11/17/2023

**Merrlawski Investments, LLC**
Attn: Chris Merritt

**Subject:** **Riverside Drive – Infiltration & Geo Hazard Assessments**
TPN: 035067002003; 107 Riverside Dr, Packwood WA 98361
Project Number QG23-174

Dear Client:

At your request, Quality Geo NW, PLLC (QG) has completed a infiltration investigation of the above referenced project. The investigation was performed in accordance with our proposal for professional services.

We would be pleased to continue our role as your geotechnical consultant of record during the project planning and construction phases, as local inspection firms have not been found to be as familiar or reliably experienced with geotechnical design. This may include soil subgrade inspections, periodic review of special inspection reports, or supplemental recommendations if changes occur during construction. We will happily meet with you at your convenience to discuss these and other additional *Time & Materials* services.

We thank you for the opportunity to be of service on this project and trust this report satisfies your project needs currently. QG wishes you the best while completing the project.

Respectfully Submitted,
**Quality Geo NW, PLLC**

Luke Preston McCann, L.E.G.
Owner + Principal
Licensed Engineering Geologist

Ray Gean II
Staff Geologist/Project Manager

# SOILS REPORT

**RIVERSIDE DRIVE INFILTRATION & GOELOGICAL HAZARDS**
TPN: 035067002003; 107 RIVERSIDE DR
PACKWOOD, WA 98361

**Merrlawski Investments, LLC**
Attn: Chris Merritt

Prepared by:


11/17/2023

LUKE PRESTON MCCANN

**Alexander Barnes, G.I.T.**
**Staff Geologist/Laboratory Supervisor**

**Luke Preston McCann, L.E.G.**
**Principal Licensed Engineering Geologist**

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11/17/2023

QG Project # QG23-174

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# 1.0 INTRODUCTION

This report presents the findings and recommendations of Quality Geo's (QG) soil investigation conducted in support of new site surface improvements.

## 1.1 PROJECT DESCRIPTION

QG understands the project entails development of the site into a residential neighborhood, including new home structures, stormwater controls, and private roadway through the site. QG has been contracted to perform a soils investigation of the proposed site to provide stormwater and earthwork recommendations.

## 1.2 FIELD WORK

Site exploration activities were performed on 9/20/2023 and 10/26/2023. Exploration locations were marked in the field by a QG Project Geologist with respect to the provided map and cleared for public conductible utilities. Our exploration locations were selected by a QG Project Geologist prior to field work to provide safest access to relevant soil conditions. The geologist directed the advancement of 4 excavated test pits (TP). The test pits were advanced within the vicinity of the anticipated development footprint areas, to depths of 9.0 feet below present grade (BPG) in general accordance with the specified contract depth and groundwater conditions. Additionally, a QG staff geologist collected soil samples from a perc hole that was previously excavated on site.

During explorations QG logged and field classified each soil horizon we encountered in accordance with the Unified Soil Classification System (USCS). Representative soil samples were collected from each unit, identified according to boring location and depth, placed in plastic bags to protect against moisture loss, and were transported to the soil laboratory for supplemental classification and other tests.

## 1.3 LEWIS COUNTY CRITICAL AREA ORDINANCE

*LCC 17.10.170 "Q" definitions:*

> *" Qualified critical area professional" means a person or a team of persons with experience, education, and professional degrees and/or training pertaining to the critical area in question, and with experience in performing delineations, analyzing critical area functions and values, analyzing critical area impacts, and recommending critical area mitigation and restoration. The administrator may require professionals to demonstrate the basis for qualifications and shall make final determination as to qualifications.*

*(c) A qualified professional for geologically hazardous areas must be a professional geologist, a professional engineering geologist or a professional geotechnical engineer…* ”

**QG employees Geologists, Engineering Geologists, and Professional Engineers who are licensed in Washington State. Our staff have conducted over 500 geotechnical investigations across the state. This report has been prepared and stamped by a WA Licensed Geologist and Professional Engineer. The license numbers can be referenced with the WA DOL to confirm active licensure.**

# 2.0 EXISTING SITE CONDITIONS

## 2.1 AREA GEOLOGY

QG reviewed available map publications to assess known geologic conditions and hazards present at the site location. The Washington Geologic Information Portal (WGIP), maintained by the Department of Natural Resources Division of Geology and Earth Resources, provides 1:100,000-scale geologic mapping of the region. Geology of the site location and vicinity consists of alpine glacial drift deposits (Qad(e)). The drift on site is described as being, "Quaternary till, outwash, and glaciolacustrine sediments; locally includes loess, talus, and lacustrine deposits."

The WGIP also identifies the site as being located within an area of very low to low liquefaction susceptibility. There are no landslide or erosional hazard areas mapped to exist within approximately 1750 feet of the site. The nearest mapped landslide exists approximately 9400 feet to the west of the site.

Additionally, according to Lewis County GIS, the site exists with an area listed as at severe risk for channel migration. This has been addressed in a separate report by Quality Geo NW titled, "Riverside Drive – Channel Migration Zone Evaluation" dated 11-6-2023. No other geohazards are known to exist on site.

The United States Department of Agriculture portal (USDA) provides a soil mapping of the region. The soils on site are split between Netrac Sand(138) to the northwest along the parcel boundary of the site, Ledow sand (123) in the presently forested southern area of the parcel and Siler silt loam (207) in the presently grassy area of the parcel. The Ledow sand deposits are formed as terraces and floodplains. These soils are generally described as sand from 0 to 8 inches, fine sand from 8 to 20 inches, silt loam from 20 to 24 inches, and fine sand from 24 to 60 inches. Depth to restrictive feature is more than 80 inches. Capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.57 to 1.98 in/hr). Depth to water table is more than 80 inches. Siler silt loam is also formed within floodplains and terraces. This soil is described as silt loam from 0 to 14 inches, sand from 14 to 21 inches, and stratified loamy sand to silt loam from 21 to 60 inches. Depth to restrictive feature is more than 80 inches. Capacity of the most limiting layer to transmit water (Ksat) is listed as moderately high to high (0.57 to 1.98 in/hr). Depth to water table is more than 80 inches. Along the western edge along the roadside the soils are Netrac Sand (138).

## 2.2 SITE & SURFACE & CRITICAL AREA CONDITIONS

The project area is relatively flat, laying a few feet below the elevation of Cannon Road, gently sloping southeasterly towards the Cowlitz River. The site is undeveloped, with low-lying grass and shrub cover. A forested area covers the southeastern quarter of the parcel.

There is a slope along Canon Road. At its highest is approximately 12 feet. The slope is generally less than a 3H:1V (18 degrees). Along the Cowlitz River the slope at its highest is approximately 6-feet. QG does not believe the slopes in question meet the Lewis County Definition of a steep slope. In consideration of the available information, and our direct observations, at this time **QG does not consider the site to be within an active ersosion or landslide hazard area.** With this determination, our study did not involve slope stability modeling, or deep subsurface explorations directly within the site and at this time QG does not recommend any further exploration or analysis be conducted. Based on the information herein, we provide the following development- and site-specific recommendations that will minimize the inherent risks of developing in a sloped area.

## 2.3 SOIL LOG

Site soil conditions were consistent across the property in 4 test pits. Representative lab samples were taken from TP-1 and TP-2.

- **Silt (SM)**
  Beneath the brush and grass was an approximately 5.0-foot layer of brown silt, resembling prehistoric alluvium deposits. Soils further distanced from the river had thin lenses of sandy volcanic ash interbedded in the silts. The silt is described as organic-rich (roots, humus), with light to no mottling, and in a medium stiff condition.
- **Poorly Graded Gravel with Sand (GP)**
  Beneath the cover soils, native sediments resemble a dark gray to brown sandy gravel alluvium, with minimal fines content and high cobble content, in a typically dense condition. Groundwater was encountered within this unit consistently at approximately 7.0 feet below present grade.

## 2.4 SURFACE WATER AND GROUNDWATER CONDITIONS

There are two historical farm ditches on the property that are non-functioning. According to the client, these ditches are reported to have been installed in the 1960's and have been derelict since agricultural operations ceased on the property. One ditch originates from the center of the northeastern property boundary and extends southeast to the Cowlitz River. The other channel runs along the southern property boundary. Neither show signs of active water flow within them.

During our explorations, a pervasive groundwater table was seen as shallow as 6.75 feet below the surface, in all test pits. This groundwater table is inferred to exist beneath the entire site near the same elevation. Due to the time of year, it may be assumed that this is not a seasonal high, and the water table may raise during the mid-winter months. We interpret the typical seasonal maximum water table to be within 5 feet below grade due to the proximity of the site to the Cowlitz River and its natural seasonal fluctuations.

QG's scope of work did not include determination or monitoring of seasonal groundwater elevation variations, formal documentation of wet season site conditions, or conclusive measurement of groundwater elevations at depths past the extent feasible for explorations at the time of the field explorations.

# 3.0 GEOTECHNICAL RECOMMENDATIONS

## 3.1 INFILTRATION RATE DETERMINATION

QG understands the design of on-site stormwater controls are pending the results of this study to confirm design parameters and interpreted depths to seasonal groundwater and restrictive soil features.

### *3.1.1 GRADATION ANALYSIS METHODS & RESULTS*

During test pit excavations for general site investigation, QG additionally collected representative samples of native soil deposits among potential infiltration strata and depths. Representative soil samples were selected from the center of the site (TP-1, Perc-1) to characterize the local infiltration conditions.

We understand the project will be subject to infiltration design based on the current Washington Department of Ecology Stormwater Management Manual for Western Washington (DoE SMMWW). For initial site infiltration characterization within the scope of this study, laboratory gradation analyses were completed including sieve and hydrometer tests for stormwater design characterization and rate determination to supplement field observations. Results of laboratory testing in terms of rate calculation are summarized below.

Laboratory results were interpreted to recommended design inputs in accordance with methods of the DOE SMMWW 2022 Stormwater Design Manual. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

(1) $\log10(Ksat) = -1.57 + 1.90*D10 + 0.015*D60 - 0.013*D90 - 2.08*ff$

Corrected Ksat values presented below are a product of the initial Ksat and correction factor CFT. For a generalized site-wide design situation, we have applied a site variability factor of CFv = 0.7 along with typical values of CFt = 0.4 (for the Grain Size Method) and CFm = 0.9 (assuming standard influent control).

(2) $CFT = CFv \times CFt \times CFm = 0.7 \times 0.4 \times 0.9 = 0.25$

Results were cross-referenced with test pit logs to determine the validity and suitability of unique materials as an infiltration receptor. Additional reduction factors were applied for practical rate determination based on our professional judgement.

**Table 1. Results Of Massmann Analysis**

| Boring ID | Sample Depth *(BPG)* | Unit Extent *(ft)* | Soil Type | D10 | D60 | D90 | Fines (%) | Ksat *(in/hr)* | CorrectedKsat *(in/hr)* | LT Design Infiltration Rate*(in/hr)* | Cation Exchange Capacity (meq/100g) | Organic Content % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Perc-1 | 2.0ft | 0 to 5ft | ML | 0.005 | 0.03 | 0.09 | 88 | 1.15 | 0.58 | **0.58** | 11.5 | 2.7 |
| TP-2 | 4.75ft | 0 to 5ft | ML | 0.002 | 0.02 | 0.08 | 90 | 1.03 | 0.52 | **0.52** | 13.3 | 3.3 |

QG understands that the client intends to utilize surface dispersion methods for stormwater management on site. **For surface dispersion on site, we recommend a maximum design rate of up to 0.52 inches/hour be considered**. These rates are considered applicable to all areas of the subject site at the specified depths.

QG recommends the facility designer review these results and stated assumptions per reference literature to ensure applicability with the proposed development, level of anticipated controls, and long- term maintenance plan. The designer may make reasonable adjustments to correction factors and the resulting design values based on these criteria to ensure design and operational intent is met. We recommend that we be contacted if substantial changes to rate determination are considered.

### *3.1.2 TREATMENT POTENTIAL*

Depending on stormwater and runoff sources, some stormwater features, such as rain gardens or pervious pavements may require treatment. Stormwater facilities utilizing native soils as treatment media typically require Cation Exchange Capacities (CEC) of greater than 5 milliequivalents per 100grams (meq/100g) and organic contents greater than 1% (this may vary depending on local code) with a minimum depth of 18 inches. Soil across the surface of the site **does** meet these requirements.

## 3.2 DRAINAGE RECOMMENDATIONS

QG recommends proper drainage controls for stormwater runoff during and after site development to protect the site. The ground surface adjacent to structures should be sloped to drain away at a 5% minimum to prevent ponding of water adjacent to them.

Due to the relatively impermeable subgrade conditions, footing drains should be incorporated to maintain dry foundation conditions. QG recommends footing drains employ 4-inch minimum perforated pipe. Footing drains shall be backfilled with free-draining material and wrapped on all sides in filter fabric.

QG recommends all roof and footing water sources (new or existing) be tightlined (piped) away from structures to a drywell, dispersion area, or established channel. Stormwater system should

meet local code requirements. If storm drains are incorporated for impervious flatworks (driveways, patios, etc.), collected waters should also be discharged according to the above recommendations. All drainage tightlines should be composed of appropriately sturdy material (such as rigid PVC), sized adequately according to anticipated flow, and anchored sufficiently. QG recommends slope tightlines be inspected by the owner periodically to look for signs of damage or displacement requiring repair.

With county/city approval, an outfall to the Cowlitz River may be considered for reasonable quantities of stormwater, so long as appropriate energy reducing features are established at the outfall, such as fabric and quarry spalls, or other approved methods, to prevent erosion.

# 4.0 CONSTRUCTION RECOMMENDATIONS

## 4.1 EARTHWORK

### *4.1.1 GRADING & EXCAVATION*

A grading plan was not available to QG at the time of this report. This study assumes finished site grade will approximate current grade. Therefore, depths referred to in this report are considered roughly equivalent to final depths. Excavations can generally be performed with conventional earthmoving equipment such as bulldozers, scrapers, and excavators.

### *4.1.2 SUBGRADE EVALUATION & PREPARATION*

After excavations have been completed to the planned subgrade elevations, but before placing fill or structural elements, the exposed subgrade should be evaluated under the part-time observation and guidance of a QG representative.

The special inspection firm should continuously evaluate all backfilling. Any areas that are identified as being soft or yielding during subgrade evaluation should be over excavated to a firm and unyielding condition or to the depth determined by the geotechnical engineer. Where over excavation is performed below a structure, the over excavation area should extend beyond the outside of the footing a distance equal to the depth of the over excavation below the footing. The over-excavated areas should be backfilled with properly compacted structural fill.

### *4.1.3 SITE PREPARATION, EROSION CONTROLL, WET WEATHER*

Any silty or organic rich native soils may be moisture-sensitive and become soft and difficult to traverse with construction equipment when wet. During wet weather, the contractor should take measures to protect any exposed soil subgrades, limit construction traffic during earthwork activities, and limit machine use only to areas undergoing active preparation.

Once the geotechnical engineer has approved the subgrade, further measures should be implemented to prevent degradation or disturbance of the subgrade. These measures could include, but are not limited to, placing a layer of crushed rock or lean concrete on the exposed subgrade, or covering the exposed subgrade with a plastic tarp and keeping construction traffic off the subgrade. Once subgrade has been approved, any disturbance because the subgrade was not protected should be repaired by the contractor at no cost to the owner.

During wet weather, earthen berms or other methods should be used to prevent runoff from draining into excavations. All runoffs should be collected and disposed of properly. Measures may also be required to reduce the moisture content of on-site soils in the event of wet weather. These measures can include, but are not limited to, air drying and soil amendment, etc.

QG recommends earthwork activities take place during the summer dry season.

## 4.2 STRUCTURAL FILL MATERIALS AND COMPACTION

### *4.2.1 MATERIALS*

All material placed below structures or pavement areas should be considered structural fill. Excavated native soils may be considered suitable for reuse as structural fill on a case-by-case basis. Imported material can also be used as structural fill. Care should be taken by the earthwork contractor during grading to avoid contaminating stockpiled soils that are planned for reuse as structural fill with native organic materials. Frozen soil is not suitable for use as structural fill. Fill material may not be placed on frozen soil.

Structural fill material shall be free of deleterious materials, have a maximum particle size of 4 inches, and be compactable to the required compaction level. Imported structural fill material should conform to the WSDOT manual Section 9-03.14(1) Gravel Borrow, or an approved alternative import material. Controlled-density fill (CDF) or lean mix concrete can be used as an alternative to structural fill materials, except in areas where free-draining materials are required or specified.

Imported materials utilized for trench back fill shall conform to Section 9-03.19, Trench Backfill, of the most recent edition (at the time of construction) of the State of Washington Department of Transportation *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*. Imported materials utilize as grade fill beneath roads shall conform to WSDOT Section 9-03.10, Gravel Base.

Pipe bedding material should conform to the manufacturer's recommendations and be worked around the pipe to provide uniform support. Cobbles exposed in the bottom of utility excavations should be covered with pipe bedding or removed to avoid inducing concentrated stresses on the pipe.

Soils with fines content near or greater than 10% fines content may likely be moisture sensitive and become difficult to use during wet weather. Care should be taken by the earthwork contractor during grading to avoid contaminating stockpiled soils that are planned for reuse as structural fill with native organic materials.

The contractor should submit samples of each of the required earthwork materials to the materials testing lab for evaluation and approval prior to delivery to the site. The samples should be submitted **at least 5 days prior to their delivery** and sufficiently in advance of the work to allow the contractor to identify alternative sources if the material proves unsatisfactory.

### *4.2.2 FILL PLACEMENT AND COMPACTION*

For lateral and bearing support, structural fill placement below footings shall extend at minimum a distance past each edge of the base of the footing equal to the depth of structural fill placed below the footing [i.e. extending at least a 1H:1V past both the interior and the exterior of the concrete footing].

Prior to placement and compaction, structural fill should be moisture conditioned to within 3 percent of its optimum moisture content. Loose lifts of structural fill shall not exceed 12 inches in thickness. All structural fill shall be compacted to a firm and unyielding condition and to a minimum percent compaction based on its modified Proctor maximum dry density as determined per ASTM D1557. Structural fill placed beneath each of the following shall be compacted to the indicated percent compaction:

- Foundation and Floor Slab Subgrades: 95 Percent
- Pavement Subgrades & wall backfill (upper 2 feet): 95 Percent
- Pavement Subgrades & wall backfill (below 2 feet): 90 Percent
- Utility Trenches (upper 4 feet): 95 Percent
- Utility Trenches (below 4 feet): 90 Percent

A sufficient number of tests should be performed to verify the compaction of each lift. The number of tests required will vary depending on the fill material, its moisture condition and the equipment being used. Initially, more frequent tests will be required while the contractor establishes the means and methods required to achieve proper compaction.

Jetting or flooding is not a substitute for mechanical compaction and should not be allowed.

## 4.3 TEMPORARY EXCAVATIONS AND TRENCHES

All excavations and trenches must comply with applicable local, state, and federal safety regulations. Construction site safety is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing soil type information solely as a service to our client for planning purposes. Under no circumstances should the information be interpreted to mean that QG is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred. The contractor shall be responsible for the safety of personnel working in utility trenches. Given that steep excavations in native soils may be prone to caving, we recommend all utility trenches, but particularly those greater than 4 feet in depth, be supported in accordance with state and federal safety regulations. Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed near the top of any excavation.

Temporary excavations and trenches should be protected from the elements by covering them with plastic sheeting or some other similar impermeable material. Sheeting sections should overlap by at least 12 inches and be tightly secured with sandbags, tires, staking, or other means to prevent wind from exposing the soils under the sheeting.

# 5.0 SPECIAL INSPECTION

The recommendations made in this report assume that an adequate program of tests and observations will be made throughout construction to verify compliance with these recommendations. Testing and observations performed during construction should include, but not necessarily be limited to, the following:

- Geotechnical plan review and engineering consultation as needed prior to construction phase,
- Observations and testing during site preparation, earthwork, structural fill, and pavement section placement,
- Consultation on temporary excavation cutslopes and shoring if needed,
- Consultation as necessary during construction.

QG recommends that we be retained for construction phase soils testing and periodic earthwork observation in accordance with the local code requirements. We also strongly recommend that QG be retained as the project Geotechnical Engineering Firm of Record (GER) during the construction of this project to perform periodic supplementary geotechnical observations and review the special inspectors reports during construction.

Our knowledge of the project site and the design recommendations contained herein will be of great benefit in the event that difficulties arise and either modifications or additional geotechnical engineering recommendations are required or desired. We can also, in a timely fashion observe the actual soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

We would be pleased to meet with you at your convenience to discuss the *Time & Materials* scope and cost for these services.

# 6.0 LIMITATIONS

Upon acceptance and use of this report, and its interpretations and recommendations, the user shall agree to indemnify and hold harmless QG, including its owners, employees and subcontractors, from any adverse effects resulting from development and occupation of the subject site. Ultimately, it is the owner's choice to develop and live in such an area of possible geohazards (which exist in perpetuity across the earth in one form or another), and therefore the future consequences, both anticipated and unknown, are solely the responsibility of the owner. By using this report for development of the subject property, the owner must accept and understand that it is not possible to fully anticipate all inherent risks of development. The recommendations provided above are intended to reduce (but may not eliminate) such risks.

This report does not represent a construction specification or engineered plan and shall not be used or referenced as such. The information included in this report should be considered supplemental to the requirements contained in the project plans & specifications and should be read in conjunction with the above referenced information. The selected recommendations presented in this report are intended to inform only the specific corresponding subjects. All other requirements of the above-mentioned items remain valid, unless otherwise specified.

Recommendations contained in this report are based on our understanding of the proposed development and construction activities, field observations and explorations, and laboratory test results. It is possible that soil and groundwater conditions could vary and differ between or beyond the points explored. If soil or groundwater conditions are encountered during construction that differ from those described herein, or if the scope of the proposed construction changes from that described in this report, QG should be notified immediately in order to review and provide supplemental recommendations.

The findings of this study are limited by the level of scope applied. We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the subject region. No warranty, expressed or implied, is made. The recommendations provided in this report assume that an adequate program of tests and observations will be conducted by a WABO approved special inspection firm during the construction phase in order to evaluate compliance with our recommendations.

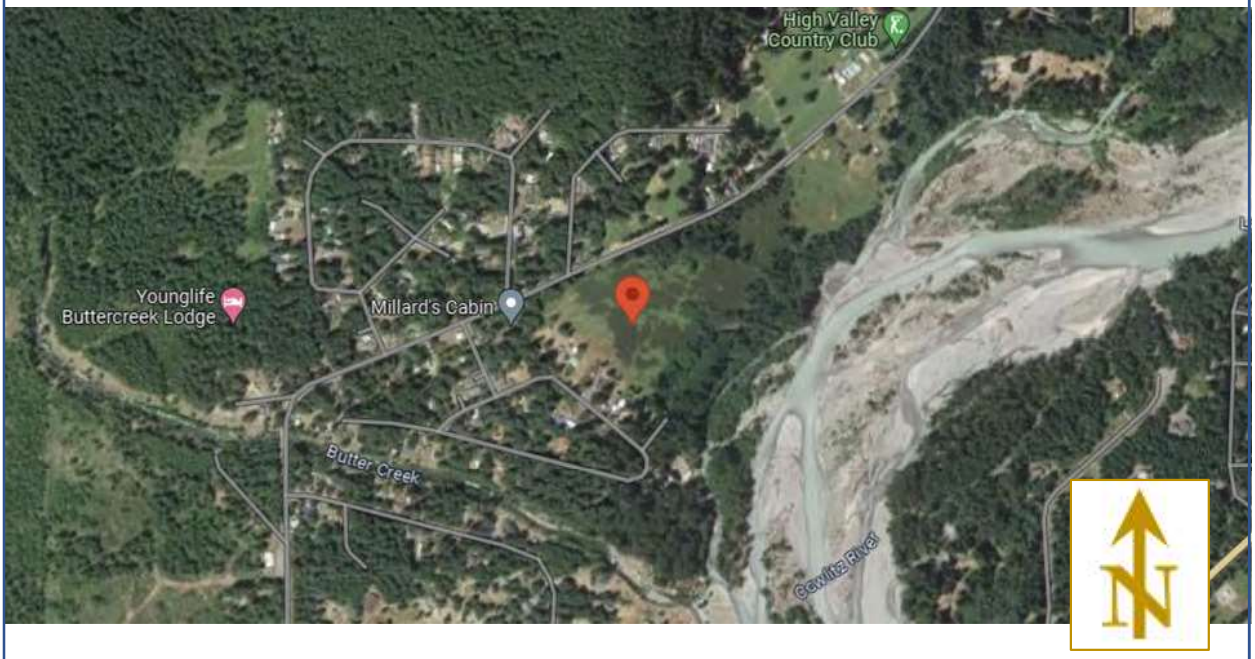
This report may be used only by the Client and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. It is the Client's responsibility to ensure that the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. Note that if another firm assumes Geotechnical Engineer of Record responsibilities, they need to review this report and either concur with the findings, conclusions, and recommendations or provide alternate findings, conclusions and recommendation.

Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required. Based on the intended use of the report, QG may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release QG from any liability resulting from the use of this report. The Client, the design consultants, and any unauthorized party, agree to defend, indemnify, and hold harmless QG from any claim or liability associated with such unauthorized use or non-compliance. We recommend that QG be given the opportunity to review the final project plans and specifications to evaluate if our recommendations have been properly interpreted. We assume no responsibility for misinterpretation of our recommendations.

# Appendix A. Region & Vicinity Maps

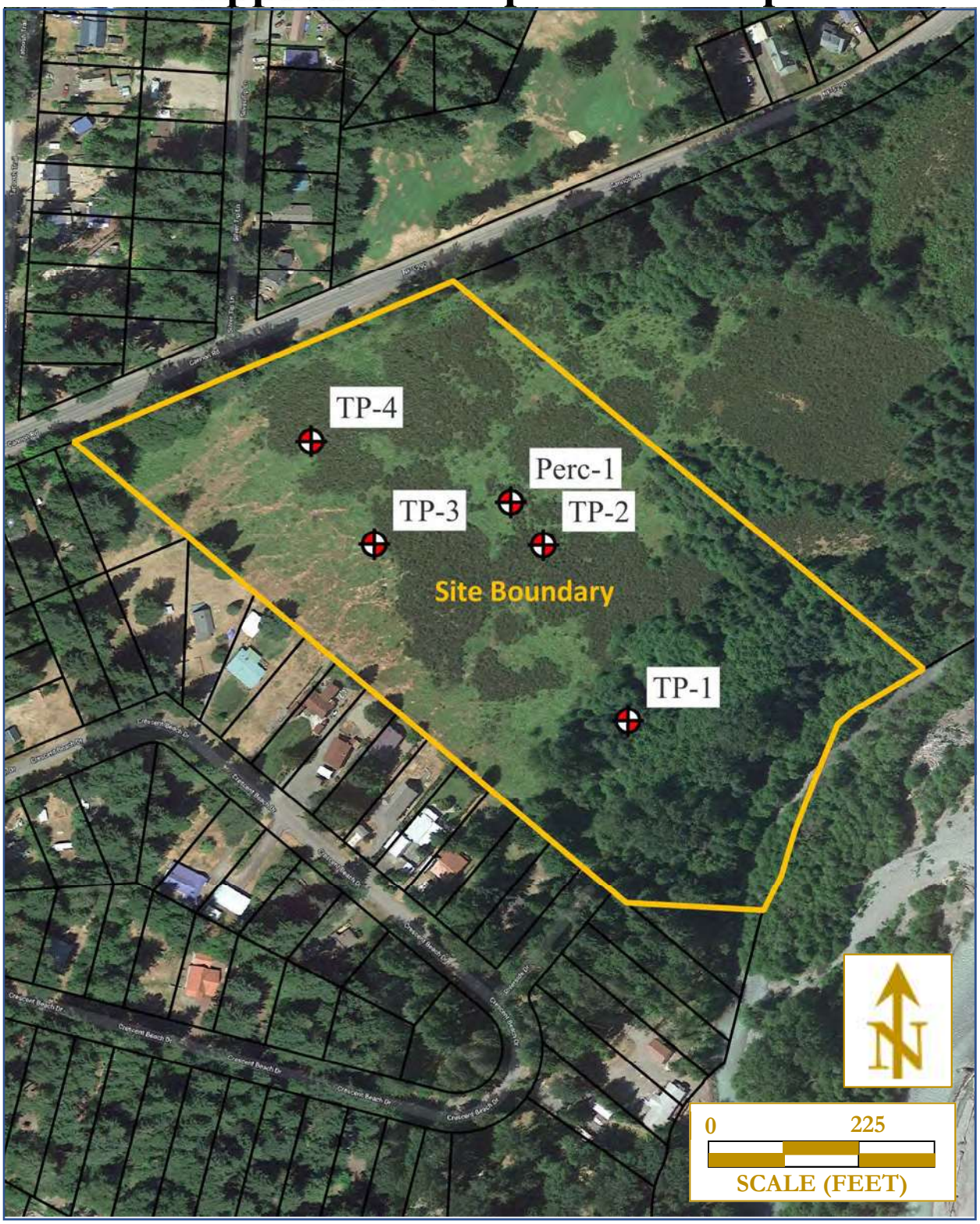
**REGION**


**VICINITY**




| Quality Geo NW, PLLC | **Site Region** Riverside Dr | Source: Google Imagery, 2023 **Scale & Locations are approx.** **Not for Construction** | **Figure 1** |
|---|---|---|---|

# Appendix B. Exploration Map




| Quality Geo NW, PLLC | **Site Map** Riverside Dr | Source: Lewis Co GIS 2023 **Scale & Locations are approx.** **Not for Construction** | **Figure 2** |
|---|---|---|---|

# Appendix C. Exploration Logs

**Test Pit Log** Perc-1

**PROJECT NUMBER** QG23-174
**PROJECT NAME** Riverside Dr Infiltration
**PROJECT LOCATION** Packwood, WA

**FIELD WORK DATE** 9/20/2023
**DRILLING METHOD** Existing Perc Hole

**BORING LOCATION** TPN 035067002003; center of parcel in existing perc hole
**SURFACE ELEVATION** Existing
**LOGGED BY** AW

**COMMENTS**

| Depth (ft) | Samples | Graphic Log | USCS | Material Description |
|---|---|---|---|---|
| 0 | | | TS | TOPSOIL |
| 0.5 | | | ML | Brown, moist, high organics, no cobbles, no mottling, medium dense. |
| 1 | | | | Gravel= 0% Sand= 12% Fines= 88% |
| 1.5 | | | | SILT |
| 2 | TP-1@2ft | | | Gray/brown, moist, medium organics, some cobbles to 5-inches, minor mottling, medium stiff. |
| 2.5 | | | | Gravel= 0% Sand= 12% Fines= 88% |
| 3 | | | | |
| 3.5 | | | | |
| 4 | | | | |
| 4.5 | | | | |
| 5 | | | | |
| 5.5 | | | | |
| 6 | | | | |
| 6.5 | | | | |
| 7 | | | | |
| 7.5 | | | | |
| 8 | | | | |
| 8.5 | | | | |
| 9 | | | | |
| 9.5 | | | | |
| 10 | | | | Terminated at contracted depth, |
| 10.5 | | | | No groundwater encountered. |

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## Test Pit Log TP-1

**PROJECT NUMBER** QG23-174
**PROJECT NAME** Riverside Dr Infiltration
**PROJECT LOCATION** Packwood, WA

**FIELD WORK DATE** 10/26/2023
**DRILLING METHOD** Excavator Boring

**BORING LOCATION** TPN 035067002003; Southern end of parcel, forested area
**SURFACE ELEVATION** Existing
**LOGGED BY** AB

**COMMENTS**

| Depth (ft) | Samples | Graphic Log | USCS | Material Description |
|---|---|---|---|---|
| 0 | | | ML | SILT (TOPSOIL)<br>Dark brown, moist, organics (roots, humus), no mottling, medium dense<br><br>Gravel= 0% Sand= 10% Fines= 90% |
| 2.5 | | | GP | POORLY GRADED GRAVEL with SAND<br>Dark gray to brown, moist, no mottling, abundant cobbles (to 5-inches, rounded), no organics, dense<br><br>Gravel= 70% Sand= 30% Fines= 0% |
| 7 | | | | ▽<br>Terminated at contracted depth,<br>Groundwater pooling @ 7.0 feet |

0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5

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## Test Pit Log TP-2

**PROJECT NUMBER** QG23-174
**PROJECT NAME** Riverside Dr Infiltration
**PROJECT LOCATION** Packwood, WA

**FIELD WORK DATE** 10/26/2023
**DRILLING METHOD** Excavator Boring

**BORING LOCATION** TPN 035067002003; Center of parcel
**SURFACE ELEVATION** Existing
**LOGGED BY** AB

**COMMENTS**

| Depth (ft) | Samples | Graphic Log | USCS | Material Description |
|---|---|---|---|---|
| 0.5 | | | ML | SILT (TOPSOIL)<br>Dark brown, moist, organics (roots, humus), some mottling, medium dense<br><br>Gravel= 0% Sand= 10% Fines= 90% |
| 1 | TP-2@1ft | | | |
| 1.5 | | | | |
| 2 | | | | |
| 2.5 | | | | |
| 3 | | | | |
| 3.5 | | | | |
| 4 | | | | |
| 4.5 | | | | |
| 5 | | | GP | POORLY GRADED GRAVEL with SAND<br>Dark gray to brown, moist, no mottling, abundant cobbles (to 5-inches, rounded), no organics, dense<br><br>Gravel= 70% Sand= 30% Fines= 0% |
| 5.5 | | | | |
| 6 | | | | |
| 6.5 | | | | ▽ |
| 7 | | | | Terminated at contracted depth,<br>Groundwater pooling @ 6.75 feet |
| 7.5 | | | | |
| 8 | | | | |
| 8.5 | | | | |
| 9 | | | | |
| 9.5 | | | | |

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## Test Pit Log TP-3

**PROJECT NUMBER** QG23-174
**PROJECT NAME** Riverside Dr Infiltration
**PROJECT LOCATION** Packwood, WA

**FIELD WORK DATE** 10/26/2023
**DRILLING METHOD** Excavator Boring

**BORING LOCATION** TPN 035067002003; Northwest of center of parcel
**SURFACE ELEVATION** Existing
**LOGGED BY** AB

**COMMENTS**

| Depth (ft) | Samples | Graphic Log | USCS | Material Description |
|---|---|---|---|---|
| 0 | | | ML | SILT (TOPSOIL)<br>Dark brown, interbedded lenses of tephra (1-2 inches), moist, organics (roots, humus), no mottling, no cobbles, medium dense<br><br>Gravel= 0% Sand= 10% Fines= 90% |
| 4 | | | | SILT<br>Brown, moist, organics, no mottling, no cobbles, medium dense<br><br>Gravel= 0% Sand= 10% Fines= 90% |
| 6 | | | GP | POORLY GRADED GRAVEL with SAND<br>Dark gray to brown, moist, no mottling, abundant cobbles (to 5-inches, rounded), no organics, dense<br><br>Gravel= 70% Sand= 30% Fines= 0% |
| 8 | | | | ▽<br>Terminated at contracted depth,<br>Groundwater pooling @ 8.0 feet |

0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5

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## Test Pit Log TP-4

**PROJECT NUMBER** QG23-174
**PROJECT NAME** Riverside Dr Infiltration
**PROJECT LOCATION** Packwood, WA

**FIELD WORK DATE** 10/26/2023
**DRILLING METHOD** Excavator Boring

**BORING LOCATION** TPN 035067002003; Northwest portion of parcel
**SURFACE ELEVATION** Existing
**LOGGED BY** AB

**COMMENTS**

| Depth (ft) | Samples | Graphic Log | USCS | Material Description |
|---|---|---|---|---|
| 0 | | | ML | SILT (TOPSOIL)<br>Dark brown to light brown, interbedded lenses of tephra (1-2 inches), moist, organics (roots, humus), minor mottling, no cobbles, medium dense<br><br>Gravel= 0% Sand= 10% Fines= 90% |
| 5 | | | | SILT<br>Light brown, moist, organics, heavy mottling, no cobbles, medium dense<br><br>Gravel= 0% Sand= 10% Fines= 90% |
| 8 | | | GP | POORLY GRADED GRAVEL with SAND<br>Dark gray to brown, moist, no mottling, abundant cobbles (to 5-inches, rounded), no organics, dense<br><br>Gravel= 70% Sand= 30% Fines= 0% |
| 9 | | | | ▽<br>Terminated at contracted depth,<br>Groundwater pooling @ 9.0 feet |

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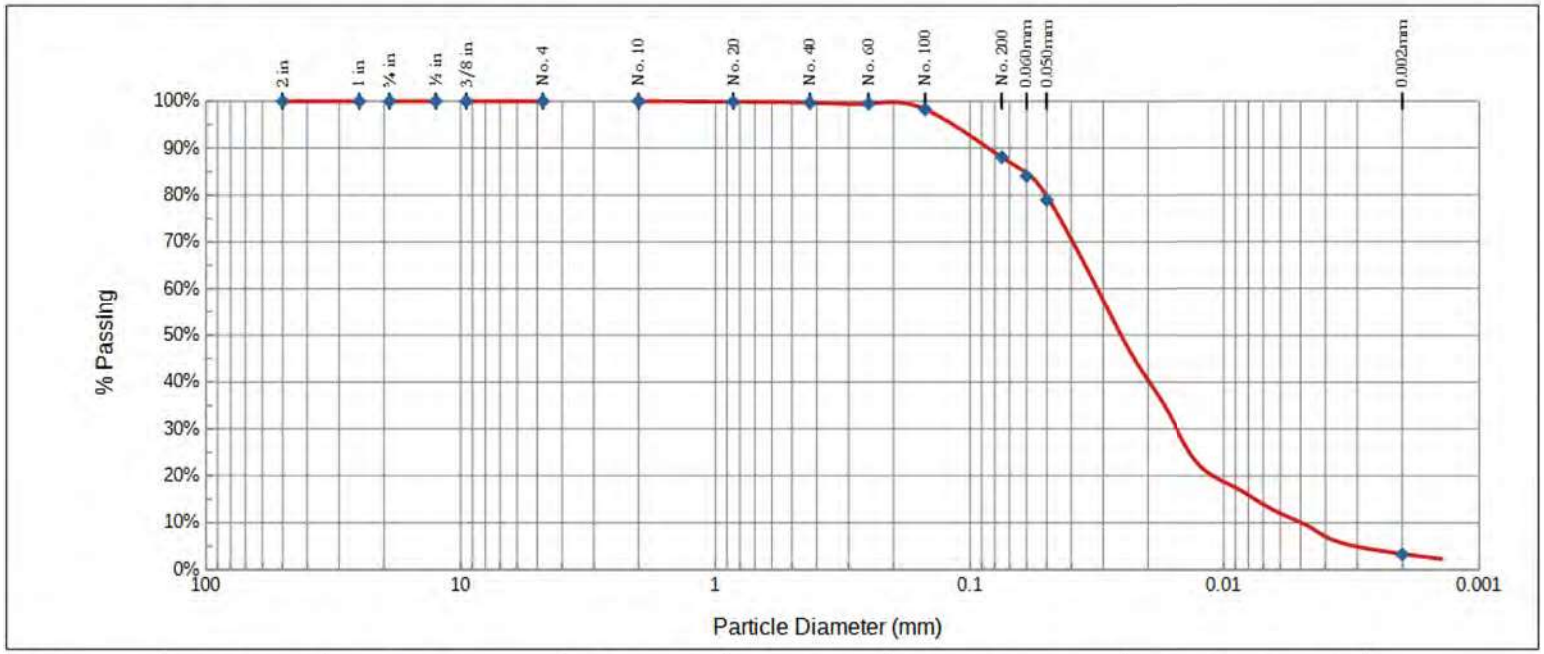
# Appendix D. Laboratory Results

| | |
|---|---|
| Project Name: | Riverside Drive Geo |
| Project Number: | QG23-174 |
| Date Collected: | 09/20/23 |
| Date Reported: | 10/05/23 |
| Boring ID: | Perc-1 |
| Boring Depth: | 2ft |

**SAMPLE ID: Perc-1@2ft**

☑ Sieve Analysis | ☑ Wet Wash | ☑ Hydrometer | ☑ Atterberg Limits




| USCS Scale | Coarse Gravel | | Fine Gravel | | | Coarse Sand | | Medium Sand | | Fine Sand | | | (% of Fines Passing #200 Sieve) Hydrometer Method | | | Sand Total | Gravel Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sieve # | 2" | 1" | ¾" | ½" | 3/8" | 4 | 10 | 20 | 40 | 60 | 100 | 200 | | | | | |
| Diameter, mm | 50 | 25 | 19 | 12.5 | 9.5 | 4.75 | 2 | 0.85 | 0.425 | 0.25 | 0.15 | 0.075 | 0.060 | 0.050 | 0.002 | | |
| Retained | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.3% | 0.5% | 1.7% | 12.0% | | | | **12.0%** | **0.0%** |
| Passing | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 99.9% | 99.7% | 99.5% | 98.3% | **88.0%** | 84.0% | 79.0% | 3.26% | | |

**Graph Values**

| | | | | | |
|---|---|---|---|---|---|
| D90 | 0.09 | | | | |
| D60 | 0.03 | Coefficient of Uniformity: | 2.07 | CEC: | 11.5 meq/100g |
| D30 | 0.015 | Coefficient of Gradation: | 1.47 | OM (LOI 360): | 2.7 % |
| D10 | 0.005 | | | | |

| Unified Soil Classification System (USCS) Description | |
|---|---|
| ML | SILT |

Staff Initials: T

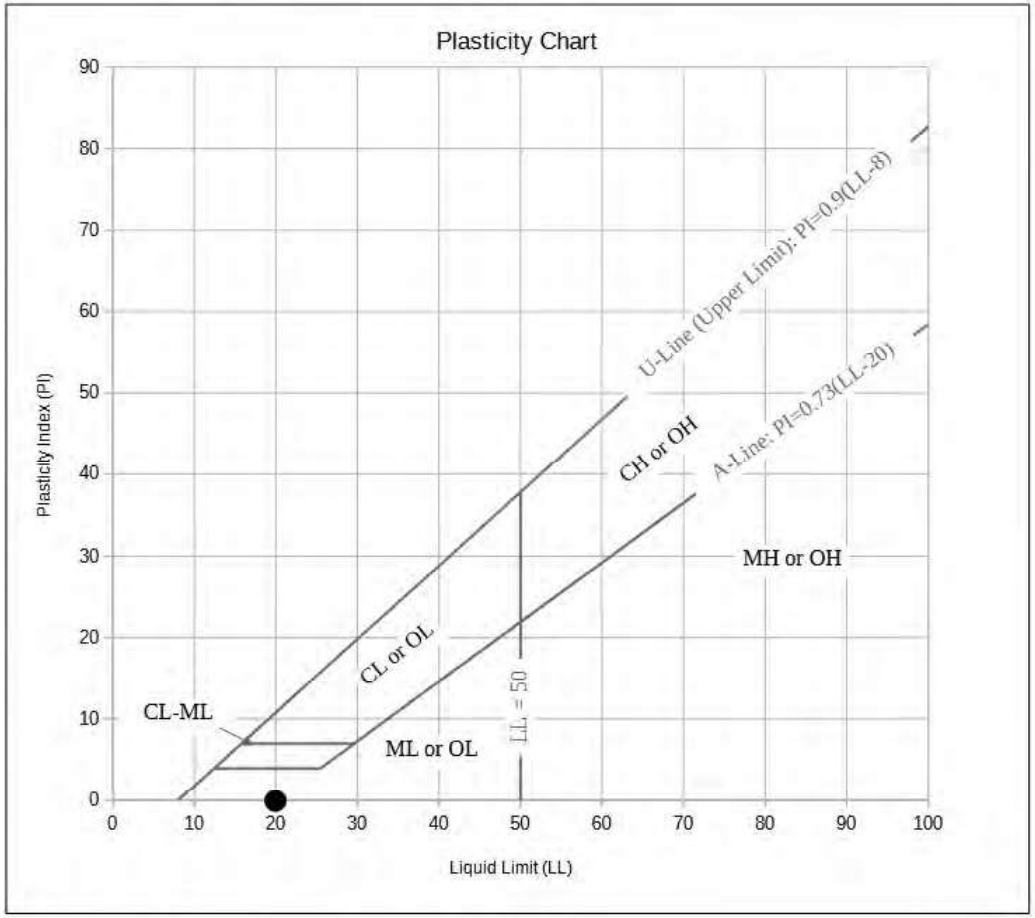
Test Methods: ASTM D6913, ASTM D7928, ASTM D4318

October 5, 2023

# Atterberg Limits Report

## SAMPLE ID: Perc-1@2ft

| | |
|---|---|
| Project Name: | Riverside Drive Geo |
| Project Number: | QG23-174 |
| Date Collected: | 09/20/23 |
| Date Reported: | 10/05/23 |
| Boring ID: | Perc-1 |
| Boring Depth: | 2ft |




**Liquid Limit (LL): 20**

**Plastic Limit (PL): 20**

**Plasticity Index (PI): 0**

**P.I. Soil Description Ranges**

| | |
|---|---|
| 0 | Non-plastic |
| <7 | Slightly plastic |
| 7-17 | Medium plastic |
| >17 | Highly plastic |

| Unified Soil Classification System (USCS) Description |
|---|
| SILT (ML) |

Staff Initials: T

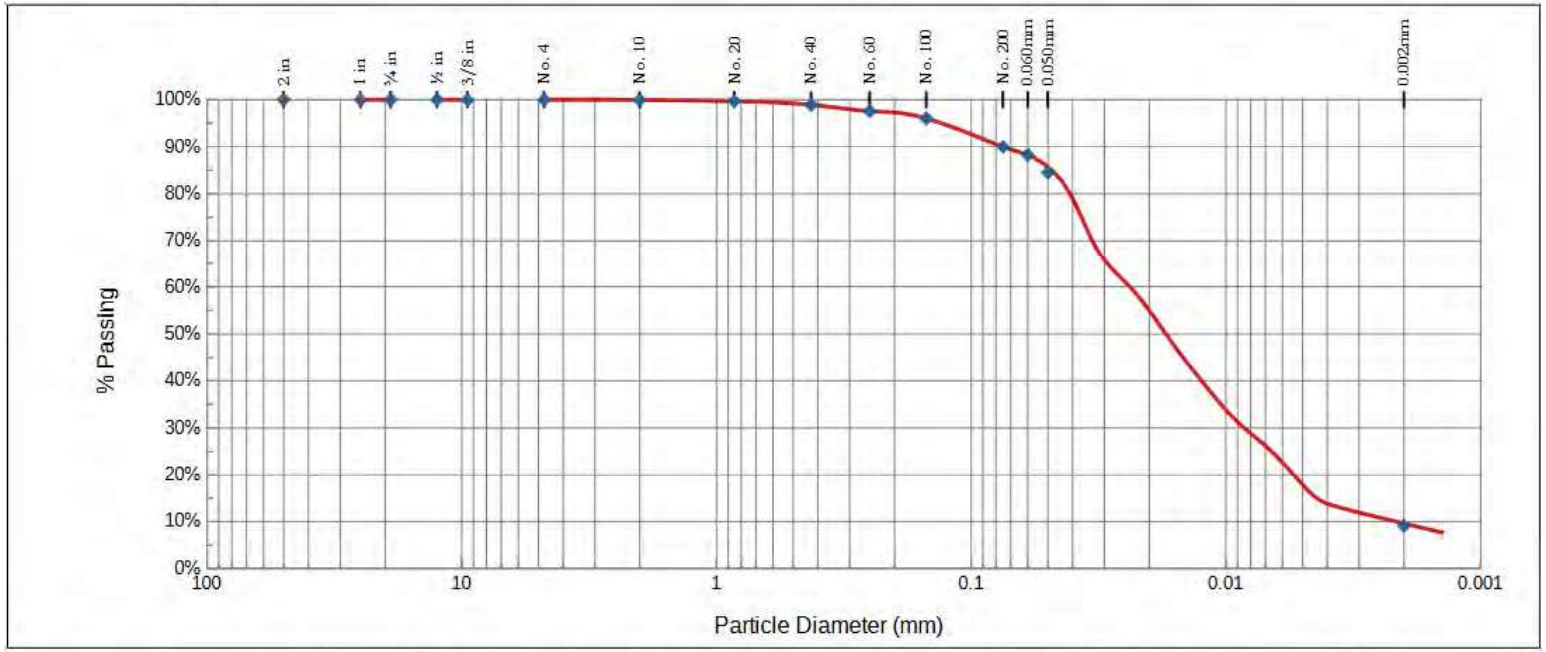
Test Methods: ASTM D6913, ASTM D7928, ASTM D4318

October 5, 2023

| | |
|---|---|
| Project Name: | Riverside Drive Infiltratio |
| Project Number: | QG23-174 |
| Date Collected: | 10/26/23 |
| Date Reported: | 11/02/23 |
| Boring ID: | TP-2 |
| Boring Depth: | 1ft |

## SAMPLE ID: TP-2@1ft

☑ Sieve Analysis | ☑ Wet Wash | ☑ Hydrometer | ☑ Atterberg Limits




| USCS Scale | Coarse Gravel | | Fine Gravel | | | Coarse Sand | | Medium Sand | | Fine Sand | | | (% of Fines Passing #200 Sieve) Hydrometer Method | | | Sand Total | Gravel Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sieve # | 2" | 1" | ¾" | ½" | 3/8" | 4 | 10 | 20 | 40 | 60 | 100 | 200 | | | | | |
| Diameter, mm | 50 | 25 | 19 | 12.5 | 9.5 | 4.75 | 2 | 0.85 | 0.425 | 0.25 | 0.15 | 0.075 | 0.060 | 0.050 | 0.002 | | |
| Retained | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% | 1.1% | 2.4% | 4.0% | 10.0% | | | | **10.0%** | **0.0%** |
| Passing | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 99.7% | 98.9% | 97.6% | 96.0% | **90.0%** | 88.2% | 84.5% | 9.12% | | |

**Graph Values**

| | | | | | |
|---|---|---|---|---|---|
| D90 | 0.08 | | | | |
| D60 | 0.02 | Coefficient of Uniformity: | 2.80 | CEC: | 13.3 meq/100g |
| D30 | 0.009 | Coefficient of Gradation: | 1.30 | OM (LOI 360): | 3.3 % |
| D10 | 0.002 | | | | |

| Unified Soil Classification System (USCS) Description | |
|---|---|
| ML | SILT |

Staff Initials: T

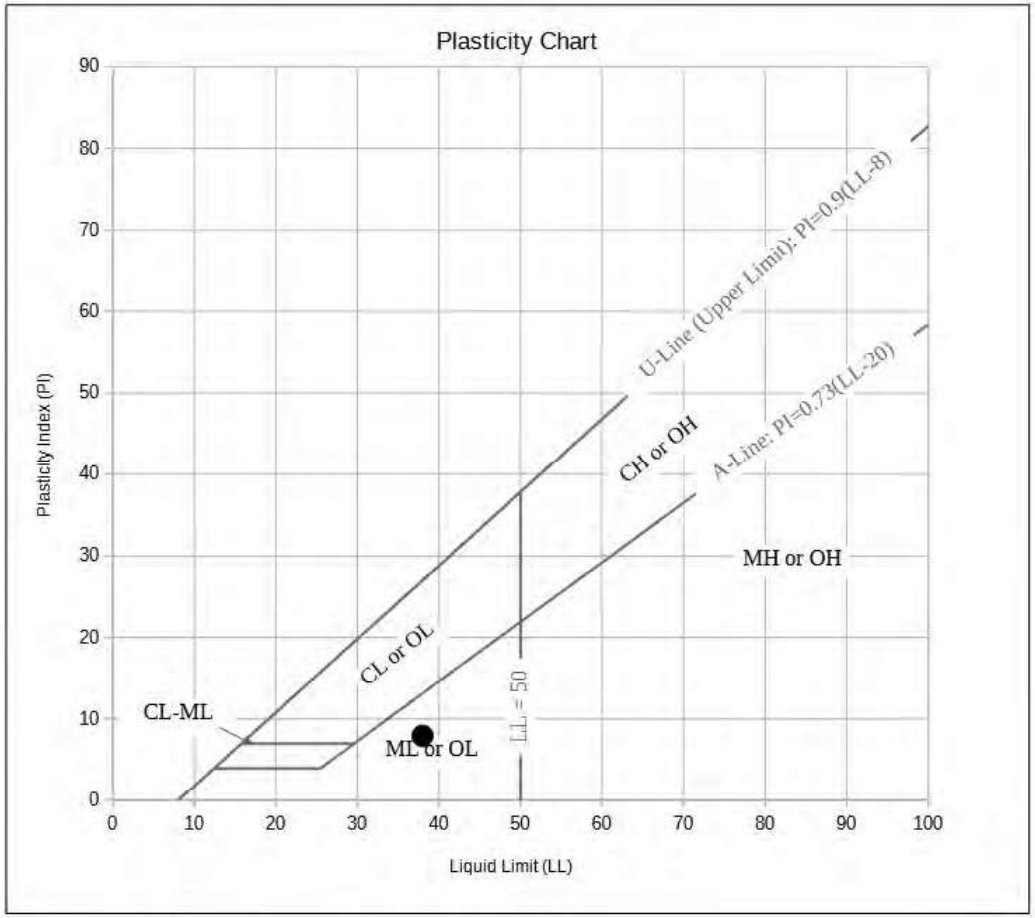
Test Methods: ASTM D6913, ASTM D7928, ASTM D4318

November 2, 2023

# Atterberg Limits Report

## SAMPLE ID: TP-2@1ft

| | |
|---|---|
| Project Name: | Riverside Drive Infiltratio |
| Project Number: | QG23-174 |
| Date Collected: | 10/26/23 |
| Date Reported: | 11/02/23 |
| Boring ID: | TP-2 |
| Boring Depth: | 1ft |




**Liquid Limit (LL): 38**

**Plastic Limit (PL): 30**

**Plasticity Index (PI): 8**

**P.I. Soil Description Ranges**

| | |
|---|---|
| 0 | Non-plastic |
| <7 | Slightly plastic |
| 7-17 | Medium plastic |
| >17 | Highly plastic |

| Unified Soil Classification System (USCS) Description |
|---|
| SILT (ML) |

Staff Initials: T

Test Methods: ASTM D6913, ASTM D7928, ASTM D4318

November 2, 2023

Soil PAP NAPT 2023

soiltest farm consultants, inc.

2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

Soil & Plant Program 2023 NAPT Participating Laboratory

**QUALITY GEO NW**
4631 WHITMAN LANE SE
SUITE D
LACEY , WA 98513
Laboratory #: S23-22981

Date Received: 10/2/2023
Grower: QG23-175
Field: TP-1 AT 2FT
Sampled By:
Customer Account #:
Customer Sample ID:

**Soil Test Results**

| | | | |
|---|---|---|---|
| Cation Exchange | CEC | meq/100g | 11.5 |

pH 1:1
E.C. 1:1 m.mhos/cm
Est Sat Paste E.C. m.mhos/cm
Effervescence

Ammonium - N mg/kg
Organic Matter W.B. %

Other Tests:

| | | |
|---|---|---|
| Organic Matter (LOI 360) | 2.7 | %: |

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**QUALITY GEO NW**
4631 WHITMAN LANE SE
SUITE D
LACEY , WA 98513
Laboratory #: S23-27151

Date Received: 10/31/2023
Grower: QG23-174
Field: TP-2 AT 1FT
Sampled By:
Customer Account #:
Customer Sample ID:

**Soil Test Results**

| | | | | | |
|---|---|---|---|---|---|
| Cation Exchange | CEC | meq/100g | 13.3 | pH 1:1 | |
| | | | | E.C. 1:1 | m.mhos/cm |
| | | | | Est Sat Paste E.C. | m.mhos/cm |
| | | | | Effervescence | |
| | | | | Ammonium - N | mg/kg |
| | | | | Organic Matter W.B. | % |

Other Tests:

| | | | | |
|---|---|---|---|---|
| | | Organic Matter (LOI 360) | 3.3 | %: |
| 0 - 12 | LOI | Ash | 96.69 | % |