Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
4820 – 83RD AVENUE NORTHEAST
MARYSVILLE, WASHINGTON

ES-7386.01

15365 NE 90th Street, Suite 100 • Redmond, WA 98052 • (425) 449-4704
3130 Varney Lane, Suite 105 • Pasco, WA 99301 • (509) 905-0275
esnw.com

PREPARED FOR

KEYSTONE LAND, LLC

January 30, 2024

Samuel E. Suruda, L.G.
Senior Staff Geologist

01/30/2024

Henry T. Wright, P.E.
Associate Principal Engineer

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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
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Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

January 30, 2024
ES-7386.01

Keystone Land, LLC
13805 Smokey Point Boulevard, Suite 102
Marysville, Washington 98271

Attention: Joe Long

Dear Joe:

Earth Solutions NW, LLC (ESNW), is pleased to present this geotechnical engineering study to support the proposed residential development. Based on the results of our investigation, the proposed project is feasible from a geotechnical standpoint. Our study indicates the site is underlain primarily by competent native soil.

The site will be mass graded to create access drives and building pads. New structural fill should be placed on competent soil. The subgrade of the existing sloped areas of the site will need to be keyed and benched prior to placing new structural fill; drainage measures may be necessary prior to placing new fill on the benched subgrade. If earthwork activities occur during wet weather, additional drainage measures, cement treatment of native soil, and/or the use of select fill material will likely be necessary. After completing earthwork activities in accordance with recommendations in this report, the proposed structures can be supported on conventional spread and continuous foundations bearing on undisturbed, competent native soil, compacted native soil, or new structural fill. If structural building pads are disturbed during wet weather, remediation measures such as cement treatment or overexcavation and replacement with rock may be necessary in some areas.

From a geotechnical standpoint, stormwater infiltration on the subject site should be considered infeasible due to the slope gradients on site, and the relative low permeability of the site soil.

Pertinent geotechnical recommendations are provided in this study. We appreciate the opportunity to be of service to you on this project. If you have any questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Samuel E. Suruda, L.G.
Senior Staff Geologist

cc: Perkls Properties, LLC
Attention: Nate Perkl

Solid Ground Engineering
Attention: Tom Abbott, P.E.

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GEOTECHNICAL ENGINEERING STUDY
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MARYSVILLE, WASHINGTON

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INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed residential development to be constructed at 4820 – 83rd Avenue Northeast, in Marysville, Washington. The purpose of this study was to develop geotechnical recommendations for the project. The following tasks were completed as part of our scope of services for this project:

- Observation of test pits and borings to characterize soil and groundwater conditions.
- Laboratory testing of soil samples collected at the test locations.
- Engineering analyses and recommendations for the proposed development.
- Preparation of this report.

Project Description

The proposed project is currently pursuing redevelopment of the existing parcel for the construction of a new 21-lot residential plat. The existing single-family residence will remain, and the remainder of the associated improvements will be redeveloped into 20 additional single-family residences. A stormwater detention vault is proposed for the southwestern corner of the site.

Based on the referenced civil plans, site grading will include fills of up to about 28 feet and cuts of up to about 6 feet to achieve the proposed finish grade elevations. Block retaining walls and rockeries are proposed to facilitate grade changes where necessary. Cuts of up to about 15 feet will be required to construct the proposed detention vault. Earthwork will also include installation of underground utilities.

Based on our experience with similar projects, the proposed residential structures will likely be two to three stories in height and constructed utilizing relatively lightly loaded wood framing supported on conventional foundations. Perimeter footing loads will likely be 1 to 2 kips per linear foot, isolated footing loads will be less than 20 kips, and we anticipate slab-on-grade loading of 150 pounds per square foot (psf).

If the above design assumptions either change or are incorrect, ESNW should be contacted to review the recommendations provided in this report. ESNW should review final designs to confirm that our geotechnical recommendations have been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is directly southwest of the intersection between 83rd Avenue Northeast and 49th Street Northeast in Marysville, Washington. The approximate site location is illustrated on Plate 1 (Vicinity Map). The property is comprised of a single tax parcel (Snohomish County Parcel Number 00590700013600), totaling roughly 4.66 acres. Topography across the subject site generally descends to the south-southwest, with some gently sloped areas and some moderately to steeply sloped areas. There is approximately 60 feet of total elevation change present across the parcel. The subject site is bordered by 83rd Avenue Northeast to the east, 49th Street Northeast to the north, a single-family residence to the south, and a powerline easement to the west. Vegetation within the subject site primarily consists of mature trees, forest undergrowth, landscaping, and some areas overgrown with invasive vegetation. We understand that a delineated Category 3 wetland is present on the south portion of the subject site, this study has been produced under the assumption that the buffers pertaining to the wetland will be maintained.

Subsurface

An ESNW representative observed, logged, and sampled five test pits on October 2, 2023. The test pits were excavated at accessible site locations, using an operator and mini trackhoe retained by ESNW. Additionally, two borings were completed on October 5, 2023 using an operator and machine retained by ESNW. The subsurface exploration was completed to evaluate soil and groundwater conditions within the proposed development area. The maximum exploration depth was approximately 46.5 feet below the existing ground surface (bgs). The primary purposes of the borings were to evaluate slope stability for the proposed regrading of the sloped area. The approximate locations of the explorations are depicted on Plate 2 (Subsurface Exploration Plan). Please refer to the logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the exploration locations were analyzed in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil

Topsoil, where present, was observed at depths of 6 to 12 inches bgs. The topsoil was characterized by its dark brown color, the presence of fine organic material, and small root intrusions.

Fill

Fill was not encountered during our subsurface explorations. Based on the existing topography on site throughout the areas of improvements, we anticipate some fill may be encountered during mass grading. If significant amounts of fill are encountered within the subject site, ESNW should be evaluate the materials for potential applications on site.

Native Soil

Underlying the topsoil, native soil encountered at the test pit locations were observed primarily as medium dense to dense silty sand with varying amounts of gravel (USCS: SM). Density was observed to increase at depths of roughly four to six feet bgs across the subject site, and the soil was observed to transition to a weakly cemented and unweathered state. The borings indicate somewhat variable fines content and soil density within the upper 20 to 40 feet which was underlain by very dense silty sand at the bottom of each boring.

Geologic Setting

Geologic mapping identifies Vashon glacial till (Qvt) across the site and the nearby area. Vashon glacial till consists primarily of a nonsorted mixture of silt, sand, and sub-rounded to well-rounded gravels, commonly referred to as “hardpan.” The till was deposited directly from the glacier as it advanced over bedrock and older Quaternary sediment.

The referenced Web Soil Survey (WSS) identifies Tokul gravelly medial loam as the primary unit underlying the subject site. The Tokul series formed in hillslopes and glacial till plains. Based on our field observations, on-site native soils are similar to the typical makeup of glacial till but the variability encountered within the upper 20 to 40 feet may be more representative of transitional bed deposits.

Groundwater

Groundwater seepage was encountered at boring B-2 at a depth of approximately 18 feet, roughly at the transition from the loose silt material to the dense silty sand. Light groundwater seepage was also encountered at test pit location TP-3 at a depth of approximately two feet bgs. Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. Groundwater seepage flow rates are typically higher during the winter, spring, and early summer months. Therefore, perched groundwater seepage should be expected in site excavations, particularly if excavations are made in winter, spring, and early summer months.

GEOLOGIC HAZARD AREAS EVALUATION

As part of this geotechnical engineering study, ESNW reviewed available geologic hazard mapping and the geologic hazard areas section of the Marysville Municipal Code. Based on review of the topographic survey, the site contains some areas with slope gradients of 15 to 40 percent.

Landslide Hazard

With respect to landslide hazards, section 22A.020.130 of the Marysville Municipal Code defines landslide hazard areas as follows:

(1) Low Hazard. Areas with slopes of less than 15 percent.

(2) Moderate Hazard. Areas with slopes of between 15 and 40 percent and that are underlain by soils consisting largely sand, gravel, bedrock or glacial till.

(3) High Hazard. Areas with slopes between 15 and 40 percent that are underlain by soils consisting largely of silt and clay, and all areas sloping more steeply than 40 percent.

(4) Very High Hazard. Areas with slopes over 40 percent and areas of known mappable landslide deposits.

Based on the above definition, the areas of the site with slopes between 15 and 40 percent classify as moderate to high landslide hazard areas.

The proposed project will include construction of mechanically stabilized earth (MSE) retaining walls within or near areas sloped between 15 and 40 percent. The subgrade of these sloped areas should be prepared in accordance with the recommendations in the *Slope Fill* section of this report. As part of the engineering of the proposed MSE walls, global stability analysis should be completed, because geogrid strengths and lengths may be dictated by global stability.

Based on the results of our study, it is our opinion that the risk of damage from the proposed project, both on-site and off-site, is minimal subject to the conditions set forth in this report, and the proposed project will not increase the risk of occurrence of a geologic hazard, and measures to reduce risks have been incorporated into the recommendations of this report.

Erosion Hazard

With respect to erosion hazards, section 22.A.020.060 of the Marysville Municipal Code defines erosion hazard areas as follows:

(1) Low Hazard. Areas sloping less than 15 percent.

(2) Moderate Hazard. Areas sloping between 15 and 40 percent and underlain by soils that consist predominantly of silt, clay, bedrock or glacial till.

(3) High Hazard. Areas sloping between 15 and 40 percent that are underlain by soils consisting largely of sand and gravel, and all areas sloping more steeply than 40 percent.

Based on the above definition, the areas of the site with slopes between 15 and 40 percent classify as moderate erosion hazard areas.

During our visual slope reconnaissance, no signs of large-scale erosion features were observed. It is our opinion, with proper implementation of erosion control BMPs, the proposed development presents a low erosion hazard.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include site preparation and earthwork, engineered slope cuts and fills, engineered retaining walls, utility installation, foundation support, slab-on-grade subgrade support, drainage, and the suitability of using on-site soils as structural fill.

The site will be mass graded to create access drives and building pads. New structural fill should be placed on competent soil. The subgrade of the existing sloped areas of the site will need to be keyed and benched prior to placing new structural fill; drainage measures may be necessary prior to placing new fill on the benched subgrade. If earthwork activities occur during wet weather, additional drainage measures, cement treatment of native soil, and/or the use of select fill material will likely be necessary. After completing earthwork activities in accordance with recommendations in this report, the proposed structures can be supported on conventional spread and continuous foundations bearing on undisturbed, competent native soil, compacted native soil, or new structural fill. If structural building pads are disturbed during wet weather, remediation measures such as cement treatment or overexcavation and replacement with rock may be necessary in some areas.

From a geotechnical standpoint, stormwater infiltration on the subject site should be considered infeasible due to the slope gradients on site, and the relative low permeability of the site soil.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and site clearing and stripping activities. Subsequent earthwork activities will involve mass site grading and installation of infrastructure and stormwater management improvements.

Temporary Erosion Control

The following temporary erosion and sediment control (TESC) best management practices (BMPs) are offered:

- Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access entrance surface. Placing geotextile fabric underneath the quarry spalls will provide greater stability, if needed.

- Silt fencing should be placed around the construction site perimeter.

- When not in use, soil stockpiles should be covered or otherwise protected.

- Temporary measures for controlling surface water runoff, such as interceptor trenches, sumps, or swales, should be installed prior to beginning earthwork activities.

- Dry soils disturbed during construction should be wetted to minimize dust and airborne soil erosion.

- When appropriate, permanent planting or hydroseeding will help to stabilize on-site soil.

Additional TESC BMPs, as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities. TESC BMPs may be modified during construction as site conditions require and as approved by the site erosion control lead.

Stripping

Topsoil was encountered within the upper 6 to 12 inches, and root intrusions generally extended below the topsoil into the upper weathered soil. Stripping may need to extend deeper where loose existing fill needs to be recompacted or removed and replaced with structural fill. The organic-rich topsoil should be stripped and segregated into a stockpile for later use on site or to haul off site. The material remaining immediately below the topsoil may have some root zones and will likely be variable in composition, density, and/or moisture content. The material exposed after initial topsoil stripping will likely not be suitable for direct structural support as is and will likely need to either be compacted in place or stripped and stockpiled for reuse as fill; depending on the time of year stripping occurs, the soil exposed below the topsoil may be too wet to compact and may need to be aerated or treated. ESNW should observe initial stripping activities to provide recommendations regarding stripping depths and material suitability.

Excavations and Slopes

Excavation activities on site are likely to expose medium dense to dense native soil within the upper four to six feet of existing grades. Based on the soil conditions observed at the test locations, the following maximum allowable temporary slope inclinations may be used. The applicable Federal Occupation Safety and Health Administration and Washington Industrial Safety and Health Act soil classifications are also provided:

- Areas exposing groundwater 1.5H:1V (Type C)
- Loose soil 1.5H:1V (Type C)
- Medium dense soil 1H:1V (Type B)
- Dense to very dense "hardpan" native soil 0.75H:1V (Type A)

Permanent slopes should be planted with vegetation to both enhance stability and minimize erosion and should maintain a gradient of 2H:1V or flatter. The presence of perched groundwater may cause localized sloughing of temporary slopes. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope recommendations, as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations.

Slope Fill

Structural fill within sloping areas (where a "sloping area" is defined as an area inclined at 15 percent or steeper) should be placed on a level bench as depicted on Plate 3 (Slope Fill Detail). Benches must be "keyed" into the slope and subsequently filled and compacted with suitable structural fill before continuing to the next bench; the need for drainage below the new structural fill should be evaluated during construction. Sloping finish grades should be "overbuilt" using a bench-style fill and cut to the design gradient to ensure a compacted slope face is maintained. ESNW should observe structural fill placement to confirm subgrade conditions and provide additional drainage recommendations, as necessary.

In-situ and Imported Soil

The on-site soil is moisture sensitive, and successful use of the on-site soil as structural fill will largely be dictated by the moisture content at the time of placement and compaction. Remedial measures may be necessary as part of site grading and earthwork activities. If the on-site soil cannot be successfully compacted, the use of an imported soil may be necessary. In our opinion, a contingency should be provided in the project budget for the export of soil that cannot be successfully compacted as structural fill, particularly if grading activities take place during periods of rainfall. In general, soils with appreciable fines contents (greater than 5 percent) typically degrade rapidly when exposed to periods of rainfall.

Imported soil intended for use as structural fill should consist of a well-graded, granular soil with a moisture content that is at (or slightly above) the optimum level. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, retaining wall, and utility trench backfill areas. Structural fill placed and compacted during site grading activities should meet the following specifications and guidelines:

- Structural fill material — Granular soil*
- Moisture content — At or slightly above optimum**
- Relative compaction*** — 95 percent (Modified Proctor)
- Loose lift thickness (maximum) — 12 inches

* *Existing soil may not be suitable for use as structural fill unless at (or slightly above) the optimum moisture content at the time of placement and compaction.*
** *Soil shall not be placed dry of optimum and should be evaluated by ESNW during construction.*
*** *Relative compaction of 90 percent can be considered for mass grading activities and should be evaluated by ESNW during construction.*

With respect to underground utility installations and backfill, local jurisdictions may dictate the soil type(s) and compaction requirements. Areas of otherwise unsuitable material and debris should be removed from structural areas and replaced with structural fill.

Foundations

After completing earthwork activities in accordance with recommendations in this report, the proposed structures can be supported on conventional spread and continuous foundations bearing on undisturbed, competent native soil, compacted native soil, or new structural fill. If structural building pads are disturbed during wet weather, remediation measures such as cement treatment or overexcavation and replacement with rock may be necessary in some areas.

Provided the structures will be supported as described above, the following parameters may be used for design of the new foundations:

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 300 pcf
- Coefficient of friction — 0.40

A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. The passive earth pressure and coefficient of friction values include a safety factor of 1.5. With structural loading as expected, total settlement in the range of one inch is anticipated, with differential settlement of about one-half inch. Most of the anticipated settlement should occur during construction as dead loads are applied.

Seismic Design

The 2018 International Building Code (2018 IBC) recognizes the most recent edition of the Minimum Design Loads for Buildings and Other Structures manual (ASCE 7-16) for seismic design, specifically with respect to earthquake loads. Based on the soil conditions encountered at the test pit and boring locations, the parameters and values provided below are recommended for seismic design per the 2018 IBC.

Parameter	Value
Site Class	C*
Mapped short period spectral response acceleration, S_S (g)	1.098
Mapped 1-second period spectral response acceleration, S_1 (g)	0.39
Short period site coefficient, F_a	1.2
Long period site coefficient, F_v	1.5
Adjusted short period spectral response acceleration, S_{MS} (g)	1.317
Adjusted 1-second period spectral response acceleration, S_{M1} (g)	0.585
Design short period spectral response acceleration, S_{DS} (g)	0.878
Design 1-second period spectral response acceleration, S_{D1} (g)	0.39

* *Assumes very dense soil conditions, encountered to a maximum depth of 46.5 feet bgs during the field exploration, remain very dense to at least 100 feet bgs. Based on our experience with the project geologic setting (glacial till) across the Puget Sound region, soil conditions are likely consistent with this assumption.*

Liquefaction

Liquefaction is a phenomenon that can occur within a soil profile as a result of an intense ground shaking or loading condition. Most commonly, liquefaction is caused by ground shaking during an earthquake. Sand or silt soil profiles that are loose, cohesionless, and present below the groundwater table are most susceptible to liquefaction. During the ground shaking, the soil contracts, and porewater pressure increases. The increased porewater pressure occurs quickly and without sufficient time to dissipate, resulting in water flowing upward to the ground surface and a liquefied soil condition. Soil in a liquefied condition possesses very little shear strength in comparison to the drained condition, which can result in a loss of foundation support for structures.

In our opinion, the liquefaction potential for the site should be considered low. The soil composition, relative density, and the absence of an established shallow groundwater table are the primary bases for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed structures should be supported on firm and unyielding subgrades. Unstable or yielding subgrade areas should be recompacted or overexcavated and replaced with suitable structural fill prior to slab construction.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below each slab. The free-draining material should have a fines content of 5 percent or less (percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed per manufacturer specifications.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters may be used for design:

- Active earth pressure (unrestrained condition) — 35 pcf (equivalent fluid)
- At-rest earth pressure (restrained condition) — 55 pcf
- Traffic surcharge* (passenger vehicles) — 70 psf (rectangular distribution)
- Passive earth pressure — 300 pcf (equivalent fluid)
- Coefficient of friction — 0.40
- Seismic surcharge — 8H psf**

* *Where applicable.*
** *Where H equals the retained height (in feet).*

The above passive earth pressure and coefficient of friction values include a safety factor of 1.5 and are based on a level backfill condition and level grade at the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other relevant loads should be included in the retaining wall design.

Retaining walls should be backfilled with free-draining material that extends along with the height of the wall and a distance of at least 18 inches behind the wall. The upper 12 inches of the wall backfill may consist of less permeable soil if desired. A sheet drain may be considered instead of free-draining backfill. A perforated drainpipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 4. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Based on our field observations, groundwater seepage should be anticipated within site excavations, particularly utility and stormwater detention excavations. Temporary measures to control surface water runoff and groundwater seepage during construction will be critical to minimizing the potential for on-site soils to degrade. ESNW should be consulted during preliminary grading to identify areas of seepage and provide recommendations to reduce the potential for seepage-related instability.

Finish grades must be designed to direct surface drain water away from structures and slopes. Water must not be allowed to pond adjacent to structures or slopes. Grades adjacent to buildings should be sloped away from the buildings at a gradient of either at least 2 percent for a horizontal distance of 10 feet or the maximum allowed by adjacent structures. In our opinion, foundation drains should be installed along building perimeter footings. A typical foundation drain detail is provided on Plate 5.

Infiltration Evaluation

As indicated in the *Subsurface* section of this report, the native soil encountered during our fieldwork is generally considered to be low permeability. Additionally, the site is generally moderately sloped, and stability of proposed retaining walls and slopes could be negatively impacted by concentrated stormwater infiltration. From a geotechnical standpoint, stormwater infiltration on the subject site should be considered infeasible due to the slope gradients on site, and the relative low permeability of the site soil.

Stormwater Vault Design

We understand a stormwater vault will be constructed to manage stormwater. Interflow groundwater seepage into the vault excavation should be anticipated, particularly if completed during the wet season. The vault foundations should be supported on dense native soil or crushed rock placed on dense native soil. Final stormwater vault designs must incorporate adequate buffer space from property boundaries such that temporary excavations to construct the vault structure can be successfully completed. Perimeter drains should be installed around the vault and conveyed to an approved discharge point.

The following parameters can be used for stormwater vault design:

• Allowable soil bearing capacity (dense native soil)	5,000 psf
• Active earth pressure (unrestrained)	35 pcf
• Active earth pressure (unrestrained, hydrostatic)	80 pcf
• At-rest earth pressure (restrained)	55 pcf
• At-rest earth pressure (restrained, hydrostatic)	100 pcf
• Coefficient of friction	0.40
• Passive earth pressure	300 pcf
• Seismic Surcharge	8H*

* *Where H equals the retained height.*

The vault walls should be backfilled with free-draining material or suitable sheet drainage that extends along the height of the walls. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the wall and connected to an approved discharge location. If the elevation of the vault bottom is such that gravity flow to an outlet is not possible, the portion of the vault below the drain should be designed to include hydrostatic pressure. Design values accounting for hydrostatic pressure are included above. The above passive earth pressure and coefficient of friction values include a safety factor of 1.5.

ESNW should observe grading operations for the vault and the subgrade conditions prior to concrete forming and pouring to confirm conditions are as anticipated, and to provide supplemental recommendations as necessary. Additionally, ESNW should be contacted to review final vault designs to confirm that appropriate geotechnical parameters have been incorporated.

Vault backfill should be placed and compacted in accordance with the recommendations provided in the *Structural Fill* section of this report.

Preliminary Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proofrolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications previously detailed in this report. Soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions will require remedial measures, such as overexcavation and/or placement of thicker crushed rock or structural fill sections, prior to pavement.

We anticipate new pavement sections will be subjected primarily to passenger vehicle traffic. For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

- A minimum of two inches of hot-mix asphalt (HMA) placed over four inches of crushed rock base (CRB).

- A minimum of two inches of HMA placed over three inches of asphalt-treated base (ATB).

Heavier traffic areas generally require thicker pavement sections depending on site usage, pavement life expectancy, and site traffic. For preliminary design purposes, the following pavement sections for occasional truck traffic and access roadways may be considered:

- Three inches of HMA placed over six inches of CRB, or;

- Three inches of HMA placed over four and one-half inches of ATB.

The HMA, ATB, and CRB materials should conform to WSDOT and/or the City of Marysville specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557. Final pavement design recommendations, including recommendations for heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the City may supersede the recommendations provided in this report.

If an inverted crown will be used for roadway surfaces, drainage measures should be included in the design to prevent accumulation of water in the subgrade adjacent to catch basins. Such measures may consist of finger drains extending from the catch basins.

Utility Support and Trench Backfill

In our opinion, the on-site soil will generally be suitable for support of utilities. However, remedial measures may be necessary in some areas to provide support for utilities, such as overexcavation and replacement with structural fill and/or placement of geotextile fabric. Groundwater seepage may be encountered within utility excavations, and caving of trench walls may occur where groundwater or unsuitable fill are encountered. Depending on the time of year and conditions encountered, dewatering and/or temporary trench shoring may be necessary during utility excavation and installation.

The on-site soil may not be suitable for use as structural backfill throughout utility trench excavations unless the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. Moisture conditioning of the soil may be necessary at some locations prior to use as structural fill. Each section of the utility lines must be adequately supported in the bedding material. Utility trench backfill should be placed and compacted to the structural fill specifications previously detailed in this report or to the applicable specifications of the presiding jurisdiction.

LIMITATIONS

This study has been prepared for the exclusive use of Keystone Land, LLC and its representatives. The recommendations and conclusions provided in this study are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. No warranty, express or implied, is made. Variations in the subsurface conditions observed at the test locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this study if variations are encountered.

Additional Services

ESNW should have an opportunity to review the final design with respect to the geotechnical recommendations provided in this report. ESNW should also be retained to provide testing and consultation services during construction.

REFERENCES

The following documents were reviewed as part of the preparation of this study:

- Preliminary Road and Grading, prepared by Solid Ground Engineering, dated December 5, 2023

- Geologic Map of the Lake Stevens Quadrangle, Snohomish County, Washington, prepared by James P. Minard, dated 1983

- Chapter 22E.10 Article IV – Geologic Hazard Areas, provided the City of Marysville, updated September 26, 2023

- Stormwater Management Manual for Western Washington, adopted by the City of Marysville, dated 2019

- WSS, provided by the USDA, Natural Resources Conservation Service

Reference:
Snohomish County, Washington
OpenStreetMap.org

NORTH

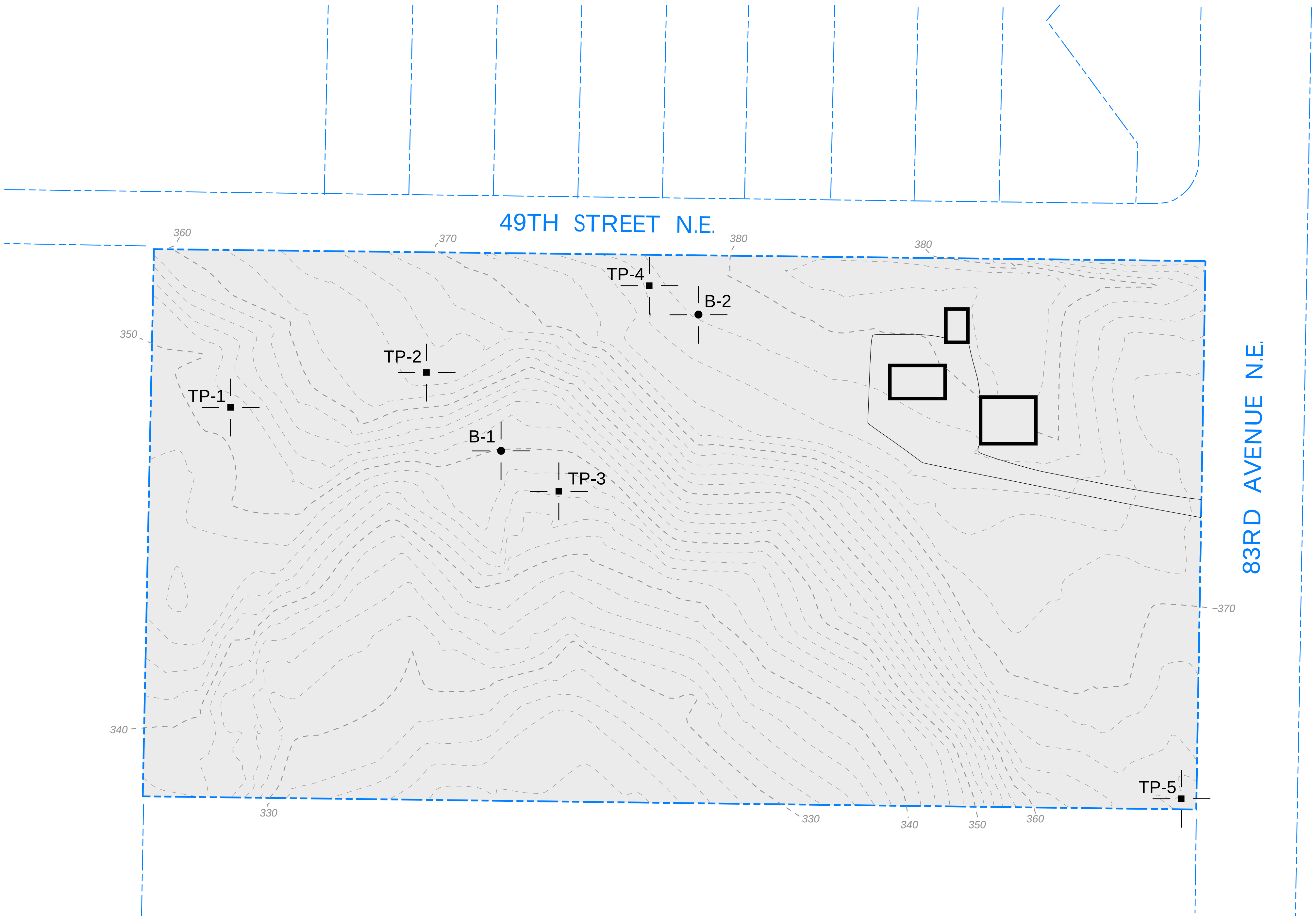
Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Taylor 83rd
Marysville, Washington

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Drawn MRS	Date 11/02/2023	Proj. No. 7386.01
Checked SES	Date Nov. 2023	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-7386.01, Oct. 2023

B-1 — Approximate Location of ' ESNW Boring, Proj. No. ES-7386.01, Oct. 2023

Subject Site

Existing Building

NORTH

0 50 100 200

1"=100'

Scale in Feet

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

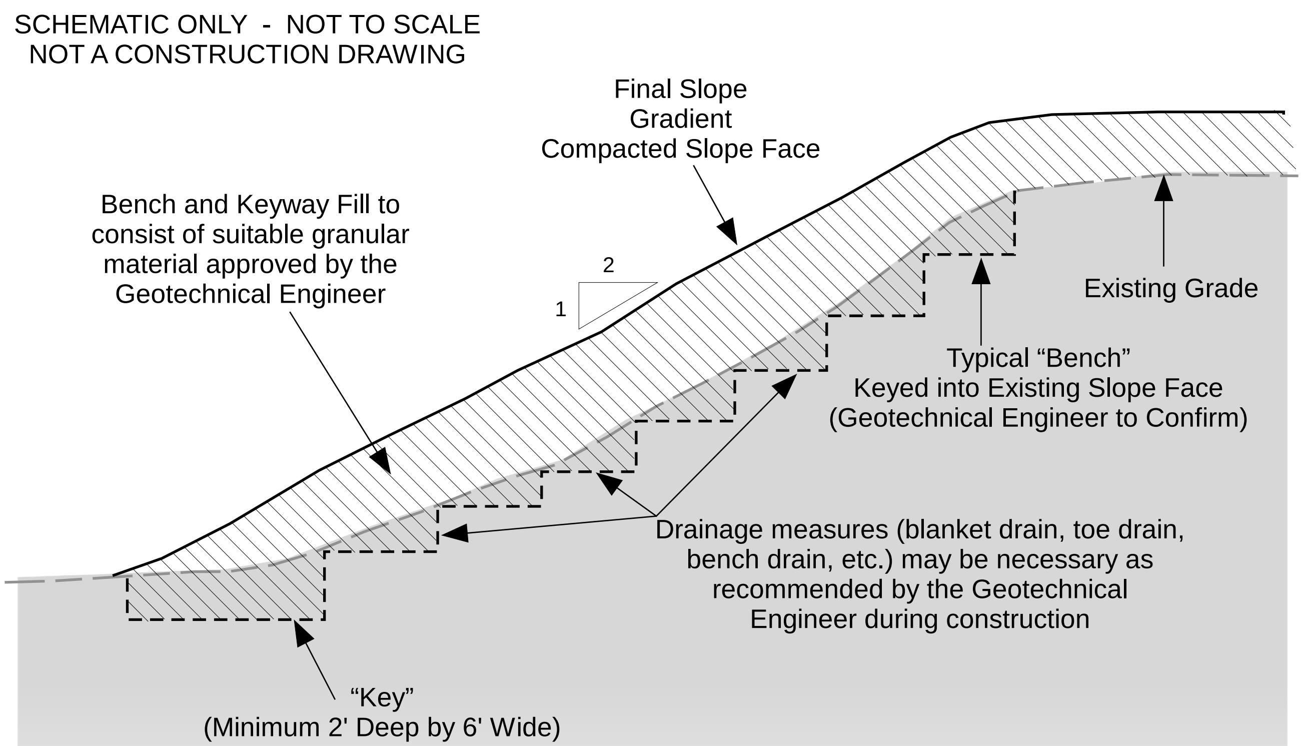
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Subsurface Exploration Plan
Taylor 83rd
Marysville, Washington

Earth Solutions NWLLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Earth Solutions NWLLC

Drawn	MRS
Checked	SES
Date	11/02/2023
Proj. No.	7386.01
Plate	2



NOTES:

- Slope should be stripped of topsoil and unsuitable materials prior to excavating Keyway or benches.
- Benches will typically be equal to a bulldozer blade width of approximately 8 feet but shall be at least 4 feet.
- Final slope gradient should be 2H : 1V.
- Final slope face should be densified by over-building with compacted fill and trimming back to shape or by compaction with a bulldozer or vibratory drum roller.
- Planting or hydroseeding slope face with a rapid growth deep-rooted vegetative mat will reduce erosion potential of slope area.
- Use of pegged-in-place jute matting or geotechnical fabric will help maintain the seed and mulch in place until the root system has an opportunity to germinate.
- Structural fill should be placed in thin loose lifts not exceeding 12 inches in thickness. Each lift should be compacted to no less than the degree specified in the "Site Preparation and Earthwork" section of this report. No additional lift should be placed until compaction is achieved.

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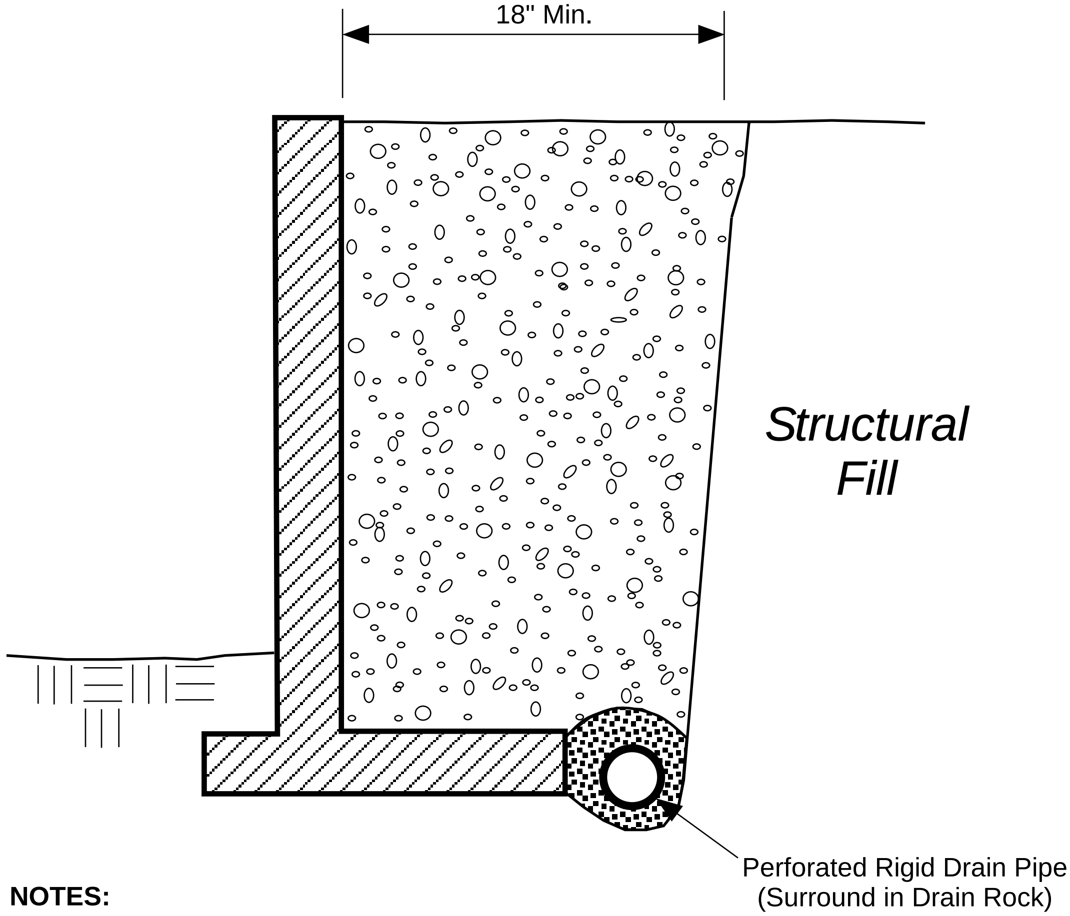
Slope Fill Detail
Taylor 83rd
Marysville, Washington

Drawn MRS	Date 11/06/2023	Proj. No. 7386.01
Checked SES	Date Nov. 2023	Plate 3



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free-draining Structural Backfill

1-inch Drain Rock

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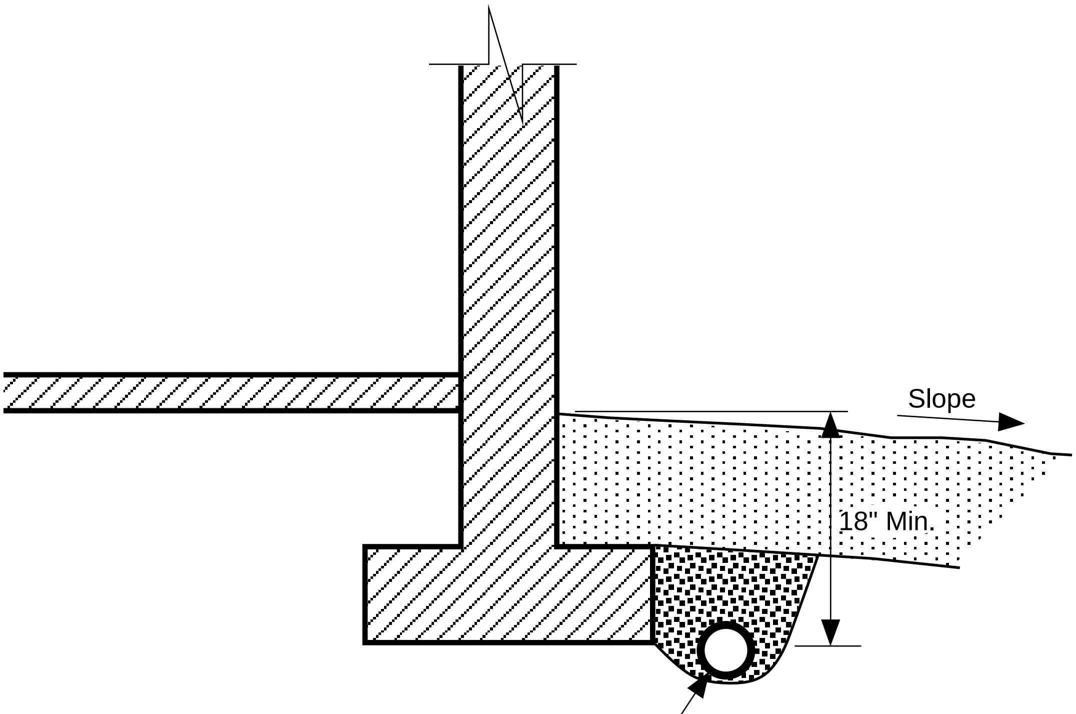
Retaining Wall Drainage Detail
Taylor 83rd
Marysville, Washington

Drawn MRS	Date 11/06/2023	Proj. No. 7386.01
Checked SES	Date Nov. 2023	Plate 4



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

LEGEND:

(dotted pattern)	Surface Seal: native soil or other low-permeability material.
(dense dotted pattern)	1-inch Drain Rock

SCHEMATIC ONLY - NOT TO SCALE
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Footing Drain Detail
Taylor 83rd
Marysville, Washington

Drawn MRS	Date 11/06/2023	Proj. No. 7386.01
Checked SES	Date Nov. 2023	Plate 5

Appendix A

Subsurface Exploration Logs

ES-7386.01

Subsurface conditions at the subject site were explored on October 2, 2023 and October 5, 2023. Five test pits were excavated and two borings were advanced using equipment and operators retained by ESNW. The approximate locations of the explorations are illustrated on Plate 2 of this study. The boring and test pit logs are provided in this Appendix. The maximum exploration depth was approximately 46.5 feet bgs.

The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

Major Divisions			Group Symbol	Group Name
Coarse-Grained Soils - More Than 50% Retained on No. 200 Sieve	Gravels - More Than 50% of Coarse Fraction Retained on No. 4 Sieve	< 5% Fines	GW	Well-graded gravel with or without sand, little to no fines
			GP	Poorly graded gravel with or without sand, little to no fines
		> 12% Fines	GM	Silty gravel with or without sand
			GC	Clayey gravel with or without sand
	Sands - 50% or More of Coarse Fraction Passes No. 4 Sieve	< 5% Fines	SW	Well-graded sand with or without gravel, little to no fines
			SP	Poorly graded sand with or without gravel, little to no fines
		> 12% Fines	SM	Silty sand with or without gravel
			SC	Clayey sand with or without gravel
Fine-Grained Soils - 50% or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less Than 50		ML	Silt with or without sand or gravel; sandy or gravelly silt
			CL	Clay of low to medium plasticity; lean clay with or without sand or gravel; sandy or gravelly lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt with or without sand or gravel; sandy or gravelly elastic silt
			CH	Clay of high plasticity; fat clay with or without sand or gravel; sandy or gravelly fat clay
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils
Fill			FILL	Made Ground

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch

Damp - Perceptible moisture, likely below optimum MC

Moist - Damp but no visible water, likely at/near optimum MC

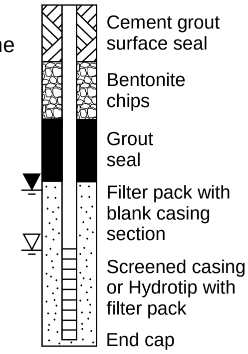
Wet - Water visible but not free draining, likely above optimum MC

Saturated/Water Bearing - Visible free water, typically below groundwater table

Symbols

ATD = At time of drilling

Static water level (date)



Terms Describing Relative Density and Consistency

Coarse-Grained Soils:

Density	SPT blows/foot
Very Loose	< 4
Loose	4 to 9
Medium Dense	10 to 29
Dense	30 to 49
Very Dense	≥ 50

Fine-Grained Soils:

Consistency	SPT blows/foot
Very Soft	< 2
Soft	2 to 3
Medium Stiff	4 to 7
Stiff	8 to 14
Very Stiff	15 to 29
Hard	≥ 30

Test Symbols & Units

Fines = Fines Content (%)

MC = Moisture Content (%)

DD = Dry Density (pcf)

Str = Shear Strength (tsf)

PID = Photoionization Detector (ppm)

OC = Organic Content (%)

CEC = Cation Exchange Capacity (meq/100 g)

LL = Liquid Limit (%)

PL = Plastic Limit (%)

PI = Plasticity Index (%)

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

Modifier Definitions

Percentage by Weight (Approx.)	Modifier
< 5	Trace (sand, silt, clay, gravel)
5 to 14	Slightly (sandy, silty, clayey, gravelly)
15 to 29	Sandy, silty, clayey, gravelly
≥ 30	Very (sandy, silty, clayey, gravelly)

Classifications of soils in this geotechnical report and as shown on the exploration logs are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D2487 and D2488 were used as an identification guide for the Unified Soil Classification System.

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EXPLORATION LOG KEY

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

BORING NUMBER B-1

PROJECT NUMBER ES-7386.01
PROJECT NAME Taylor 83rd
DATE STARTED 10/5/23 **COMPLETED** 10/5/23
GROUND ELEVATION
DRILLING CONTRACTOR Geologic Drill Partners
LATITUDE 48.04009 **LONGITUDE** -122.12093
LOGGED BY SES **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF DRILLING
SURFACE CONDITIONS Duff
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SM		Brown silty SAND, dense, damp
	SS	67	18-25-31 (56)	MC = 9.1			
							-becomes gray
5	SS	56	5-10-14 (24)	MC = 13.9			-becomes medium dense, moist
							-becomes dense to very dense
	SS	56	7-21-26 (47)	MC = 9.9			
10	SS	89	12-26-27 (53)	MC = 10.2			
15							-becomes dense
	SS	78	13-17-20 (37)	MC = 16.4			
20						20.0	

(Continued Next Page)

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Branch Office: Pasco, WA

BORING NUMBER B-1

PROJECT NUMBER ES-7386.01		**PROJECT NAME** Taylor 83rd	
DATE STARTED 10/5/23	**COMPLETED** 10/5/23	**GROUND ELEVATION**	
DRILLING CONTRACTOR Geologic Drill Partners		**LATITUDE** 48.04009	**LONGITUDE** -122.12093
LOGGED BY SES	**CHECKED BY** HTW	**GROUND WATER LEVEL:**	
NOTES		AT TIME OF DRILLING	
SURFACE CONDITIONS Duff		**AFTER DRILLING**	

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20	SS	78	13-7-12 (19)	MC = 13.0	SM		Gray silty SAND, medium dense, damp
							-increasing sand
							-becomes moist
25	SS	78	7-9-11 (20)	MC = 14.1			
30	SS	78	5-5-5 (10)	MC = 13.2 Fines = 43.0			[USDA Classification: gravelly LOAM]
35	SS	100	4-5-10 (15)	MC = 13.2			
40						40.0	

(Continued Next Page)

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Branch Office: Pasco, WA

BORING NUMBER B-1

PROJECT NUMBER ES-7386.01 **PROJECT NAME** Taylor 83rd
DATE STARTED 10/5/23 **COMPLETED** 10/5/23 **GROUND ELEVATION**
DRILLING CONTRACTOR Geologic Drill Partners **LATITUDE** 48.04009 **LONGITUDE** -122.12093
LOGGED BY SES **CHECKED BY** HTW **GROUND WATER LEVEL:**
NOTES **AT TIME OF DRILLING**
SURFACE CONDITIONS Duff **AFTER DRILLING**

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40	SS	100	23-50/6"	MC = 12.4	SM		Gray silty SAND, very dense, moist
45	SS	80	28-40-50/3"	MC = 10.5		46.5	

Boring terminated at 46.5 feet below existing grade. No groundwater encountered during drilling. Boring backfilled with bentonite.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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Redmond, WA 98052
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Branch Office: Pasco, WA

BORING NUMBER B-2

PROJECT NUMBER ES-7386.01
PROJECT NAME Taylor 83rd
DATE STARTED 10/5/23 **COMPLETED** 10/5/23
GROUND ELEVATION
DRILLING CONTRACTOR Geologic Drill Partners
LATITUDE 48.03983 **LONGITUDE** -122.12118
LOGGED BY SES **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF DRILLING
SURFACE CONDITIONS Duff
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					SM		Brown silty SAND, dense, damp
	SS	89	6-15-19 (34)	MC = 8.5			
5							-becomes medium dense
	SS	67	2-7-20 (27)	MC = 13.5		6.5	
					ML		Dark brown sandy SILT, loose, wet
	SS	100	2-4-4 (8)	MC = 16.4			
10							[USDA Classification: slightly gravelly LOAM]
	SS	100	3-6-6 (12)	MC = 19.6 Fines = 60.6			-becomes gray
15	SS	100	5-5-3 (8)	MC = 14.4		18.0	
					SM		Gray silty SAND, dense, moist to wet -groundwater seepage
20							

(Continued Next Page)

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Redmond, WA 98052
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Branch Office: Pasco, WA

BORING NUMBER B-2

PROJECT NUMBER ES-7386.01
PROJECT NAME Taylor 83rd
DATE STARTED 10/5/23 **COMPLETED** 10/5/23
GROUND ELEVATION
DRILLING CONTRACTOR Geologic Drill Partners
LATITUDE 48.03983 **LONGITUDE** -122.12118
LOGGED BY SES **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF DRILLING
SURFACE CONDITIONS Duff
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20	SS	67	17-22-22 (44)	MC = 12.7	SM		Gray silty SAND, dense, moist to wet *(continued)*
							-becomes very dense
25	SS	100	50/6"	MC = 16.1			
30	SS	100	50/5"	MC = 12.0		30.5	

Boring terminated at 30.5 feet below existing grade. Groundwater seepage encountered at 18.0 feet during drilling. Boring backfilled with bentonite.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-7386.01
PROJECT NAME Taylor 83rd
DATE STARTED 10/2/23 **COMPLETED** 10/2/23
GROUND ELEVATION
EXCAVATION CONTRACTOR NW Excavating
LATITUDE 48.03987 **LONGITUDE** -122.12192
LOGGED BY SES **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Duff
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	Dark brown TOPSOIL, root intrusions to 2'
			SM		Brown silty SAND, medium dense, moist
		MC = 8.5			
					-becomes dense
5					-becomes gray, increasing sand
		MC = 10.7 Fines = 47.1			[USDA Classification: slightly gravelly LOAM]
10		MC = 9.0		10.0	

Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-2

PROJECT NUMBER ES-7386.01
PROJECT NAME Taylor 83rd
DATE STARTED 10/2/23 **COMPLETED** 10/2/23
GROUND ELEVATION
EXCAVATION CONTRACTOR NW Excavating
LATITUDE 48.04008 **LONGITUDE** -122.12145
LOGGED BY SES **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Duff
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	Dark brown TOPSOIL, shallow root intrusions
		MC = 8.6	SM		Brown silty SAND, medium dense, moist
5					-becomes gray, dense
					-becomes very dense
10		MC = 9.9		10.0	

Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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TEST PIT NUMBER TP-3

PROJECT NUMBER ES-7386.01 **PROJECT NAME** Taylor 83rd
DATE STARTED 10/2/23 **COMPLETED** 10/2/23 **GROUND ELEVATION**
EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 48.03979 **LONGITUDE** -122.12097
LOGGED BY SES **CHECKED BY** HTW **GROUND WATER LEVEL:**
NOTES ∇ **AT TIME OF EXCAVATION**
SURFACE CONDITIONS Duff on slope **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL
		MC = 29.2 Fines = 38.8	SM		Dark brown silty SAND, loose, wet -light groundwater seepage at 2' [USDA Classification: gravelly LOAM]
5		MC = 15.8			-becomes medium dense, moist
		MC = 13.0		7.0	-becomes dense, weakly cemented

Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 2.0 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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TEST PIT NUMBER TP-4

PROJECT NUMBER ES-7386.01
PROJECT NAME Taylor 83rd
DATE STARTED 10/2/23 **COMPLETED** 10/2/23
GROUND ELEVATION
EXCAVATION CONTRACTOR NW Excavating
LATITUDE 48.04012 **LONGITUDE** -122.12098
LOGGED BY SES **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Duff
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0			TPSL		0.5	Dark brown TOPSOIL, minimal root intrusions
		MC = 7.0	SM			Brown silty SAND, medium dense, damp
5						-becomes dense, moist, weakly cemented
		MC = 9.6			9.0	

Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

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TEST PIT NUMBER TP-5

PROJECT NUMBER ES-7386.01 **PROJECT NAME** Taylor 83rd
DATE STARTED 10/2/23 **COMPLETED** 10/2/23 **GROUND ELEVATION**
EXCAVATION CONTRACTOR NW Excavating **LATITUDE** 48.03944 **LONGITUDE** -122.11980
LOGGED BY SES **CHECKED BY** HTW **GROUND WATER LEVEL:**
NOTES **AT TIME OF EXCAVATION**
SURFACE CONDITIONS **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, root intrusions to 2'
		MC = 9.5 Fines = 16.2	SM		Brown silty SAND with gravel, medium dense, moist [USDA Classification: gravelly loamy coarse SAND]
5		MC = 10.5			-becomes gray, dense -weakly cemented
10		MC = 10.4		10.0	

Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Appendix B

Laboratory Test Results

ES-7386.01

Earth Solutions NW LLC
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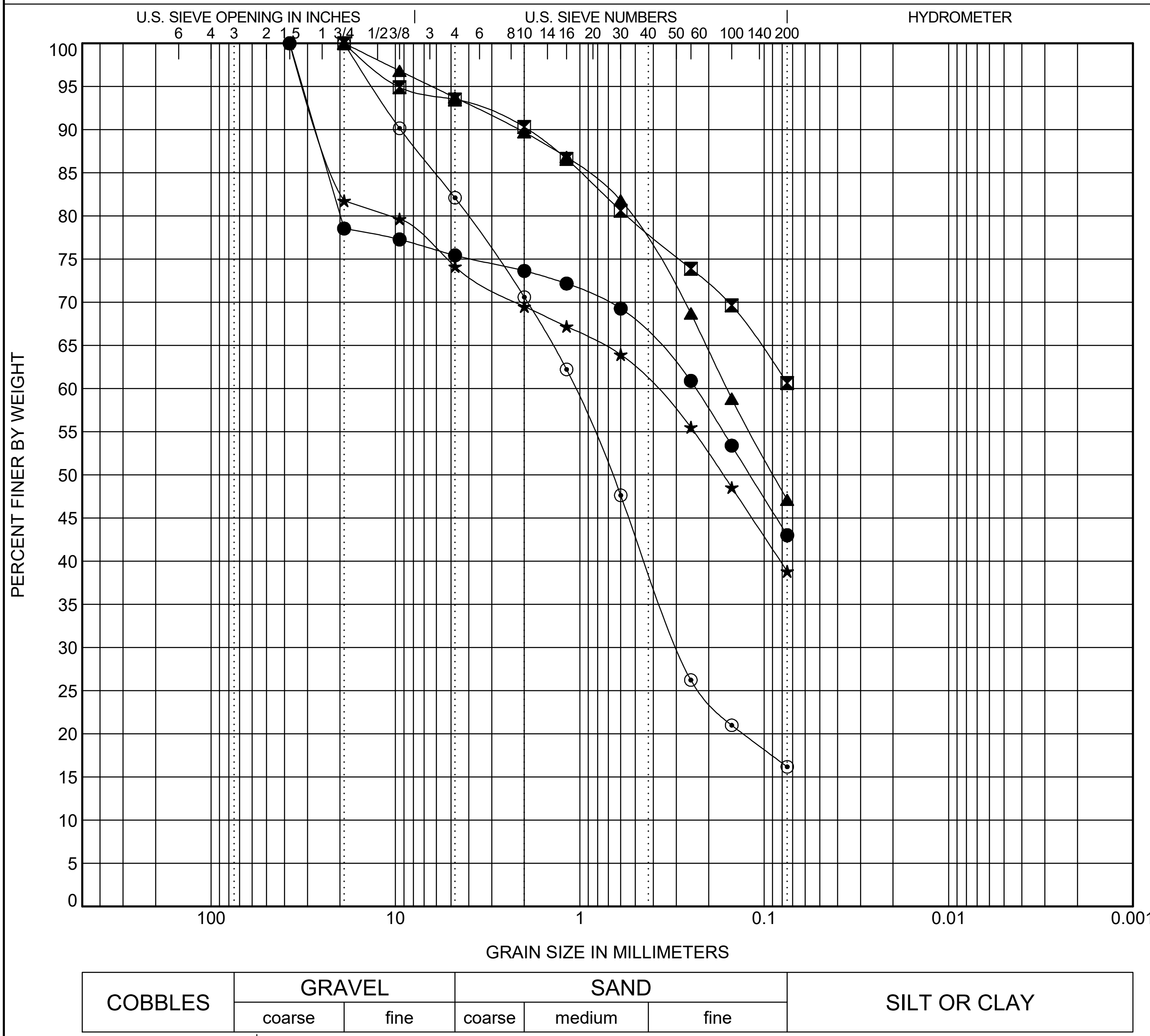
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-7386.01 **PROJECT NAME** Taylor 83rd



Specimen Identification		Classification	Cc	Cu
● B-01	30.00ft.	**USDA: Gray Gravelly Loam. USCS: SM with Gravel.**		
⧗ B-02	10.00ft.	**USDA: Dk Brown Slightly Gravelly Loam. USCS: Sandy ML.**		
▲ TP-01	6.00ft.	**USDA: Gray Slightly Gravelly Loam. USCS: SM.**		
★ TP-03	2.00ft.	**USDA: Dk Brown Gravelly Loam. USCS: SM with Gravel.**		
⊙ TP-05	2.00ft.	**USDA: Brown Gravelly Loamy Coarse Sand. USCS: SM with Gravel.**		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● B-01	30.0ft.	37.5	0.235						43.0	
⧗ B-02	10.0ft.	19							60.6	
▲ TP-01	6.0ft.	19	0.159						47.1	
★ TP-03	2.0ft.	37.5	0.399						38.8	
⊙ TP-05	2.0ft.	19	1.065	0.292					16.2	