



6/23/2022

Fuller Design
1101 Kresky Ave
Centralia, WA

Subject: Deskin Infiltration Consultation
TPN: 51300100000, 6411 198th Ave SW, Rochester, WA
QG Project No.: QG22-095

Dear Client:

At your request, Quality Geo NW, PLLC (QG) has completed a limited geotechnical consultation of the above referenced property's existing site conditions, including site visual reconnaissance, soil evaluation, and review of existing geologic literature for the site. The project site consists of a developed parcel, planned for new construction.

QG understands that the design team requests a geotechnical consultation to provide any necessary recommendation regarding soil evaluation and infiltration conditions. The following report presents the findings and conclusions of our literature review, addresses feasibility of proposed site development, and provides additional geotechnical recommendations for planning and design.

A site region and vicinity map are provided in Appendix A, and an aerial site map is presented in Appendix B. Exploration logs are provided in Appendix C, and laboratory results are provided in Appendix D.

GEOLOGIC LITERATURE REVIEW

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 Continental glacial outwash and gravel (Qgog) deposits. The Qgog is typically described as, "Recessional and proglacial, stratified pebble, cobble, and boulder gravel deposited in meltwater streams and their deltas; locally contains ice-contact deposits."

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Available LiDAR imagery of the site did not reveal any obvious or prominent geologic hazards within the site or immediate vicinity.

The United States Department of Agriculture portal (USDA) provides a soil mapping of the region. The soils in the vicinity are mapped as Spanaway gravelly sandy loam (110), these are formed by terraces and outwash plains. The parent material for the soils on site is volcanic ash over gravelly outwash. The soils are described as gravelly sandy loam from 0 to 15 inches, very gravelly loam from 15 to 20 inches, and extremely gravelly sand from 20 to 60+ inches. Depth to restrictive feature is more than 80 inches. Capacity of most limiting layer to transmit water (ksat), is listed as high (1.98 to 5.95 in/hr). Depth to water table is more than 80 inches.

Prior to QG being hired to conduct field investigation, previous test pits and samples were collected by others. The lab analyses were conducted and completed by others. The client provided QG with the results of the lab analysis for review. QG utilized data provided from lab analysis to determine infiltration rate and best management practices.

SITE INVESTIGATION METHODOLOGY

On 5/13/2022 a QG Project Geologist visited the site to perform visual reconnaissance of the surface and shallow soil conditions of the site. While on site, we conducted site surface explorations for site feasibility characterization. Relevant property dimensions and soil conditions were documented and mapped at representative intervals as access allowed. Soil conditions were evaluated through local exposures, compared to existing soil data.

Exploration locations were marked in the field by an QG Project Geologist with respect to the provided map and cleared for public conductible utilities. Our exploration locations were selected by an QG Project Geologist prior to field work to provide safest access to relevant soil conditions. The geologist directed the advancement of 3 hand augers (HA). The HAs were advanced within the vicinity of the anticipated development footprint area, to a depth of 1 foot below present grade in general accordance with the specified contract depth.

During explorations QG logged each soil horizon encountered, and field classified them 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 back to the office for supplemental classification and other tests.

SURFACE OBSERVATION

The site is rectangular in shape and generally flat. The proposed improvement area is to the south of the existing single-family residence. Topography was consistently gentle across the parcel. Soils were generally dense and moist across most of the surface.

SUBSURFACE CONDITIONS:

The intermixed material of the topsoil typically comprises of a brown gravelly outwash. These soils were moist, heavily cobbled, and in a dense at the time of our hand auger exploration. QG did not observe groundwater seepage during exploration.

DISCUSSION & RECOMMENDATIONS

The findings of QG's site reconnaissance at the subject site appear broadly consistent with available geologic literature and indicates site soil conditions are generally amenable, assuming appropriate site management efforts are maintained.

Infiltration Feasibility

During 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 north portion of the site (HA-1) to characterize the local infiltration conditions.

We understand the project will be subject to infiltration design based on the 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.

Client provided laboratory results were interpreted to recommended design inputs in accordance with methods of the 2019 DoE SMMWW. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

$$(1) \quad \log_{10}(K_{sat}) = -1.57 + 1.90 \cdot D_{10} + 0.015 \cdot D_{60} - 0.013 \cdot D_{90} - 2.08 \cdot ff$$

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 $CF_v = 0.7$ along with typical values of $CF_t = 0.4$ (for the Grain Size Method) and $CF_m = 0.9$ (assuming standard influent control).

(2) $CFT = CF_v \times CF_t \times CF_m = 0.7 \times 0.4 \times 0.9 = 0.25$

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

| TP # | Sample Depth (BPG) | Unit Extent (ft) | Soil Type | D10 | D60 | D90 | Fines (%) | Ksat (in/hr) | Corrected Ksat (in/hr) | LT Design Infiltration Rate(in/hr) |
|------|--------------------|------------------|-----------|-----|-----|-----|-----------|--------------|------------------------|------------------------------------|
| 1 | 4.0 | ~1.0 to 10+ | GW | 0.3 | 7.0 | 10 | 0.9 | 93.43 | 25.23 | 20 |

For in-ground facilities, a minimum of 5 feet of separation is generally required between the base of any gallery or drywell and any confining unit or water table. **For in-ground infiltration galleries, we recommend a maximum design rate of up to 20 inch/hour be considered, for any shallow infiltration features such as rain gardens, pervious pavement or swales, we recommend the designer consider a reduced rate of 1.0 inches per hour** which is typically suitable for most shallow infiltration features and considers potential reductions from compaction during construction.

In-ground infiltration structures are required to maintain a minimum separation from restrictive soil & perched water features. Available well logs not indicate the potential for shallow ground water. The required separation appears generally achievable across the site. At this time, QG does not recommend mounding analysis due to the generally suitable site conditions.

Alternatives to in ground infiltration include the use of rain gardens, bio-swales, or pervious pavement, which can be considered at the discretion of the designer and client depending on final development needs and constraints. For shallow infiltration features utilizing treatment media, we recommend a maximum design rate of up to 1.0 inch/hour be considered. This considers potential reductions from compaction during construction.

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.

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.

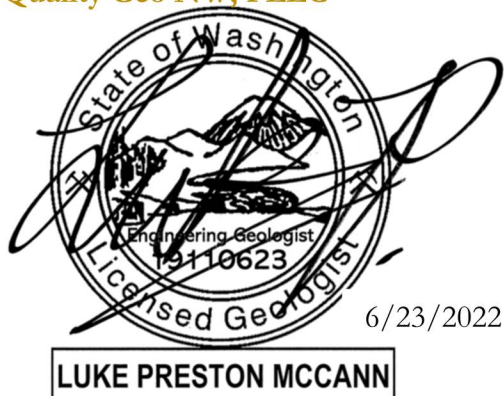
QG recommends all stormwater catchments (new or existing) be tightlined (piped) away from structures to an existing catch basin, stormwater system, established channel, or approved outfall to be released using appropriate energy-dissipating features at the outfall to minimize point erosion. Roof and footing drains should be tightlined separately or should be gathered in an appropriately sized catch basin structure and redistributed collectively. If storm drains are incorporated for impervious flatworks (driveways, sidewalks, etc.) collected waters should also be discharged according to the above recommendations. Based on our observations of a shallow groundwater table, appropriate measures should be taken by the site designer to consider and allow for an adequate emergency outfall location in the event of future record stormwater fall that cannot be anticipated.

CLOSING:

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

Respectfully Submitted,

Quality Geo NW, PLLC



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

Ray Gean II
Staff Geologist/Project Manager

Attachments: *Limitations*
Appendix A. Site Region and Vicinity Maps
Appendix B. Aerial Site Map
Appendix C. Exploration Logs
Appendix D. Laboratory Results

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LIMITATIONS

Upon acceptance and use of this report, and its interpretations and recommendations, the owner 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.

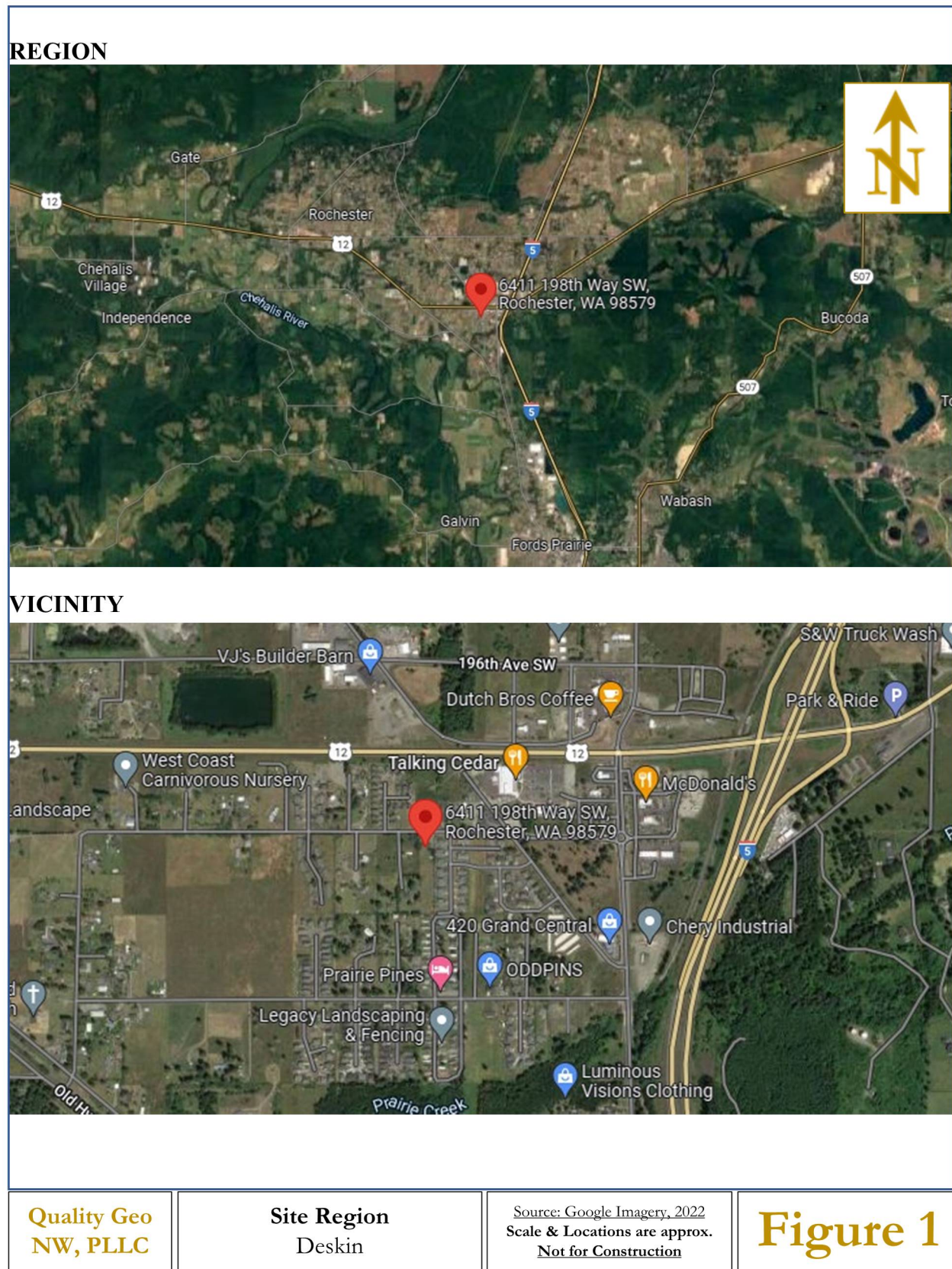
Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required. Based on the intended use of the report, QG may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these 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.

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Appendix A. Site Region & Vicinity

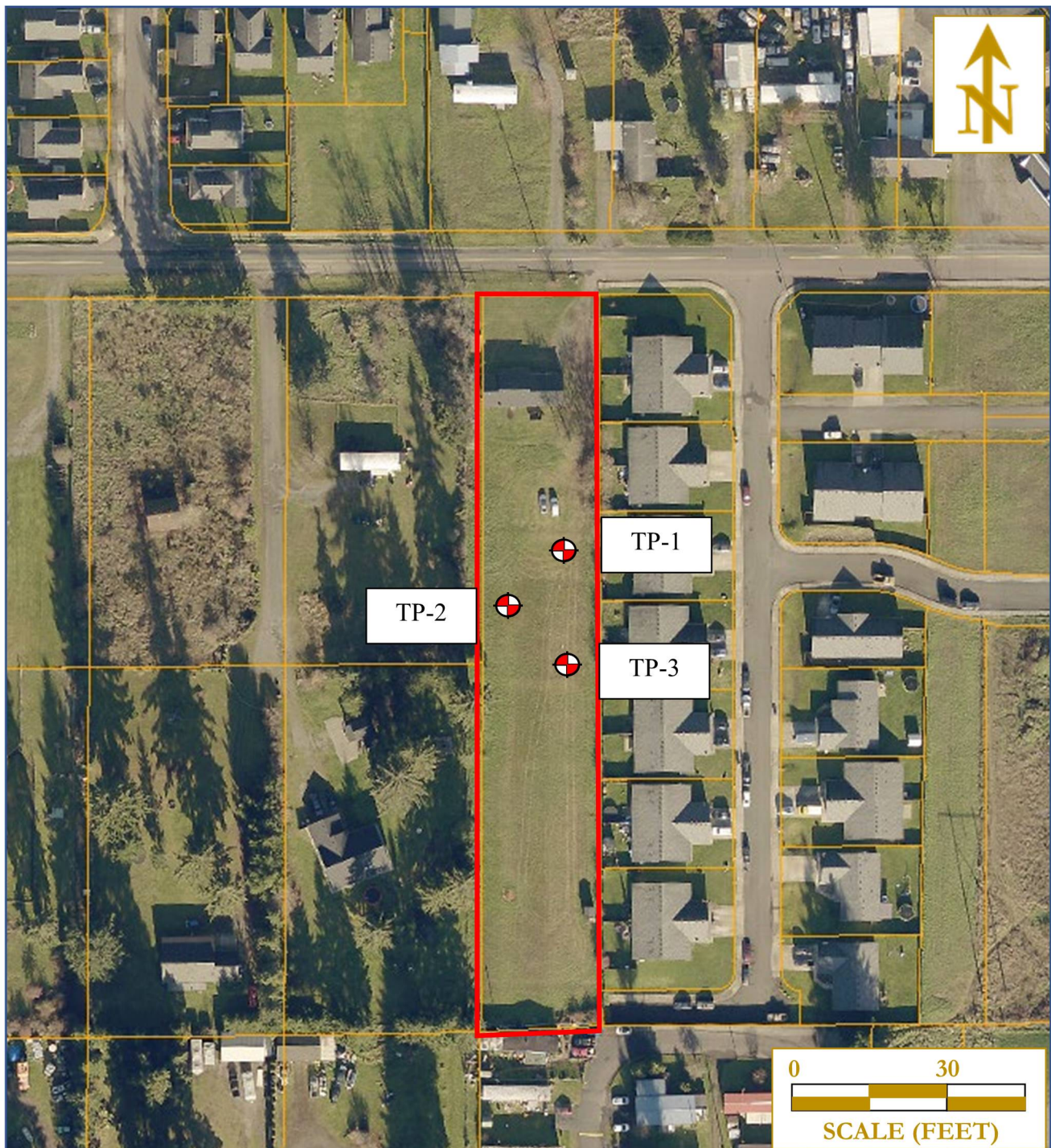


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Appendix B. Site Map



| | | | |
|-------------------------|--------------------|---|----------|
| Quality Geo NW, PLLC | Site Map Deskin | Source: Thurston Co. GIS 2022 Scale & Locations are approximate <u>Not for Construction</u> | Figure 2 |
|-------------------------|--------------------|---|----------|

Appendix C. Exploration Logs



HAND AUGER LOG HA-1

| PROJECT NUMBER QG22-095 | | FIELD WORK DATE 5/13/2022 | | BORING LOCATION South of house | |
|----------------------------------|---------|-----------------------------------|-------------|--------------------------------|---|
| PROJECT NAME Deskin Infiltration | | DRILLING METHOD Hand Auger Boring | | SURFACE ELEVATION Existing | |
| PROJECT LOCATION Rochester, WA | | TOTAL DEPTH 0.5 | | LOGGED BY RG | |
| COMMENTS | | | | | |
| Depth (ft) | Samples | Is Analysed? | Graphic Log | USCS | Material Description |
| | | | | TS | TOPSOIL / INTERMIXED GRAVEL |
| 0.5 | | | | | Termination Depth at 0.5 Feet. Terminated due to practical equipment refusal No Groundwater Encountered |



HAND AUGER LOG HA-2

| PROJECT NUMBER QG22-095 | | FIELD WORK DATE 5/13/2022 | | BORING LOCATION ~21' SW of HA-1 | |
|----------------------------------|---------|-----------------------------------|-------------|---------------------------------|--|
| PROJECT NAME Deskin Infiltration | | DRILLING METHOD Hand Auger Boring | | SURFACE ELEVATION Existing | |
| PROJECT LOCATION Rochester, WA | | TOTAL DEPTH 0.917 | | LOGGED BY RG | |
| COMMENTS | | | | | |
| Depth (ft) | Samples | Is Analysed? | Graphic Log | USCS | Material Description |
| 0.5 | | | | TS | TOPSOIL / INTERMIXED GRAVEL |
| 1 | | | | | Termination Depth at 11 inches. Terminated due to practical equipment refusal No Groundwater Encountered |

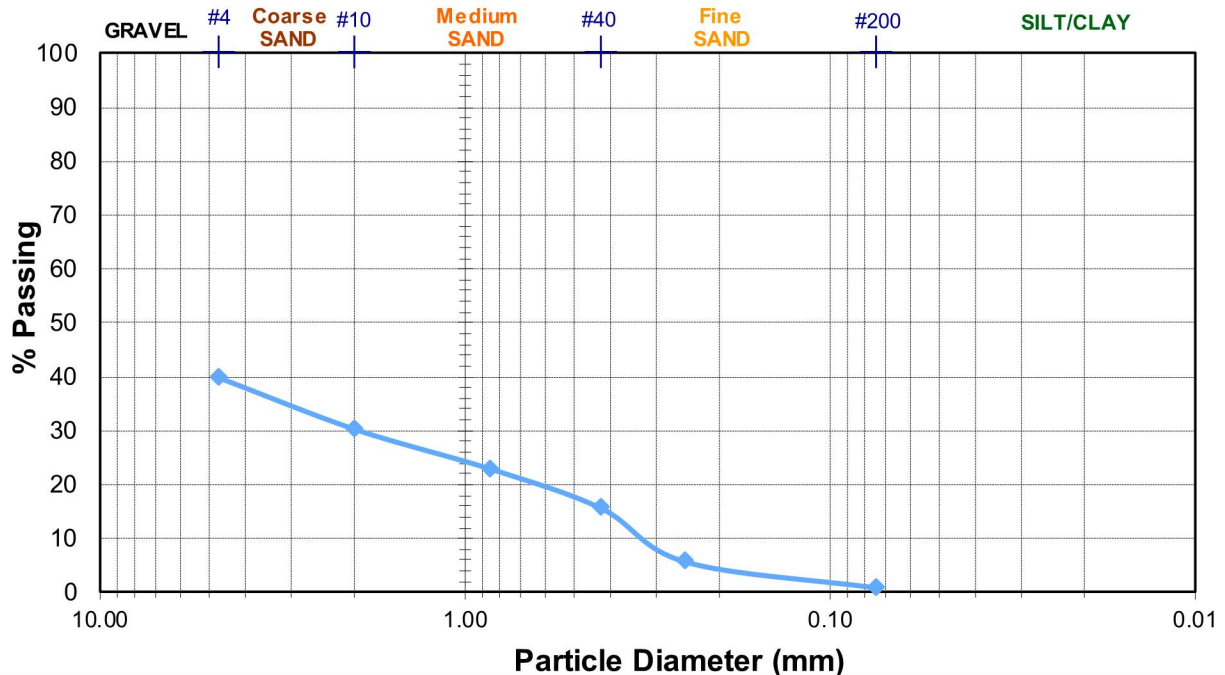


HAND AUGER LOG HA-3

| PROJECT NUMBER QG22-095 | | FIELD WORK DATE 5/13/2022 | | BORING LOCATION ~50' S of HA-2 | |
|----------------------------------|---------|-----------------------------------|-------------|--------------------------------|--|
| PROJECT NAME Deskin Infiltration | | DRILLING METHOD Hand Auger Boring | | SURFACE ELEVATION Existing | |
| PROJECT LOCATION Rochester, WA | | TOTAL DEPTH 0.917 | | LOGGED BY RG | |
| COMMENTS | | | | | |
| Depth (ft) | Samples | Is Analysed? | Graphic Log | USCS | Material Description |
| 0.5 | | | | TS | TOPSOIL / INTERMIXED GRAVEL |
| | | | | | Termination Depth at 11 inches. Terminated due to practical equipment refusal No Groundwater Encountered |

Appendix D. Laboratory Results

| Sieve Number | Diameter (mm) | Mass of Sieve (g) | Mass of Sieve & Soil (g) | Soil Retained (g) | Soil Retained (%) | Soil Passing (%) |
|--------------|---------------|-------------------|--------------------------|-------------------|-------------------|------------------|
| #4 | 4.75 | 485.9 | 837.7 | 351.8 | 60.3 | 39.7 |
| #10 | 2.00 | 452.8 | 508.8 | 56.0 | 9.6 | 30.2 |
| #20 | 0.85 | 383.1 | 425.8 | 42.7 | 7.3 | 22.8 |
| #40 | 0.43 | 346.7 | 388.8 | 42.1 | 7.2 | 15.6 |
| #60 | 0.25 | 329.2 | 386.9 | 57.7 | 9.9 | 5.8 |
| #200 | 0.075 | 315 | 343 | 28.0 | 4.8 | 1.0 |
| Pan | | 348.1 | 353.4 | 5.3 | 0.9 | 0.0 |
| TOTAL: | | | | 583.6 | 99.9 | |



| | | | |
|---|------|--------------------------|-------|
| Grain Size Distribution Curve Results: | | | |
| % Gravel: | 60.3 | D ₁₀ : | 0.3 |
| % Sand: | 38.8 | D ₃₀ : | 2 |
| % Fines: | 0.9 | D ₆₀ : | 7 |
| | | D ₉₀ : | 10 |
| | | fines | 0.075 |
| Saturation Correction Factors | | | |
| CF _v : | 0.8 | | |
| CF _t : | 0.4 | | |
| CF _m : | 0.9 | | |
| CF _r : | 0.27 | | |
| | | Short-K _{sat} : | 93.43 |
| | | Long-K _{sat} : | 25.23 |