10/13/2021

Fuller Designs
1101 Kresky Ave
Centralia, WA

Subject: **Geotechnical Services Report**
Hamilton Storage- Geotechnical Investigation
TPN 017765004002, 017896006003, 017765005000, 017896005000,
Hamilton Rd, Chehalis, WA Project Number: QG21-112

Dear Client:

At your request, Quality Geo NW, PLLC (QG) has completed a soils 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.
Principal Licensed Engineering Geologist

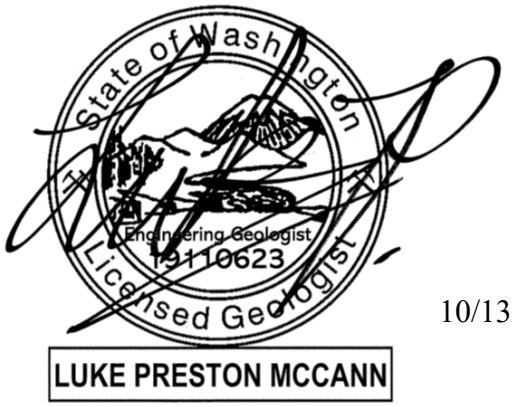
Ray Gean II
Staff Geologist

SOILS REPORT

HAMILTON STORAGE
HAMILTON RD
CHEHALIS, WA

Fuller Designs
1101 Kresky Ave
Centralia, WA

Prepared by:



10/13/2021

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10/13/2021

QG Project # QG21-112

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TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the findings and recommendations of Quality Geo NW'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 as an storage complex, including new building and paving of the site. Exterior improvements are anticipated to include infrastructure for auto access and parking, flatworks, and other necessary site amenities. 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 9/8/2021. Exploration locations were marked in the field by an QG Staff Geologist with respect to the provided map and cleared for public conductible utilities. Our exploration locations were selected by an QG Staff Geologist prior to field work to provide safest access to relevant soil conditions. The geologist directed the advancement of 3 excavated test pits (TP). The test pits were advanced within the vicinity of the anticipated development footprint areas, to depths of 10.0 feet below present grade (BPG) in general accordance with the specified contract depth.

During explorations QG logged each soil horizon we 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 to the soil laboratory for supplemental classification and other tests.

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 continental Quaternary alluvium deposits (Qa). The alluvium on site is described as typically Silt, sand, and gravel deposited in streambeds and fans; surface relatively undissected. The WGIP Map also offers layers of mapped geohazard conditions within the state. According to the regional-scale interactive map, no known geohazards are mapped for the site.

The United States Department of Agriculture portal (USDA), provides a soil mapping of the region. The soils in the vicinity are mapped as Olequa Silt Loam (152), these are formed by terraces. The soils are described as silt loam from 0 to 20 inches, silty clay loam from 20 to 51 inches, and silt loam from 51 to 60+ inches. Depth to restrictive feature is more than 80 inches. Capacity of most limiting layer to transmit water (ksat), is listed as moderately high (0.20 to 0.57 in/hr). Depth to water table is more than 80 inches.

2.2 SITE & SURFACE CONDITIONS

The project area is relatively flat, near the same elevation as the adjacent road, The site is currently 4 separate parcels that are undeveloped and is mostly grasses.

2.3 SOIL LOG

Site soil conditions were generally identical across the property in all 3 test pits. Representative lab samples were taken from TP-1 and TP-2. Soil conditions on site were as follows:

- **0.0’ to 1.25’ – Topsoil:**

  An overriding 14 to 16-inch layer of topsoil was present over the site.

- **1.25’ to 3.5’ – Silty Sand with Gravel (SM)**

  Beneath topsoil, was approximately a 2.0-foot layer of brown organic rich layer, which was loose to medium dense.

- **3.5’ to 5.0’ – Silt with Gravel (ML)**
  Beneath silty sand soil, was approximately a 1.5 -foot layer of grey-brown organic layer, which was loose to medium dense.

- **5.0’ to 10’ Well Graded Sand with Gravel (SW)**

  Beneath silty sand with gravel, native sediments resemble a reddish-brown sandy gravelly alluvium deposit, with minimal fines content and cobble content, in a typically medium dense condition. Groundwater was encountered within this unit and the other test pits at approximately 9 to 10 feet below present grade.

2.4 SURFACE WATER AND GROUNDWATER CONDITIONS

No active surface water features are present on site. During our test pit explorations, a pervasive groundwater table was encountered at approximately 9 to 10 feet below present grade. This groundwater table is inferred to exist at approximately 7 feet beneath the entire site, based on well logs made publicly available by the WA Department of Ecology. Due to the time of year, it may be assumed that the explorations did not occur during the seasonal high, and the water table may raise during the mid-winter months.

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 SHALLOW FOUNDATION RECOMMENDATIONS

QG recommends excavating loose or organic cover soils down to firm bearing conditions expected within 0.5 feet from the surface. As the variability in subgrade support between consolidated glacial deposits and weathered medium dense cover soils may result in differential settlement, QG recommends that foundations be placed on compacted native soils wherever, or on firm structural fill installed over these compacted soils to achieve footing grade.

Assuming site preparation is completed as described above, we recommend the following:

- **Subgrade Preparation**

  QG recommends excavating and clearing any loose or organic cover soils, including the thin overriding layer of topsoil where necessary, from areas of proposed building and pavement construction, down to firm bearing conditions and benching the final bottom of subgrade elevation flat. Excavations should be performed with a smooth blade bucket to limit disturbance of subgrade soils. Vibratory compaction methods are suitable for densification of the non-organic native soils.

  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 periodic guidance of a QG representative. Any areas that are identified as being soft or yielding during subgrade evaluation should be brought to the attention of 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.

  The proposed buildings may utilize either stepped or continuous footings with slab-on-grade elements. For continuous footing elements, upon reaching bearing strata, we recommend benching foundation lines flat. Continuous perimeter and strip foundations may be stepped as needed to accommodate variations in final subgrade level. We also recommend maximum steps of 18 inches with spacing of at least 5 feet be constructed unless specified otherwise by the design engineer. Structural fill may then be placed as needed to reestablish final foundation grade.

- **Allowable Bearing Capacity:**

  Up to 1,500 pounds per square foot (psf) for foundations placed on compacted native soil or on approved structural fill soils placed in accordance with the recommendations of *Section 4.2*. Bearing capacities, at or below 1,500 psf may eliminate the need for additional inspection

requirements if approved by the county. The allowable bearing capacity may be increased by 1/3 for transient loading due to wind and seismic events.

- **Minimum Footing Depth:**

  For a shallow perimeter and spread footing system, all exterior footings shall be embedded a minimum of 18 inches and all interior footings shall be embedded a minimum of 12 inches below the lowest adjacent finished grade, but not less than the depth required by design. However, all footings must also penetrate to the prescribed bearing stratum cited above. Minimum depths are referenced per IBC requirements for frost protection; other design concerns may dictate greater values be applied.

- **Minimum Footing Width:**

  Footings should be proportioned to meet the stated bearing capacity and/or the IBC 2012 (or current) minimum requirements. For a shallow perimeter and spread footing system, continuous strip footings should be a minimum of 16 inches wide and interior or isolated column footings should be a minimum of 24 inches wide.

- **Estimated Settlements:**

  All concrete settles after placement. We estimate that the maximum settlements will be on the order of 0.5 inch, or less, with a differential settlement of ½ inch, or less, over 50 linear feet. Settlement is anticipated to occur soon after the load is applied during construction.

3.1.1 BUILDING SLAB ON GRADE FLOOR

QG anticipates that slab-on-grade floors are planned for the interior of the proposed building. Based on typical construction practices, we assume finished slab grade will be similar to or marginally above present grade for the below recommendations. If floor grades are planned to be substantially raised or lowered from existing grade, QG should be contacted to provide revised or alternative recommendations.

- **Capillary Break:**

  A capillary break will be helpful to maintain a dry slab floor and reduce the potential for floor damage resulting from shallow perched water inundation. To provide a capillary moisture break, a 6-inch thick, properly compacted granular mat consisting of open-graded, free-draining angular aggregate is recommended below floor slabs. To provide additional slab structural support, or to substitute for a structural fill base pad where specified, QG recommends the capillary break should consist of crushed rock all passing the 1-inch sieve and no more than 3 percent (by weight) passing the U.S. No. #4 sieve, compacted in accordance with *Section 5.2.2* of this report.

- **Vapor Barrier:**

  A vapor retarding membrane such as 10 mil polyethylene film should be placed beneath all floor slabs to prevent transmission of moisture where floor coverings may be affected. Care should be taken during construction not to puncture or damage the membrane. To protect the membrane, a layer of sand no more than 2 inches thick may be placed over the membrane if desired. If excessive relict organic fill material is discovered at any location, additional sealant or more industrial gas barriers may be required to prevent off-gassing of decaying material from infiltrating the new structure. These measures shall be determined by the structural engineer to meet local code requirements as necessary.

- **Structural Design Considerations:**

  QG assumes design and specifications of slabs will be assessed by the project design engineer. We suggest a minimum unreinforced concrete structural section of 4.0 inches be considered to help protect against cracking and localized settlement, especially where larger equipment or localized loads are anticipated. It is generally recommended that any floor slabs and annular exterior concrete paving subject to vehicular loading be designed to incorporate reinforcing. Additionally, some level of reinforcing, such as a wire mesh may be desirable to prolong slab life due to the overwhelming presence of such poor underlying soils. It should be noted that QG does not express any guarantee or warranty for proposed slab sections.

3.2 INFILTRATION RATE DETERMINATION

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

3.2.1 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 northwest corner of the site (where an infiltration pond is proposed) 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.

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

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

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)*	Cation Exchange Capacity (meq/100g)	Organic Content %
1	8.0	5’ to 10’	SW	0.35	6.0	55	0.4	41.03	10.25	**10.25**	20.5	1.1
2	4.0	14” to 7’	SW	0.21	3.3	14	2.2	63.42	89.2	**15.85**	23.3	2.3

Beneath topsoils, the lower brown to red-brown soils were observed to generally exhibit minimal fines content and minimal oxidation patterns. In-ground infiltration structures are required to maintain a minimum separation from restrictive soil & groundwater features. QG recommends that penetration of shallow stormwater measures do NOT penetrate deeper than 4 feet in order to maintain a 5-foot separation from the groundwater table.

For in-ground infiltration galleries, we recommend a maximum design rate of up to 10.25 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 4 inches per hour** which is typically suitable for most shallow infiltration features, and 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.

3.2.2 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). The underlying red-brown soils did meet these treatment standards.

If the overall infiltration rate must be decreased to allow more treatment time, QG recommends placing a minimum 6" thick layer of ASTM c33 sand between the native soil and base of the infiltrating feature. This will typically reduce the infiltration rate to approximately 9in/hr and allow for proper treatment of stormwater within above treatment soils.

3.2.3 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.

3.3 IMPERVIOUS PAVEMENT CONSIDERATIONS

QG anticipates most pavements will be constructed of flexible Hot Mix Asphalt surfacing, with thickened sections for anticipated heavy load areas. The main entrance/exit drive will likely experience different traffic volumes than the far end of the pavement areas. As a result, consideration could be given to increasing the pavement section in the main entrance/exit drive. Pavement sections presented in the above table should not be used for areas which experience repeated truck traffic/parking, equipment or truck parking areas, entrances and exit aprons, or

contain trash dumpster loading zones. In these areas, a Portland Cement Concrete (PCC) pavement should be used, as opposed to HMA.

One of the important considerations in designing a high quality and durable pavement is providing adequate drainage. Design of drainage for the proposed pavement section is outside of QG 's scope of work at this time. It is important that bird baths (leeching basins) and surface waves are not created during construction of the HMA layer. A proper slope should also be allowed, and drainage should be provided along the edges of pavements and around catch basins to prevent accumulation of free water within the base course, which otherwise may result in subgrade softening and pavement deterioration under exposure and repeated traffic conditions.

All pavements require regular maintenance and repair in order to maintain the serviceability of the pavement. These repairs and maintenance are due to normal wear and tear of the pavement surface and are required in order to extend the serviceability life of the pavement. However, after 10 years of service, a normal pavement structure is likely to deteriorate to a point where pavement rehabilitation may be required to maintain the serviceability. The deterioration is more likely if the pavement is constructed over poor subgrade soils or in area of higher traffic volumes.

Rigid pavement components are commonly utilized for portions of accesses and ancillary exterior improvements. The project civil designer may re-evaluate the below general recommendations for pavement thicknesses and base sections, if necessary, to ensure proper application to a given structure and use. QG recommends that we be contacted for further consultation if the below sections are proposed to be reduced.

Concrete driveway aprons and curb alignments, if utilized, should consist of a minimum 6-inch thickness of unreinforced concrete pavement over structural base fill. Base thickness should correspond to related location and anticipated traffic loading. For light traffic areas, a 6-inch minimum base thickness (total 12-inch section) can be applied. For heavy traffic zones, we recommend allotting a 12- inch minimum base section beneath the pavement, or the incorporation of reinforcing steel in the concrete.

Concrete sidewalks, walkways and patios if present may consist of a minimum 4-inch section of plain concrete (unreinforced) installed over a 6-inch minimum compacted base of crushed rock. At locations where grade has been raised with structural fill, a 4-inch minimum crushed rock section may be used. Flatworks should employ frequent joint controls to limit cracking potential.

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. However, based on provided conceptual plans, 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 an 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 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 runoff 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 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 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 a local and reputable materials testing & inspection firm be retained for construction phase testing and 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.

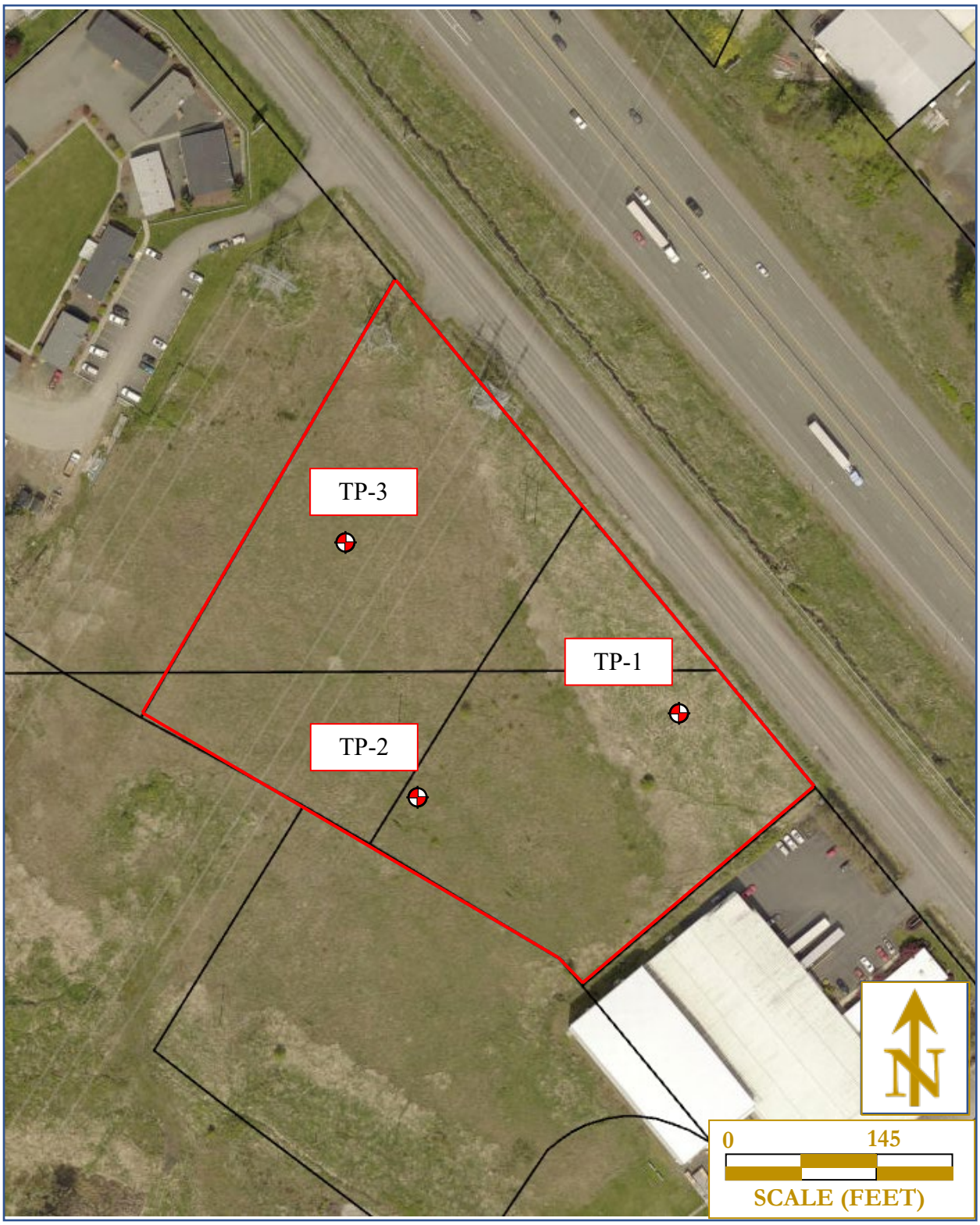
Appendix A. Region & Vicinity Maps

REGION

VICINITY

Quality Geo NW, PLLC	**Site Region** Hamilton Storage	Source: Google Imagery, 2021 **Scale & Locations are approx.** **Not for Construction**	**Figure 1**

Appendix B. Exploration Map



Quality Geo NW, PLLC	**Site Map** Hamilton Storage	Source: Lewis County GIS, 2021 **Scale & Locations are approx.** **Not for Construction**	**Figure 2**

Appendix C. Exploration Logs

TEST PIT LOG TP-1

PROJECT NUMBER QG21-112
PROJECT NAME Hamilton Storage
PROJECT LOCATION Chehalis, WA

FIELD WORK DATE 09/8/2021
DRILLING METHOD Excavated Test Pit

BORING LOCATION East part of the site
SURFACE ELEVATION Existing
LOGGED BY RG

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0.5				TS	TOPSOIL
1					
1.5				SM	SILTY SAND w/ GRAVEL Brown color, moist, organics, cobble up to 1 inch, medium dense to dense. Light Mottling at 2.5 feet Gravel %=20 Sand%=50 Fines%=30
2					
2.5					
3					
3.5				ML	SILT w/ GRAVEL. Gray-Brown color, moist, minor organics, medium dense to dense, cobble up to 8 inches. Mottling observed Gravel%=40 Sand%=20 Fines%=50
4					
4.5					
5				SW	WELL GRADED SAND w/ GRAVEL. Red-Brown color, moist to saturated, minor organics, cobble up to 8 inches, medium dense to dense, Mottling observed. Groundwater encountered at 10' Gravel%=45, Sand%=54, Fines%= <1
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9					
9.5					
10					▽
10.5					Termination Depth at 10.0 Feet. Terminated at Contracted Depth Groundwater encountered at 10 feet

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TEST PIT LOG TP-2

PROJECT NUMBER QG21-112
PROJECT NAME Hamilton Storage
PROJECT LOCATION Chehalis, WA

FIELD WORK DATE 09/8/2021
DRILLING METHOD Excavated Test Pit

BORING LOCATION Southern part of the site
SURFACE ELEVATION Existing
LOGGED BY RG

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				TS	TOPSOIL
1				SW	WELL GRADED SAND w/ GRAVEL. Red-Brown color, moist, minor organics, cobble up to 8 inches, medium dense to dense, Mottling observed. Gravel%=30, Sand%=68, Fines%= 2
7				SM	SILTY SAND w/ GRAVEL Brown color, moist to saturated organics, cobble up to 3 inch, medium dense to dense. Mottling observed, Groundwater observed at 10' Gravel %=20 Sand%=50 Fines%=30
10					Termination Depth at 10.0 Feet. Terminated at Contracted Depth Groundwater encountered at 10 feet

TEST PIT LOG TP-3

PROJECT NUMBER QG21-112
PROJECT NAME Hamilton Storage
PROJECT LOCATION Chehalis, WA

FIELD WORK DATE 09/8/2021
DRILLING METHOD Excavated Test Pit

BORING LOCATION Northwest part of the site
SURFACE ELEVATION Existing
LOGGED BY RG

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				TS	TOPSOIL
1.5				SW	WELL GRADED SAND w/ GRAVEL. Red-Brown color, moist, minor organics, cobble up to 8 inches, medium dense to dense, Mottling observed. Gravel%=30, Sand%=68, Fines%= 2
7				SM	SILTY SAND w/ GRAVEL Brown color, moist to saturated organics, cobble up to 3 inch, medium dense to dense. Mottling observed, Groundwater observed at 9 feet. Gravel %=20 Sand%=50 Fines%=30
10					Termination Depth at 10.0 Feet. Terminated at Contracted Depth Groundwater encountered at 9 feet

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Appendix D. Laboratory Results

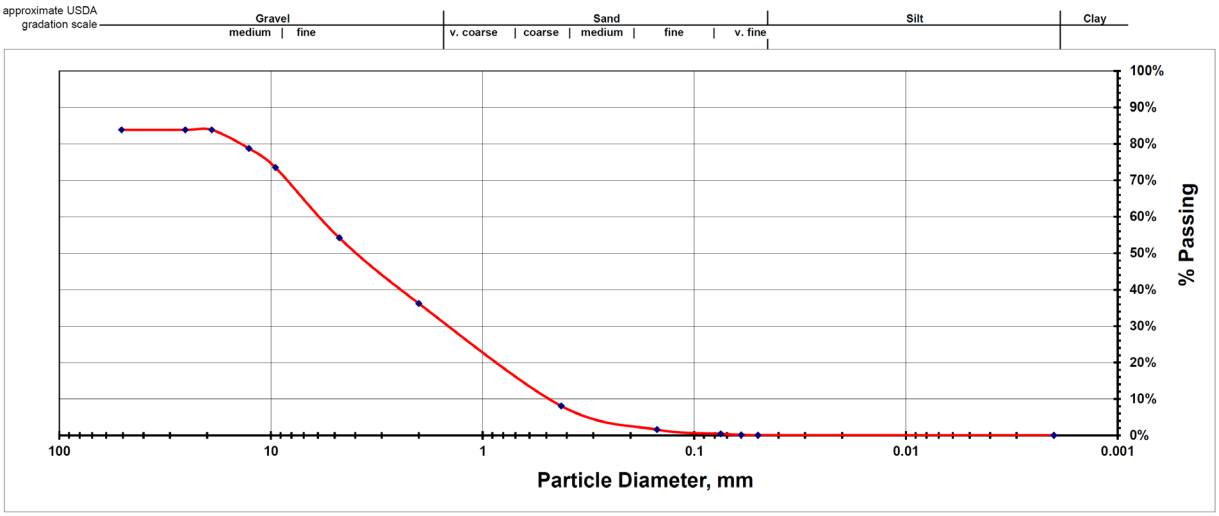
soiltest farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

PARTICLE SIZE DISTRIBUTION REPORT

CLIENT: Quality Geo NW
PROJECT: HAMILTON STORAGE
Lab # S21-20945

Date Received 9/17/2021
Date Reported 10/4/2021
Test Method: ASTM D2487/ D 422

SAMPLE ID: TP-1 at 8'



description	CoCr	CoGr	MedGr	MedGr	MedGr	FiGr	vCoS	MedS	FiS	vFiS	(% of Whole Sample Passing last Sieve) Hydrometer Method			Sand	Gravel
seive #	2"	1"	3/4"	1/2"	3/8"	4	10	40	100	200				Total	Total
diameter, mm	50.8	25.4	19.05	12.70	9.53	4.75	2.00	0.425	0.150	0.075	0.060	0.050	0.002		
Retained	16.2%	0.0%	0.0%	5.1%	5.2%	19.3%	18.0%	28.1%	6.5%	1.2%	0.3%	0.1%	0.0%	54.0%	45.8%
Passing	84%	84%	84%	78.7%	73.5%	54.2%	36.2%	8.1%	1.6%	0.4%					

Graph Values

D_{90}	55
D_{60}	6.0
D_{30}	1.50
D_{10}	0.35

Coefficient of Uniformity: 17.1
Coefficient of Gradation: 1.07

	Sand	Silt	Clay
% of Sample < 2mm	69%	20%	11%

USDA TEXTURAL CLASSIFICATION of FRACTION PASSING 2mm SEIVE: SANDY LOAM

OM (LOI 360) 1.1 %
CEC 20.5 meq/100g

Reviewed by: BCT Date: 10/4/2021

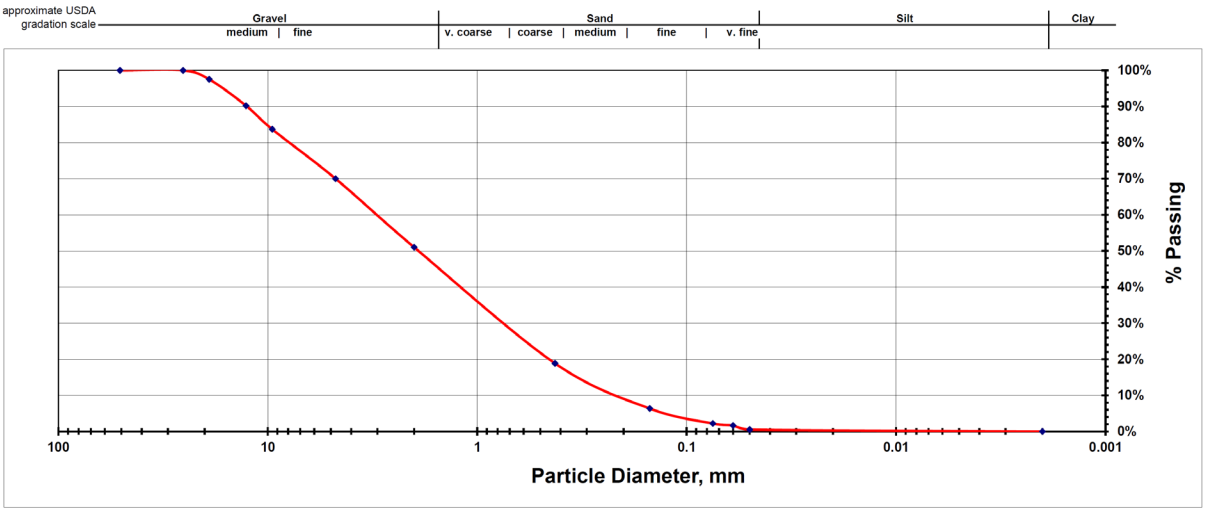
soiltest farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 - www.soiltestlab.com
Office: (509)765-1622 - Fax:(509)765-0314 - (800)764-1622

PARTICLE SIZE DISTRIBUTION REPORT

CLIENT: Quality Geo NW
PROJECT: HAMILTON STORAGE
Lab # S21-20946

Date Received 9/17/2021
Date Reported 10/4/2021
Test Method: ASTM D2487/ D 422

SAMPLE ID: TP-2 at 4'



description	CoCr	CoGr	MedGr	MedGr	MedGr	FiGr	vCoS	MedS	FiS	vFiS	(% of Whole Sample Passing last Sieve) Hydrometer Method			Sand	Gravel
seive #	2"	1"	3/4"	1/2"	3/8"	4	10	40	100	200				Total	Total
diameter, mm	50.8	25.4	19.05	12.70	9.53	4.75	2.00	0.425	0.150	0.075	0.060	0.050	0.002		
Retained	0.0%	0.0%	2.5%	7.3%	6.5%	13.7%	19.0%	32.2%	12.5%	4.1%	0.6%	1.1%	0.5%	68.4%	30.0%
Passing	100%	100%	98%	90.2%	83.7%	70.0%	51.0%	18.9%	6.4%	2.2%					

Graph Values

D_{90}	14
D_{60}	3.3
D_{30}	0.70
D_{10}	0.21

Coefficient of Uniformity: 15.7
Coefficient of Gradation: 0.71

% of Sample < 2mm	Sand	Silt	Clay	
	25%	51%	24%	
USDA TEXTURAL CLASSIFICATION of FRACTION PASSING 2mm SEIVE				SILT LOAM

OM (LOI 360) 2.3 %
CEC 23.3 meq/100g

Reviewed by: BCT Date: 10/4/2021