end pipe piles, closed-end pipe piles, or H-piles could be most suitable to transfer the building loads to the underlying compact to dense sand and gravel material as a means of establishing adequate foundation support.

The following provides input and recommendations for design and construction of driven piles. Please note, the below listed assumptions were made for the deep foundation system.

- The compact to dense sand and gravel material extends beyond the depth of the boreholes and will be the end-bearing strata.



- A pile length of 10.67 m (35 feet) will be used, to ensure adequate penetration into the bearing strata.
- Topsoil and organic rich materials extend to a maximum depth of 1.2 mbgs.
- Based on a groundwater study completed in the Bow Valley, groundwater fluctuations of up to 1.0 m are anticipated. Based on the observed groundwater level of 7.27 mbgs, groundwater is anticipated to exist as shallow as 6.27 mbgs.

Driven Pile Design

In accordance with the Alberta Building Code, the design of foundations is governed using limit states design. The Alberta Building Code incorporates both Ultimate Limit State (ULS, described as the point of structural failure of the designed element) and Serviceability Limit States (SLS, described as the point of the structure or element no longer being usable) into the scope of foundation design. Guidance for geotechnical resistance factors for deep foundation based on the Canadian Foundation Engineering Manual (4th Edition, 2006) is provided in Table 4.

Table 4: Geotechnical Resistance Factors for Pile Foundations

Case	Resistance factor, Φ
Resistance to axial load using semi-empirical analysis and in-situ test data	0.4
Uplift resistance by semi-empirical analysis	0.3
Horizontal load resistance	0.5

The material parameters for the observed in situ soils summarized in Table 5 below were considered in design calculations. These material parameters are unfactored. The presence of groundwater should be considered in design calculations.

Piles may be designed to resist static axial compressive loads based on factored shaft resistance and factored end bearing resistance parameters at ULS. The unfactored and factored frictional resistance and end bearing resistance is provided in Table 5 for each subsurface material for general pile type/size. Taylor can provide pile-specific resistances and capacities following selection of the optimal pile type and size by the client.



Table 5: Frictional Resistance and End Bearing Resistance for Observed Site Conditions

Material	Depth Interval (mbgs)	Ultimate Resistance		Factored Resistance, $\Phi = 0.4$	
		Frictional Resistance (kPa) ¹	End Bearing Resistance (kPa) ²	Frictional Resistance (kPa) ¹	End Bearing Resistance (kPa) ²
Frost Depth	0 – 2.1	-	-	-	-
Silt to Silty Sand	2.1 – 7.6	50	-	20	-
Sand and Gravel	7.6 – Pile Tip	25	5,000	11	2,000

¹To determine the frictional capacity (kN) of the pile, multiply the frictional resistance (kPa) by the surface area of the pile within each material. Neglect the depth of frost or the length of pile embedded in fill, whichever is greater.

²To determine the end bearing capacity (kN) of the pile, multiply the end bearing resistance (kPa) by the surface area of the pile tip.

General considerations for pile design are summarized below; however, detailed pile design is typically the responsibility of the contractor.

- The pile capacity should not exceed the structural capacity for the steel section of the selected pile.
- Pile design must be suitable to resist uplift due to expansion or adfreeze. Refer to section 4.3 for adfreeze considerations.
- Positive shaft resistance within fill should not be considered in design.
- Piles should have a minimum spacing of 3 times the pile diameter to reduce risks associated with group effects. If pile groups are installed with pile spacing less than the minimum, a group reduction factor must be applied to the ultimate bearing capacity of each pile.

Upon completion of pile design, detailed review should be undertaken by Taylor. This review is to ensure that the design satisfies the serviceability requirements and potential for excessive settlement is minimized. Actual pile resistances and lengths should be confirmed in the field through inspection and review of the pile driving during the installation process. This work should be carried out by qualified geotechnical personnel.

It is recommended that a test pile program be undertaken prior to construction to verify whether the loading requirements are achievable or whether revisions to detailed pile design and layout are necessary based on the in-situ conditions.

If the above recommendations are adhered to, settlement is expected to be less than 15 mm.

Driven Pile Construction

- Soil conditions can vary across site and piles designed based on the skin friction and end bearing may not need to achieve refusal to meet the required pile capacities. For steel piles driven to design depth, it is recommended to verify the piles have the required capacity by comparing the final driving set against the minimum termination set. The terminated criteria for design loads



and full refusal criteria should be verified once the proposed hammer energies and final pile details are known.

- If steel pipe piles are used, it is suggested to fill the unplugged space inside the piles with concrete after installation. Concrete filling of the pipe will add strength to the section and reduce the corrosion potential inside the pipe. Corrosion of the pipe in a partially saturated medium must be considered in selecting pipe wall thickness. If the concrete is not required for structural purposes (pile cap connections or improving rigidity) the use of lean mix concrete would be acceptable. Filling the shaft is not required to maintain the geotechnical pile design capacities provided above.
- The steel piles should be inspected prior to installation to confirm that the appropriate material specifications are satisfied; and to check that there are no protrusions on the shaft or at the tip which could result in voids along the shaft as the pile is driven.
- Monitoring of the pile installation by experienced geotechnical personnel is recommended to confirm that the piles are installed in accordance with design assumptions and that the driving criteria are satisfied. A complete driving record of blows per 300 mm of penetration for each pile should be obtained and reviewed by the pile designer. If during piling installation any areas of significantly reduced blow count are noted, further advancement of the pile may be required as determined by the geotechnical engineer-of-record.

Cast-In-Place Piles

It is also anticipated that cast-in-place concrete piles are suitable to transfer the building loads to the underlying compact to dense sand and gravel material. Taylor can provide bearing resistances and general design considerations for cast-in-place piles upon request.

4.3 FROST CONSIDERATIONS

Frost considerations are included in the following section for both shallow foundation elements and deep foundation elements.

Please note, it is anticipated that an entrance ramp associated with the below-ground parkade will be required. The entrance ramp for the parkade will be subject to regular icing and frost action. Rigid styrofoam insulation should be used to minimize frost penetration along the ramp surface and walls. Insulation will help minimize the potential for frost heaving but may result in icing of the ramp surface. Considerations should be given to using heat tracing, as well as installation of property drainage at the base of the ramp.

4.3.1 Shallow Foundation

Based on a freezing index of 1,091 degree-day °C in the Canmore area, it is recommended that all exterior footings or foundations in unheated portions of the proposed building have a minimum soil cover of 2.1 m for frost protection purposes. Interior footings or grade beams in heated structures should have a minimum soil cover of 1.4 m. Grade beams that do not have adequate frost protection should have a minimum of 100 mm of void space on the underside of the grade beam to minimize potential interaction with the underlying soils.



To permit shallowed footing embedment, consideration may be given to using rigid insulation. Generally, 25 mm thickness of rigid insulation may be assumed to provide approximately 0.3 m of equivalent soil cover. Insulation for frost protection purposes should be installed at a minimum depth of 0.6 m below the finished ground surface. The rigid insulation should extend beyond the outer edge of the buried structure. The length of the insulation extension should be determined during the detailed design phase. Frost protection details should be reviewed by a geotechnical engineer and confirmed in the field during construction.

4.3.2 Deep Foundation

For the given ground conditions at this site, the uplift forces may be calculated based on an assumed adfreeze stress of 100 kPa for fine-grained soils frozen to steel and 150 kPa for saturated sand and gravel frozen to buried steel elements. The adfreeze force is an ultimate load and should not be factored. The resisting forces should be 125% of the calculated adfreeze forces.

For an estimated frost penetration of 2.1 mbgs, it is anticipated that straight piles will need to be 8.1 m or more below final grade to adequately resist frost uplift or jacking.

Frost heave forces can also action on the underside of pile caps. Placement of a compressible material or providing a void of at least 75 mm between the underside of the concrete cap or grade beam and soil is recommended.

4.4 FLOOR SLAB

It is recommended that grade supported floor slabs be founded on an under-slab base course consisting of at least 100 mm thickness of 25 mm minus crushed gravel having less than 5% passing the 0.075 mm sieve size. This material should be placed and compacted to 98 percent of Standard Proctor maximum dry density (ASTM D698). The slab on grade should be structurally separated from all foundation elements and should include a cross joint system to control post construction cracking.

The subgrade soils should be inspected by a qualified geotechnical engineer. Any soft or spongy areas should be removed and replaced with compacted engineered fill materials.

4.5 BELOW GRADE WALLS

It is understood that the proposed development is to include design and construction of below grade walls. As such, consideration must be given to the lateral earth pressures that will act against these structures. The below described earth pressure cases should be considered and applied appropriately.

- Active Earth Pressure (k_A) should be used behind a retaining wall that is unrestrained at the top or for flexible walls that allow for some movement away from the retained soil mass.
- At Rest Pressures (k_0) should be used behind below grade walls that can not tolerate or are restrained from movements.
- Passive Earth Pressure (k_p) act along the front of the retaining wall and considers the horizontal stresses on the wall which push against the soil.



Lateral earth pressure distribution acting against retaining structures or below grade walls can be assumed to be triangular in shape and may be calculated using the below equation. Based on the observed groundwater levels, it is considered unlikely that groundwater will act against below grade walls.

$$P = KQ + K\gamma H$$

Where

- P is the lateral earth pressure at depth, H below ground level (in kPa)
- Q is any surcharge load being applied along the ground surface (in kPa)
- K is the coefficient of lateral earth pressure (considering the cases listed above)
- γ is the unit weight of soil (in kN/m³)
- H is the depth below ground surface (in m)

Please note, the above equation does not consider hydrostatic pressures acting against the wall. If groundwater is allowed to act against the wall, the following relationship may be used to calculate lateral earth pressures.

$$P = KQ + K\gamma H + \gamma_w d(1 - K)$$

Where

- γ_w is the unit weight of water (at 9.81 kN/m³)
- d is the depth below the groundwater table (in m)

Recommended design values for these parameters depend on the type of backfill being used. Table 6 summarizes Taylor's recommendations for the anticipated site conditions.

Table 6: Material parameters for soils

Soil Description	Unit Weight, γ (kN/m ³)	Coefficient of Lateral Earth Pressure		
		Active, K_A	At Rest, K_O	Passive, K_P
In-Situ Silt to Silty Sand	19.5	0.36	0.53	2.77
Compacted Granular Backfill	21	0.27	0.43	3.69

If requested, Taylor can provide detailed analysis of the site and development specific loading conditions for the design and construction of below grade walls.

It is recommended that free draining backfill is placed behind walls and a positive drainage system should be provided to prevent possible build up of hydrostatic pressures. This material should be compacted using only lightweight compaction equipment. Lift thickness of 200 mm are recommended during construction.

4.6 CONCRETE TYPE (SULPHATE RESISTANCE)

Laboratory testing on selected samples of the native soil was completed by KaizenLab. The testing results reported less than 0.0050% sulphate which presents very low risk of sulphate attack to buried concrete elements. As such, General Use (GU) cement is considered appropriate for cast in place concrete elements below grade.



4.7 FOUNDATION TANKING AND WATERPROOFING

The observed groundwater levels were noted to be approximately 7.27 m below the existing ground surface at the time of the investigation. Review of related geotechnical reports for the Bow Valley area indicate a typical groundwater fluctuation of 1.0 m in the valley bottom. A 1.0 m increase from the observed water levels corresponds to a high-water level of 6.27 mbgs.

Based on the above assumed ground water level, it is not anticipated that the below ground parkade will be subject to water infiltration; however, this is dependent on the final design elevations associated with the underground parkade. Should design elevations be anticipated to intercept the assumed groundwater level, or significant shallow groundwater be encountered at the time of construction, consideration may need to be given to foundation tanking and water proofing.

4.8 SITE DRAINAGE AND FOUNDATION DRAINAGE

Surface flows from roads and parking areas must be collected and disposed of in an approved manner. Surface flows are to be directed away from foundation elements. It is recommended that disposal areas for surface water flow are located a minimum of 5 m from foundations. Collected surface water flows should pass through a silt collector before being directed to sub-drainage system.

If a shallow foundation system is used, use of perimeter foundation drains is recommended. Weeping tile drainage should consist of 150 mm perforated plastic pipe surrounded by free draining gravel and completely wrapped in a filter cloth. Gravel should provide 150 mm of free draining cover around the pipe. If weeping tile with an integrated filter cloth is used, then the surrounding filter fabric may be disregarded.

4.9 STEEP CREEK CONSIDERATIONS

The site is located within the Steep Creek Hazard Zone of Stoneworks Creek; as such, steep creek hazards may require consideration in the design of the development. According to the Town of Canmore Property Information Viewer, the site is classified primarily as Low Hazard, with the western corner classified as Medium Hazard. See Figure 3 for reference.

Based on the Town of Canmore Revised Land Use Bylaw 2018-22, development in a medium hazard zone may be permissible so long as a Site Specific Steep Creek Risk Assessment prepared for the development is within the risk tolerance criteria. It is recommended that the client review the Town of Canmore requirements for development within the steep creek zone. Taylor can conduct a Site Specific Steep Creek Risk Assessment upon request.

4.10 GENERAL SITE DEVELOPMENT

The following provides general recommendations for development of the site.

4.10.1 Stripping

It is recommended that all existing organic and deleterious materials, including pre-existing fill, be removed from within the development areas. Based on the results of the investigation, the anticipated depth of sub-excavation for stripping is 1.2 mbgs.



For use of a shallow foundation, sub-excavation of clay-rich soils encountered at the footing level may be required. A 0.61 m thick clayey silt layer was encountered at approximately 2.1 mbgs in BH-02. Should this material be encountered at the time of excavation, sub-excavation is required. Sub-excavated materials can be replaced with compacted granular fill materials to achieve required grades.

It is imperative that highly organic materials are removed prior to construction. The subgrade of excavations shall be inspected and approved by a qualified geotechnical engineer prior to construction, as well as before placement of fills or poured concrete.

4.10.2 Construction Excavations

Temporary excavation side slopes in soils encountered on site should be developed at angles no steeper than 1 horizontal to 1 vertical for dry or dewatered conditions. Should excavation extend below the groundwater table at the time of construction, temporary slope angles should be flattened to 2 horizontal to 1 vertical. It is recommended that the horizontal limits of the excavation extend beyond the building perimeter a distance equal to the depth of the excavation.

For excavations below the groundwater table, dewatering should be in place immediately after excavation. Dewatering should work continuously while constructing below the groundwater level.

4.10.3 Temporary Shoring

Depending on the depth and proximity of the excavation to property boundaries and neighbouring structures, temporary shoring may be required. Conventional steel "H" section piles with timber lagging or structural shotcrete shoring may be considered. The design of shoring walls is proprietary in nature and is typically the responsibility of the contractor.

The following site conditions should be considered in design of temporary shoring:

- Water pressure acting behind temporary shoring;
- Dewatering requirements;
- Neighbouring structures near shoring; and
- Overall stability of the shoring system.

Comments and recommendations regarding material parameters and temporary lateral earth pressures are presented in Section 4.5.

Existing structures located behind shoring may be subject to potential movements as a result of construction activities. Generally, the zone of influence extends from the base of the excavation back at an angle of 45 degrees to the horizontal. If a structural element (or part of) is located within that 45-degree envelope, it may be at potential risk of movement or damage. Underpinning of adjacent structures in conjunction with shoring may be required.

Consideration should be given to completing a damage survey of nearby structures prior to excavation including detailed measurements and photographic records of existing damages. Also, development of a movement monitoring program for structural elements within the identified zone of influence should be considered. Establishment of survey monitoring points should be done prior to construction.



4.10.4 Temporary Construction Dewatering

Groundwater was observed in the piezometers at the time of the follow-up site visit at 7.27 mbgs. Groundwater levels are susceptible to seasonal fluctuation, with the highest groundwater levels anticipated for the spring and summer seasons. It is possible that dewatering may be required for the construction of a shallow foundation system, depending upon the time of year construction takes place as well as final design elevations. Please note, a deep foundation system would not require dewatering.

A conventional pumping arrangement from collector sumps may be suitable to manage seepage within excavations depending upon the construction methods. Construction dewatering methods and pumping rates are the responsibility of the contractor. Dry working conditions are to be maintained throughout foundation construction.

4.10.5 Fill Placement and Compaction

Due to the high content of fine-grained material within the in-situ material, re-use of the excavation spoil material for fill is not recommended. Any fill or in situ material that becomes saturated by standing water, groundwater, or storm water must be removed and replaced with competent fill.

Taylor recommends importing well-graded 80 mm minus pitrun sand and gravel containing less than 10 percent passing the 0.075 mm (# 200) sieve size for general fill material, as needed. Pitrun fill should be placed in horizontal lifts not exceeding 300 mm in loose thickness and should be compacted to at least 98 percent standard Proctor maximum dry density (ASTM D698). Please note, general fill applications include site grading and the backfill against foundation elements.

Structural fill should consist of 25 mm minus crushed gravel having less than 5 percent passing the 0.075 mm sieve size. This material should be compacted to 98 percent Standard Proctor maximum dry density (ASTM D698).

No organic soils or frozen materials should be included in fill materials. In addition, fill should not be placed on the foundation subgrade or on already placed lifts if these surfaces are frozen. Fill should also not be placed in ponded water, or on excessively wet soil or fill surfaces covered with snow.

It is recommended that the fill surfaces be crowned or sloped during construction to avoid ponding of water. Fills should be placed such that drainage is always away from the structure. Surface water should be drained away from the structure as quickly as possible.

Subject to approval of the engineer, fillcrete, or other self compacting, self densifying fills may be used in situations where traditional backfill could present a hazard to workers, the structure or surrounding structures.

4.10.6 Cold Weather Construction Practices

Winter construction poses risk associated with frost effects to the development if proper construction practices are not implemented. See Appendix B for recommendations pertaining to cold weather construction practices.



4.11 FIELD REVIEW, MONITORING AND TESTING

It is recommended that Taylor provide reviews throughout the design and construction phases of the project to ensure all geotechnical considerations addressed herein are adhered to. Table 7 below summarizes the reviews and field tests required at various phases of the project.

Table 7: Summary of Required Reviews throughout Design and Construction

Phase	Review Required	Field Testing
Design	Taylor is to review the final plans and specifications to confirm that they address the geotechnical considerations discussed herein	N/A
Subgrade Preparation	Experienced geotechnical engineer is to inspect and approve the exposed subgrade soils, prior to fill and/or footing placement.	N/A
Importing Backfill	Aggregate samples are to be taken for laboratory testing, specifically Standard Proctor testing (ASTM D698).	Sample collection. Note, a turn around time of 5 days is required for laboratory testing results.
Shallow Foundation	Experienced geotechnical engineer or field technician is to observe fill placement and compaction efforts. Approval is required prior to placing subsequent lifts.	In situ density testing to ensure specifications are met.
Deep Foundation	Inspection and review of the pile driving during the installation process.	N/A

Please note, the above table is a summary of the design and construction phases and the minimum required reviews. The review requirements are subject to change throughout the course of the project. Additionally, any alterations to the recommendations provided throughout this report require approval by an experienced geotechnical engineer with written documentation of the change.



5.0 CLOSURE

It is trusted that this letter report meets your present requirements. Should you have any questions or need additional information, please do not hesitate to contact Heather Taylor at 403-707-5082 to discuss.

Kind Regards,

TAYLOR GEOTECHNICAL LTD.

Prepared By:

Reviewed By:

Regan Mahoney, EIT
Junior Geotechnical Engineer

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Principal Geotechnical Engineer

APEGA Permit to Practice #: P14061



DISCLAIMER AND LIMITATIONS

This report is delivered subject to the expressed condition that the following disclaimers and limitations concerning use of the report and the liability of Taylor Geotechnical are accepted by the reader.

BASIS OF THE REPORT

This report was prepared for the Client for the purpose of providing geotechnical investigation for the specific site, development, and design described to Taylor Geotechnical by the Client.

The findings, opinions and recommendations in this report are only valid to the extent that the report addresses these specifics and remain subject to the limits described herein.

The opinions and recommendations in this report are based on geotechnical investigation work carried out on site in accordance with the Standard of practice described herein.

The report does not include any investigation, analytical testing or assessment of possible soil and groundwater contamination, archeological or biological considerations or sediment control measures.

The Client should provide Taylor Geotechnical with notice any material changes to the site, development, design and objectives, and provide Taylor Geotechnical with opportunity to revise the report accordingly. Any special concerns or circumstances not contemplated at the time of the report should be communicated so that Taylor Geotechnical may conduct further investigations not otherwise within the scope of services provided.

STANDARD OF PRACTICE

This report has been prepared with reasonable care and skill in accordance with the generally accepted practices for geotechnical services. This report makes no expressed or implied warranties other than being prepared according to the standards of practice described herein.

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This report is intended for the exclusive use and sole benefit of the Client, its successors and assigns. It makes no representations of fact, opinion or recommendations whatsoever to any other persons ("Third Parties"). No Third Party may use, rely upon or reproduce this report in whole or in part without the written consent of Taylor Geotechnical and on the terms and conditions set by Taylor Geotechnical.

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All intellectual property and any copyrights in this report belong to Taylor Geotechnical.

Taylor Geotechnical shall keep a paper copy of this report on file and that copy shall take precedence in the event of discrepancy with any circulated or electronic copies.

THE COMPLETE REPORT

The complete report includes all information generated and reported to the client through Taylor Geotechnical's services on this assignment. The report document does not stand alone from Client instructions, communications and other reporting by Taylor Geotechnical to the Client, all of which form part of the report. Taylor Geotechnical is not responsible for use of portions of the report without reference to the whole report.

RELIANCE ON INFORMATION PROVIDED

In preparing this report, Taylor Geotechnical has relied in good faith on information from the Client and further persons. Taylor Geotechnical is entitled to rely on such information and is not required to independently verify the truth of information provided. Taylor Geotechnical accepts no responsibility for any misstatements in the report



resulting from the misinformation, misstatements, omissions, misrepresentations or fraudulent acts by the Client or other persons.

INTERPRETATION OF SITE CONDITIONS

The interpretations of site conditions in this report are based on the conditions at sample locations on a specific site at one point in time, and the opinions and recommendations provided are only valid to that extent.

The interpretation of site conditions involves inherent and unavoidable risks. The identification and classification of soils, rocks, geological units, materials and quantities of the same is inherently judgemental in nature. The investigative practice means that some conditions may not be detected or that actual conditions may vary from sample points. Comprehensive investigations conducted according to the applicable standards by experienced personnel with appropriate equipment can still fail to locate some site conditions.

As conditions may change over time, this report is intended for immediate use. The Client should provide Taylor Geotechnical with any changes to site conditions or new information that becomes available after the date of this report and have Taylor Geotechnical re-consider its opinions and recommendations prior to the Client or Third Parties making decisions based on this report.

REGULATORY CONTEXT

This report was prepared in the context of government regulations and policies in effect and generally promulgated at the time and, unless specifically noted, does not consider any government regulations or policies that were not in effect and generally promulgated at the time it was prepared. Unless specifically stated, this report provides no advice on regulatory issues associated with the site or project.

INDEPENDENT JUDGEMENT OF CLIENT

Opinions and recommendations in this report are based on Taylor Geotechnical's interpretations of information obtained through a limited investigation within a defined scope of services. Taylor Geotechnical is not liable for the independent conclusions, interpretations and decisions of the Client or any Third Parties based on this report. This limitation includes any decisions to purchase, sell, develop, lease or rent land or buildings.

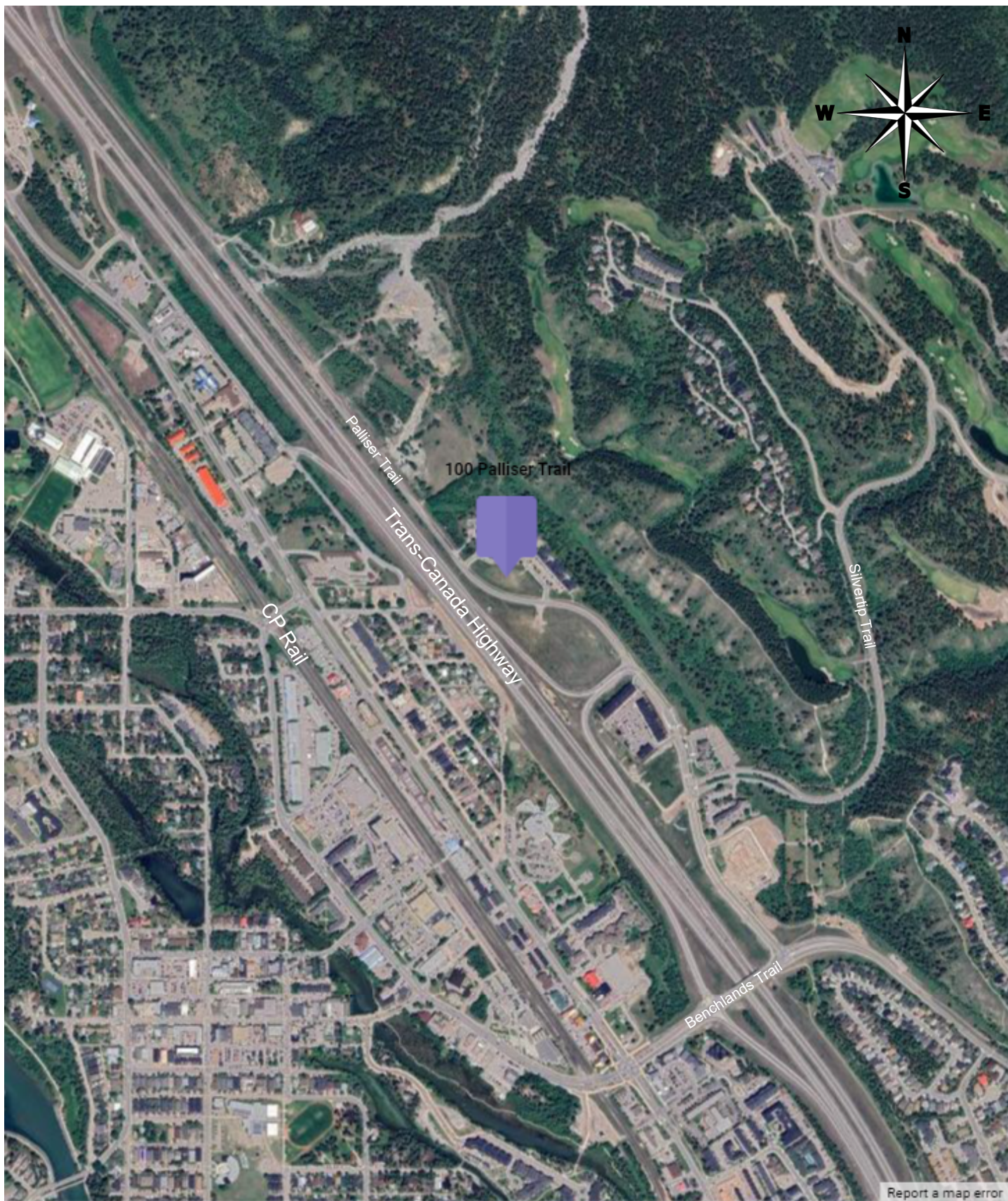
RELEASE OF POLLUTANTS


Geotechnical engineering and environmental consulting work involves risks of encountering and causing the release of pollutants or hazardous substances. Taylor Geotechnical shall have no liability to the Client or Third Parties for such releases unless the substance is specifically identified by the Client prior to the performance of services.

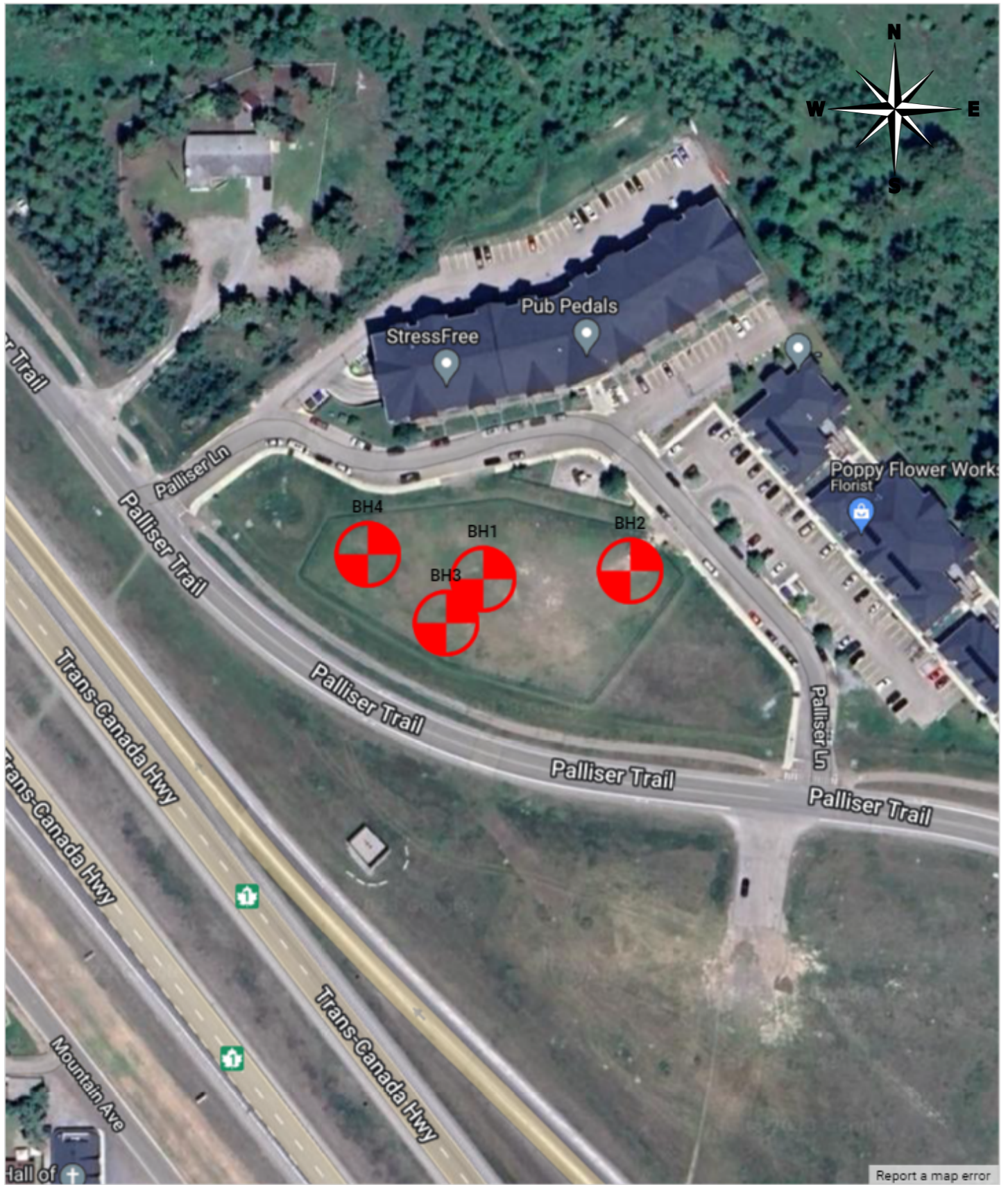
DESIGN AND CONSTRUCTION SERVICES

Where consented to by Taylor Geotechnical, this report may form part of design and construction documents for information purposes even though issued prior to final design. Any differences between the recommendations in this report and the final design should be reported to Taylor Geotechnical, and Taylor Geotechnical to review the final design for consistency with the recommendations prior to proceeding to construction. All recommendations remain subject to field review by Taylor Geotechnical during the construction phase, and Taylor Geotechnical should be retained to conduct such field review to confirm that the site conditions do not materially differ from the interpreted conditions at the time the report was prepared.

These further services may be necessary for Taylor Geotechnical to provide letters of assurance as required by regulatory bodies in some jurisdictions.



Client: Canmore Community Housing Corp.		Figure 1: Borehole Locations	
Project: 100 Palliser Trail		Address: 100 Palliser Trail, Canmore AB	 TAYLOR GEOTECHNICAL
Project No.: 2023091		Date: 2023-Sep-13	



Client: Canmore Community Housing Corp.

Figure 2: Borehole Locations

Project: 100 Palliser Trail

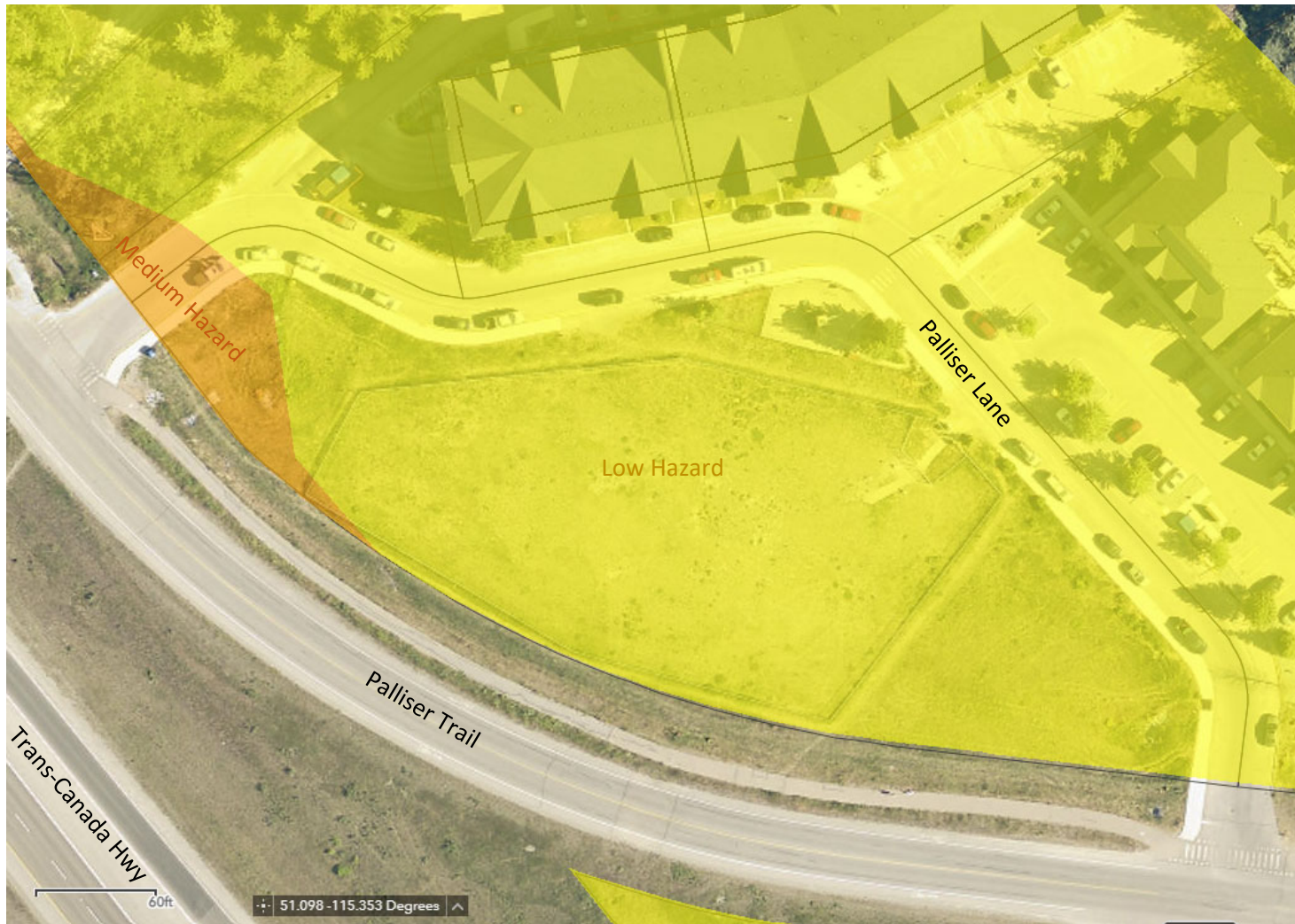
Address: 100 Palliser Trail, Canmore AB

Project No.: 2023091

Date: 2023-Sep-06



TAYLOR GEOTECHNICAL



Reference: Town of Canmore Property
Information Viewer

DATE:	2023-09-13
DRAWN:	RM
DESIGNED:	RM
CHECKED:	RM
APPROVED:	RM



TAYLOR GEOTECHNICAL

CLIENT: **Canmore Community
Housing Corp.**

PROJECT: **100 Palliser Trail**

TITLE: **Steep Creek Hazard Zone**

PROJECT #: 2023-091

FIGURE: 3

REV.: 0



APPENDIX A: BOREHOLE LOGS AND LAB TESTING RESULTS

DRAFT

BOREHOLE LOG: BH-01

Project: 100 Palliser Trail
 Site Address: Palliser Trail
 Project No.: 2023091
 Client: Michelle Ouellette
 Investigation Date: August 22, 2023

Easting: 615414
 Northing: 5662002
 Elevation: 1312 m
 Logged By: CW
 Reviewed By: JRT

DEPTH (M)	LITHOLOGIC DESCRIPTION	SYMBOL	SAMPLE TYPE	MOISTURE	COMMENTS	SPT			METHOD	PIEZOMETER
						25	50	75		
0	Ground Surface									PVC Cap
0	TOPSOIL (TS) TS, light grey, silty sand with rootlets.		#	23.3						
1	SILT (ML) ML, soft, brown, silt with trace sand and trace clay.		#	29.7						
			▽	43.7						
2										
3			#	32.2						
			▽	31						
4	SILTY SAND (SM) SM, Compact, light grey, silty sand.		#	23.2						
			#	15.6						
			#	23.8						
5			▽	19.1						
	SILT (ML) ML, soft, brown, silt, with trace sand and trace clay.		#	22.6						
6			#	23.5						
			▽	21.4						
7			#	21.4						
			#	22.7						
			#	23.4						
8	CLAY AND SILT (CL-ML) CL-ML, very stiff, light brown, clay and silt.				Potential groundwater seepage at 7.62 m					
	SAND AND GRAVEL (GP) GP, Compact to dense, sand and gravel with potential cobbles.									
9										
10										

Sonic (Vibratory)

Standpipe

4

3

8

3

21

19

24





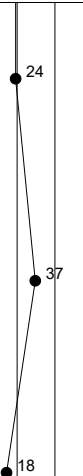
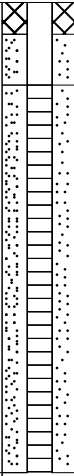
TAYLOR GEOTECHNICAL

Notes:

BOREHOLE LOG: BH-01

Project: 100 Palliser Trail
 Site Address: Palliser Trail
 Project No.: 2023091
 Client: Michelle Ouellette
 Investigation Date: August 22, 2023

Easting: 615414
 Northing: 5662002
 Elevation: 1312 m
 Logged By: CW
 Reviewed By: JRT

DEPTH (M)	LITHOLOGIC DESCRIPTION	SYMBOL	SAMPLE TYPE	MOISTURE	COMMENTS	SPT			METHOD	PIEZOMETER
						25	50	75		
10	(continued) SAND AND GRAVEL (GP) GP, Compact to dense, sand and gravel with potential cobbles.			7.9					Sonic (Vibratory)	
11										
12										
13										
14	Test Hole Terminated at 13.7 m									
15										
16										
17										
18										
19										
20										

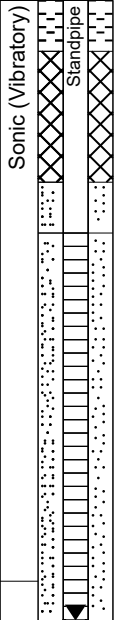


BOREHOLE LOG: BH-02

Project: 100 Palliser Trail
 Site Address: Palliser Trail
 Project No.: 2023091
 Client: Michelle Ouellette
 Investigation Date: August 22, 2023

Easting: 615454
 Northing: 5662005
 Elevation: 1312 m
 Logged By: CW
 Reviewed By: JRT

DEPTH (M)	LITHOLOGIC DESCRIPTION	SYMBOL	SAMPLE TYPE	MOISTURE	COMMENTS	SPT			METHOD	PIEZOMETER
						25	50	75		
0	Ground Surface									PVC Cap
0	TOPSOIL (TS) TS, brown, firm, silt with trace sand, containing rootlets.		[#]	28.4 29.7						
1	SILT (ML) ML, brown, soft, silt, with some sand and trace clay.		[#]	25.8 29.4 26.6 25.6	0.0% Gravel; 21.3% Sand; 78.7% Silt/Clay.					
2	CLAYEY SILT (CL-ML) CL-ML, mottled brown clayey silt with trace sand, with pore holes.		[#]	22.7	LL = 27%, PL = 21%, PI = 6.7%.					
3	SILTY SAND (ML) ML, loose to compact, light brown, silty sand.		[#]	34.5						
4			[#]	20.5						
5	Test Hole Terminated at 4.88 m		[#]	21.8						
6										
7										
8										
9										
10										



TAYLOR GEOTECHNICAL

Notes:

BOREHOLE LOG: BH-03

Project: 100 Palliser Trail
 Site Address: Palliser Trail
 Project No.: 2023091
 Client: Michelle Ouellette
 Investigation Date: August 22, 2023

Easting: 615404
 Northing: 5661990
 Elevation: 1312 m
 Logged By: CW
 Reviewed By: JRT

DEPTH (M)	LITHOLOGIC DESCRIPTION	SYMBOL	SAMPLE TYPE	MOISTURE	COMMENTS	SPT			METHOD	PIEZOMETER
						25	50	75		
Ground Surface										
0	TOPSOIL (TS) Brown, silt containing rootlets.		[#]	10.3	1.6% Gravel; 10.8% Sand, 87.5% Silt and Clay.					Sonic (Vibratory)
1	SILT (ML) ML, soft, brown, silt with trace sand and trace clay.		[#]	11.1						
2			[#]	21.1						
3		[#]	39							
4	CLAYEY SILT (CL-ML) CL-ML, Clayey silt with trace to some sand, and trace gravel, containing dark brown sandy silt inclusions with rootlets	[#]	28.2							
5	SAND (SW) SW, loose, brown, sand with trace silt.		[#]	7.1						
	Test Hole Terminated at 4.88 m		[#]	16.8						
6										
7										
8										
9										
10										

RSLog / Borehole Log, 10m with Piezo & SPT / taylor-geotechnical-ltd / admin / September 13, 2023 11:36 AM



TAYLOR GEOTECHNICAL

Notes:

BOREHOLE LOG: BH-04

Project: 100 Palliser Trail
 Site Address: Palliser Trail
 Project No.: 2023091
 Client: Michelle Ouellette
 Investigation Date: August 22, 2023

Easting: 615382
 Northing: 5662008
 Elevation: 1312 m
 Logged By: CW
 Reviewed By: JRT

DEPTH (M)	LITHOLOGIC DESCRIPTION	SYMBOL	SAMPLE TYPE	MOISTURE	COMMENTS	SPT			METHOD	PIEZOMETER
						25	50	75		
Ground Surface										
0	TOPSOIL (TS) TS, brown silt containing rootlets.									
1	SILT (ML) ML, loose, brown, silt with trace to some sand.		[#]	12.6						
2				15						
3				32						
4	CLAYEY SILT (CL-ML) CL-ML, soft, brown, clayey silt with some sand.		[#]	19						
	SILT (ML) ML, firm, brown, silt with some sand.			18						
5	Test Hole Terminated at 4.88 m									
6										
7										
8										
9										
10										

RSLog / Borehole Log, 10m with Piezo & SPT / taylor-geotechnical-ltd / admin / September 13, 2023 11:42 AM



TAYLOR GEOTECHNICAL

Notes:



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT LOGS

Terminology describing common soil genesis:	
Rootmat	Vegetation, roots and mass with organic matter and topsoil typically forming a mattress at the ground surface.
Topsoil	Mixture of soil and humus capable of supporting vegetative growth.
Peat	Mixture of visible and invisible fragments of decaying organic matter.
Till	Unstratified glacial deposit which may range from clay to boulders.
Fill	Material below the surface identified as placed by humans.

Terminology describing soil types:				
Major Divisions			Group Symbols	Typical Names
Coarse-grained Soils: More than half material is larger than No. 200 sieve size.	Gravels: More than half coarse fraction is larger than No. 4 sieve size.	Clean Gravels (little or no fines)	GW	Well-graded gravels, gravel sand mixtures, little or no fines.
			GP	Poorly-graded gravels or gravel sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly-graded sands or gravelly sands, little or no fines.
		Sands with fines	SM	Silty sands , sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
Fine-grained Soils: More than half of material is smaller than No. 200 sieve size.	Silts and Clays: Liquid limit is less than 50.		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. Quick to slow dilatancy.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. None to slow dilatancy.
			OL	Organic silts and organic silty clays of low plasticity. Slow to no dilatancy.
	Silts and Clays: Liquid limit is greater than 50.		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays and silts of medium to high plasticity.
			Highly Organic Soils	

Coarse Grain Soils Particle Sizes			
Constituent		Particle Sizes	
		(mm)	Inches & Sieve Size
Boulders		>300	>12"
Cobbles		76 – 300	3" – 12"
Gravel	Coarse	19 – 76	3/4" – 3"
	Fine	4.75 – 19	No.4 – 3/4"
Sand	Coarse	2.0 – 4.75	No. 10 – No. 4
	Medium	0.2 – 0.6	No. 40 – No. 10
	Fine	0.06 – 0.2	No.200 – No. 40.
Silt		Not visible to naked eye	






























Classification Terminology	
AND	35% – 50%
Adjective (.....Y)	20% – 35%
SOME	10% – 20%
TRACE	1% – 10%
Plasticity	
A qualitative measure of the effect that water has on the consistency of the material in question. It can be estimated on the field as low, medium or high. High plastic clays are also referred to as swelling clays. It can be quantitatively determined using the Atterberg Limit test procedure in lab (ASTM D4318).	

NOTES: Cobbles and Boulders are individually noted and recorded at the depth which they occur. Dimensions of boulders should be recorded if possible.




SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT LOGS

Terminology describing the compactness of soils				
Non-Cohesive Soils		Cohesive Soils		
Description	N-Value	Description	Undrained Shear Strength (kPa)	N-Value
Very Loose	0 – 4	Very Soft	< 12.5	0 – 2
Loose	4 – 10	Soft	12.5 – 25	2 – 4
Compact	10 – 30	Firm	25 – 50	4 – 8
Dense	30 – 50	Stiff	50 – 100	8 – 15
Very Dense	> 50	Very Stiff	100 – 200	15 – 30
		Hard	> 200	>30
N Value				
N-Value numbers are the field results of the Standard Penetration Test (SPT). N-Value represents the number of blows a 140 lb. (63.5kg) hammer falling 30 inches (300mm) required to drive a 2 inch (50.8mm) O.D. split spoon sampler one foot (300mm) into the soil. The N-Value equals the number to drive the sampler over the interval of 6 to 18 inches (300 to 610mm).				

GRAPHIC LOG/STRATA PLOT SYMBOLS			
 CH High Plasticity Clay With Sand	 GW Well Graded Gravel With Sand	 SM Silty Sand With Gravel	
 CL Low Plasticity Clay With Sand	 GW-GC Well Graded Clayey Gravel With Sand & Silt	 SP Poorly Graded Sand With Gravel	
 CL-ML Silty Clay With Sand	 GW-GM Well Graded Silty Gravel With Sand & Clay	 SP-SC Poorly Graded Clayey Sand With Gravel & Silt	
 FL Fill Material	 MH High Plasticity Silt With Sand	 SP-SM Poorly Graded Silty Sand With Gravel & Clay	
 GC Clayey Gravel With Sand	 ML Low Plasticity Silt With Sand	 SW Well Graded Sand With Gravel	
 GC-GM Clayey - Silty Gravel With Sand	 OH Organic Clay With High Plasticity	 SW-SC Well Graded Clayey Sand With Gravel & Silt	
 GM Silty Gravel With Sand	 OL Organic Clay With Low Plasticity	 SW-SM Well Graded Silty Sand With Gravel & Clay	
 GP Poorly Graded Gravel With Sand	 Pt Peat	 TILL Till-Like Sand With Occasional Cobbles	
 GP-GM Poorly Graded Silty Gravel With Sand & Clay	 SC Clayey Sand With Gravel	 TS Top Soil	
 GP-PC Poorly Graded Clayey Gravel With Sand & Silt	 SC-SM Clayey - Silty Sand With Gravel		

SAMPLE TYPE		
GS	Grab sample of specific depth.	#
SS	Split spoon sample from standard penetration test.	▽
CC	Continuous core sample.	○
BS	Bulk sample.	⬢
ST	Shelby tube.	□

WATER LEVEL MEASUREMENT	
	<ul style="list-style-type: none"> Groundwater level. Measured in standpipe, piezometer, well or observed while drilling or test pitting.

GRAIN SIZE DISTRIBUTION (SIEVE ANALYSIS)



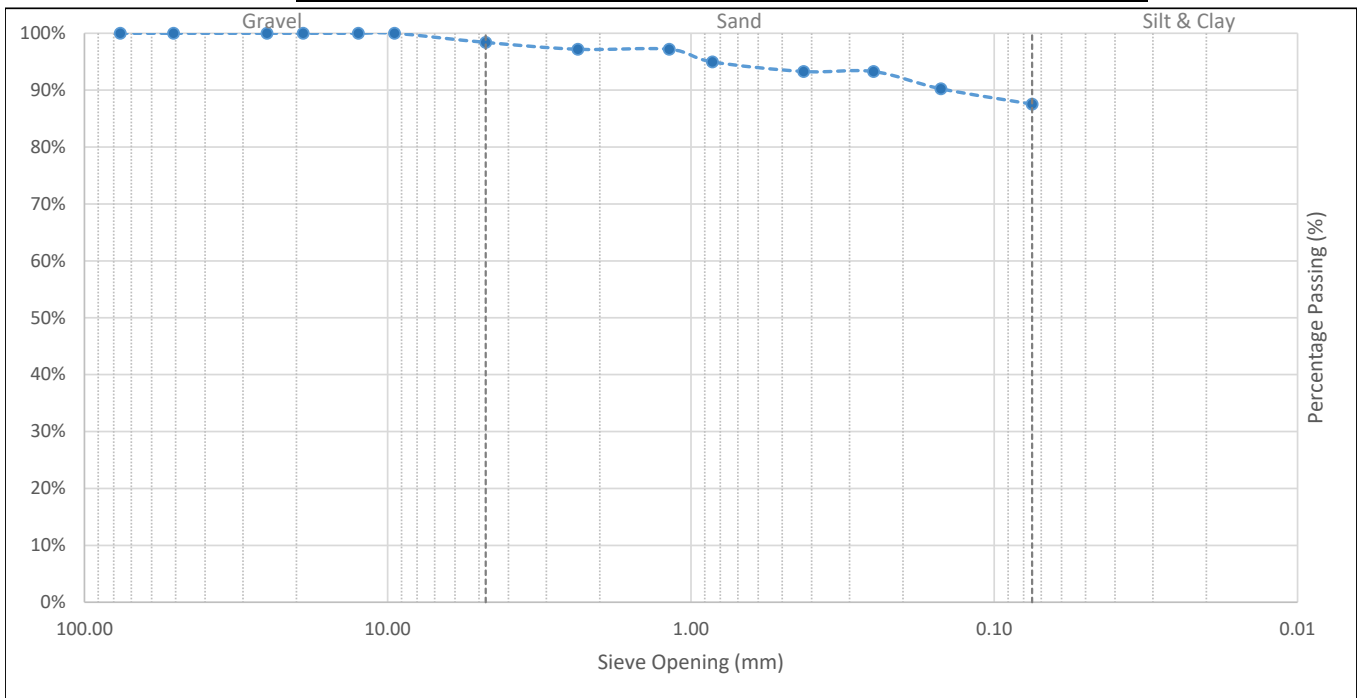
ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

1400 Railway Ave, Canmore, AB, T1W 1P6 T: 888-484-2444 www.taylorgeotechnical.com

Project Number:	2023091	Received By:	CW	Date:	08/29/2023
Project Name:	100 Palliser Trail	Tested By:	CW	Date:	08/31/2023
TGL Sample Number:	2691	Reviewed By:	RM	Date:	09/13/2023
Material Description:	BH3 GS3				

USCS SOIL CLASSIFICATION:	SILT, some sand, trace gravel (ML)
---------------------------	------------------------------------

Sieve No.	Diameter (mm)	Soil Retained (g)	Cumulative Mass (g)	Soil Retained (%)	Percent Passing (%)
4"	101.6	0.0	0.0	0.0%	100.0%
3"	76.20	0.0	0.0	0.0%	100.0%
2"	50.80	0.0	0.0	0.0%	100.0%
1"	25.00	0.0	0.0	0.0%	100.0%
3/4"	19.00	0.0	0.0	0.0%	100.0%
1/2"	12.50	0.0	0.0	0.0%	100.0%
3/8"	9.50	0.0	0.0	0.0%	100.0%
No. 4	4.75	15.0	15.0	1.6%	98.4%
No. 8	2.36	11.2	26.2	1.2%	97.2%
No. 16	1.180	0.0	26.2	0.0%	97.2%
No. 20	0.850	20.6	46.8	2.2%	95.0%
No. 40	0.425	15.6	62.4	1.7%	93.3%
No. 60	0.250	0.0	62.4	0.0%	93.3%
No. 100	0.150	28.2	90.6	3.0%	90.2%
No. 200	0.075	25.1	115.7	2.7%	87.5%
Pan		813.1	928.8	87.5%	0.0%
TOTAL		928.8	FIDELITY	100.12%	



GRAIN SIZE ANALYSIS					
% Gravel (4.75 mm to 75 mm):	1.6%	D10 (mm)	-	Cu	-
% Sand (0.075 mm to 4.75 mm):	10.8%	D30 (mm)	-	Cc	-
% Silt and Clay (< 0.075 mm):	87.5%	D60 (mm)	-		

Comments: Mechanical shaker SS14-00079 used for 8 min, hand shake for 1 min.

GRAIN SIZE DISTRIBUTION (SIEVE ANALYSIS)

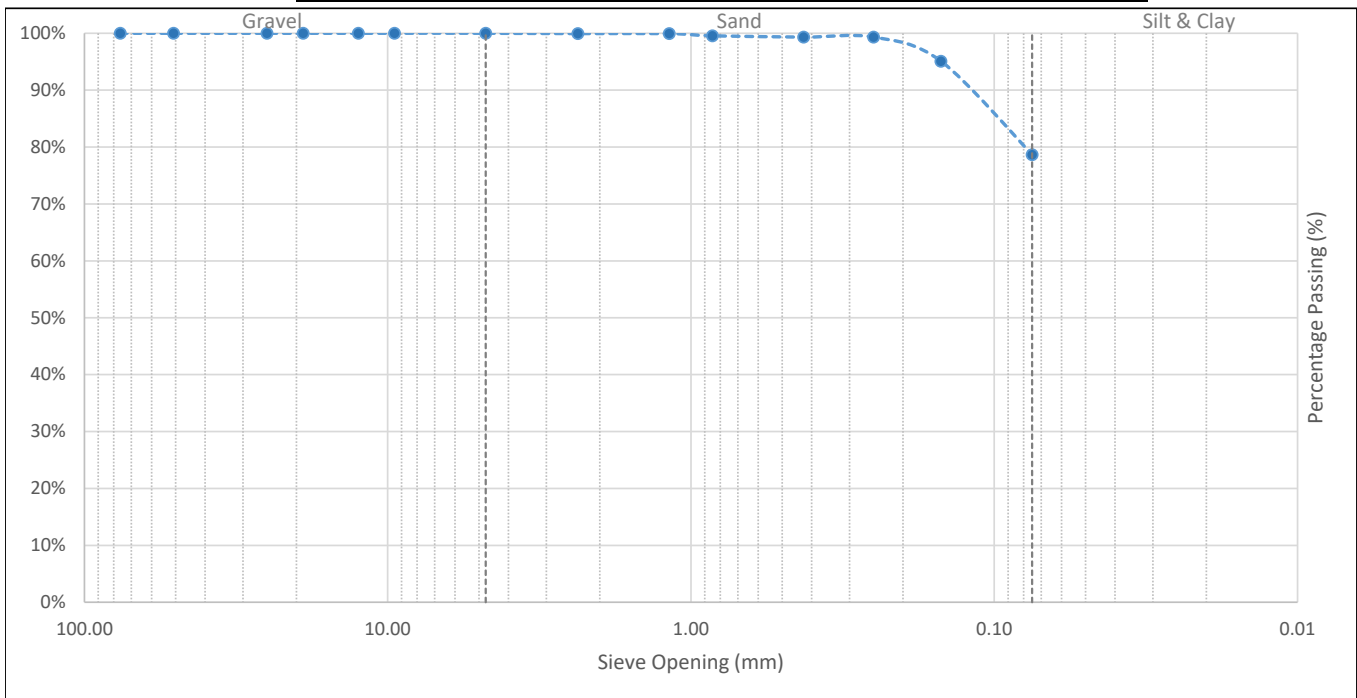
ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

1400 Railway Ave, Canmore, AB, T1W 1P6 T: 888-484-2444 www.taylorgeotechnical.com

Project Number:	2023091	Received By:	CW	Date:	08/29/2023
Project Name:	100 Palliser Trail	Tested By:	CW	Date:	08/31/2023
TGL Sample Number:	2682	Reviewed By:	RM	Date:	09/13/2023
Material Description:	BH2 GS4				

USCS SOIL CLASSIFICATION:	SILT, some sand (ML)
---------------------------	----------------------

Sieve No.	Diameter (mm)	Soil Retained (g)	Cumulative Mass (g)	Soil Retained (%)	Percent Passing (%)
4"	101.6	0.0	0.0	0.0%	100.0%
3"	76.20	0.0	0.0	0.0%	100.0%
2"	50.80	0.0	0.0	0.0%	100.0%
1"	25.00	0.0	0.0	0.0%	100.0%
3/4"	19.00	0.0	0.0	0.0%	100.0%
1/2"	12.50	0.0	0.0	0.0%	100.0%
3/8"	9.50	0.0	0.0	0.0%	100.0%
No. 4	4.75	0.0	0.0	0.0%	100.0%
No. 8	2.36	0.5	0.5	0.1%	99.9%
No. 16	1.180	0.0	0.5	0.0%	99.9%
No. 20	0.850	2.8	3.3	0.4%	99.6%
No. 40	0.425	1.7	5.0	0.2%	99.3%
No. 60	0.250	0.0	5.0	0.0%	99.3%
No. 100	0.150	31.5	36.5	4.2%	95.1%
No. 200	0.075	122.0	158.5	16.4%	78.7%
Pan		584.5	743.0	78.7%	0.0%
TOTAL		743.0	FIDELITY	100.01%	



GRAIN SIZE ANALYSIS					
% Gravel (4.75 mm to 75 mm):	0.0%	D10 (mm)	-	Cu	-
% Sand (0.075 mm to 4.75 mm):	21.3%	D30 (mm)	-	Cc	-
% Silt and Clay (< 0.075 mm):	78.7%	D60 (mm)	-		

Comments: Mechanical shaker SS14-00079 used for 8 min, hand shake for 1 min.

ATTERBERG LIMITS

ASTM 4318 - (Liquid Limit Plastic Limit and Plasticity Index of Soils)

1400 Railway Ave, Canmore, AB, T1W 1P6 T: 888-484-2444 www.taylorgeotechnical.com

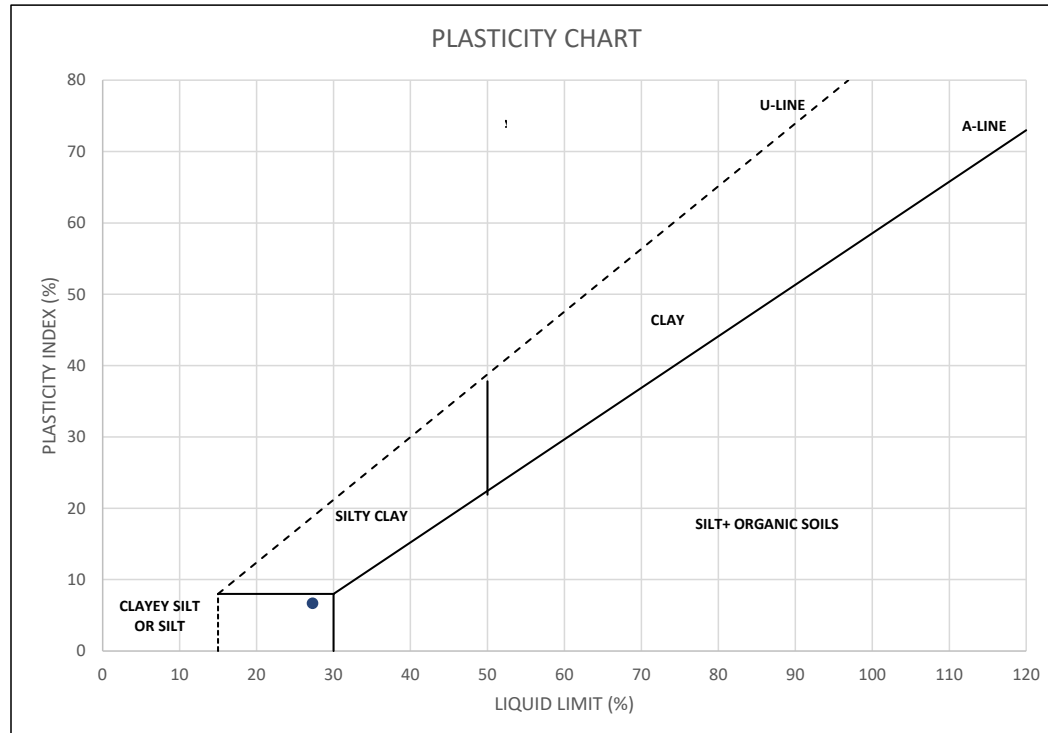
Project Number: 2023091
Project Name: 100 Palliser Trail
Sample ID: 2683

Method A (nearest percent):	Yes
Method B (One decimal):	

LIQUID LIMIT DETERMINATION								
Sample	Measured			Calculated			# of Blows	Liquid Limit
				$M_w = M_{cms} - M_{cds}$	$M_s = M_{cds} - M_c$	$w = M_w / M_s$		
Cup Number	Mc	Mcms	Mcds	Mass of Water (g)	Mass of Solids (g)	Water Content (%)		
SS	3.5	38.4	30.8	7.5	27.4	28%	27	28%
120.0	3.5	33.6	27.0	6.7	23.5	28%	18	27%
61.0	3.4	38.4	31.2	7.3	27.7	26%	31	27%

PLASTIC LIMIT DETERMINATION						
Sample	Measured			Calculated		
				$M_w = M_{cms} - M_{cds}$	$M_s = M_{cds} - M_c$	$w = M_w / M_s$
Cup Number	Mc	Mcms	Mcds	Mass of Water (g)	Mass of Solids (g)	Water Content (%)
126	3.4	12.65	11	1.62	7.63	21%
S4	3.48	14.54	12.7	1.84	9.22	20%

Average Liquid Limit, LL (%):	27	Plasticity Index, PI (%):	6.7
Average Plastic Limit, PL (%):	21	USCS Description:	Silt/Clayey Silt



Comments: More information available on request



APPENDIX B: COLD WEATHER CONSTRUCTION PRACTICES

Please see below for general winter construction comments and recommendations for earthworks. Winter conditions are in affect when the ambient temperature is at or below 0°C, or when there is a probability of the temperature falling below 0°C. The following recommendations pertain to all earthwork activities.

Construction on frozen subgrade conditions poses significant risk to the quality and long-term performance of the work. It is important that the subgrade soils shall not be permitted to freeze. If freezing of the subgrade has occurred, there are two options:

1. The frozen subgrade material should be removed and replaced with approved fill materials (that are also free from frost and frozen material).
2. The subgrade should be appropriately heated so all frost can come out of the soil prior to placement of fills or concrete elements. Subgrade soils should be allowed to moisture condition and be recompacted prior to fill placement.

Once prepared and approved, subgrade soils are not permitted to freeze throughout construction. Ensure that these surfaces are adequately protected throughout the cold weather season using insulated tarps and ground heating.

Frozen fill materials will not achieve adequate compaction. To prevent fill materials from freezing, the following is recommended:

- Use of haul trucks with heated boxes and insulated tarpaulins over the boxes to prevent freezing during transportation.
- If it is not possible to prevent freezing from occurring during transportation and/or prior to placement, fill materials will need to thaw on site. This may involve tarping stockpiles with insulated blankets and applying heat with either forced hot air, stationary heaters, hydronic heaters etc.
- Work in small areas to minimize the time it takes for spreading and compaction of fill materials. Lift thickness should be maximized but not exceed the limitations of the compaction equipment on site.
- During freezing conditions, development of a frozen crust is expected along the surface of exposed material. This frozen crust must be removed prior to placing subsequent lifts.
- If weather conditions and/or selected construction approach are not able to prevent freezing of surfaces between lifts, ground heating or insulating with tarps or a sacrificial loose lift of soil may be considered.
- Use of insulated tarps may be considered for short periods (e.g., overnight) for ambient temperatures greater than -5°C. For longer periods, or for temperatures below -5°C, ground heating or use of a thick sacrificial fill layer should be in place.

Alternatively, uniformly graded crushed gravel containing less than 5% passing the 0.075 mm (or no. 200 sieve size) is recommended for use as general fill material. This material should be placed in lifts not exceeding 0.3 m in thickness and compacted using approved compaction equipment.

Should concrete be placed during cold weather conditions, the cold weather concreting practices laid out by the CSA (Canadian Standards Association) must be followed.