Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
6236 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

ES-9013

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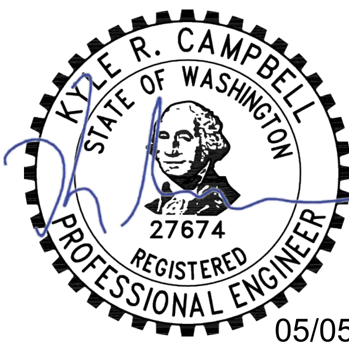
PREPARED FOR

ANTHONY ROJAS

May 5, 2023

Stephen H. Avril
Project Manager



05/05/2023

Kyle R. Campbell, P.E.
Senior 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 not 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 Not 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 not 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 not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

May 5, 2023
ES-9013

Anthony Rojas
6236 East Mercer Way
Mercer Island, Washington 98040

Dear Anthony:

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, 6236 East Mercer Way, Mercer Island, Washington".

In general, the native soil underlying the site consists of glacial till deposits based on our observation of the subsurface conditions. In our opinion, the proposed lakeside improvements can be supported on conventional continuous and spread footing foundations bearing on competent native soils, competent existing fill, or new structural fill. We anticipate suitable bearing soils will be encountered at depths below three feet. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with a suitable structural fill material will be necessary.

Groundwater seepage was observed during our site investigation (March 2023). The groundwater seepage was observed at test location B-2 at a depth of 15 feet. The client should anticipate perched groundwater seepage on the site. The maximum depth-of-exploration was 18.5 feet below the existing surface elevations.

Recommendations for foundation design, site preparation, drainage, and other pertinent recommendations are provided in this study. We appreciate the opportunity to be of service to you on this project. If you have questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Stephen H. Avril
Project Manager

Table of Contents

ES-9013

Table of Contents

Cont'd

ES-9013

GEOTECHNICAL ENGINEERING STUDY
6236 EAST MERCER WAY
MERCER ISLAND, WASHINGTON

ES-9013

INTRODUCTION

General

The property is located at the terminus of a shared driveway on the east side of Easter Mercer Way, and south of Southeast 61st Place in Mercer Island, Washington. The site is roughly rectangular in shape and is currently developed with a single-family residence. The site is located on the shore of Lake Washington.

Site redevelopment plans include the demolition of the existing landscape structures (retaining walls) that occupy the east side of the subject site along the shoreline of Lake Washington, installation of new cast-in-place retaining walls, and associated landscape improvements.

The purpose of this study was to explore subsurface conditions across the site and develop geotechnical recommendations for the proposed redevelopment. Our scope of services for completing this geotechnical engineering study included the following:

- Site exploration consisting of hollow-stem borings and hand-auger boring advanced across the property;
- Laboratory testing of soil samples obtained during subsurface exploration;
- Engineering analyses of data gathered during site exploration, and;
- Preparation of this report.

The following documents/maps were reviewed as part of our report preparation:

- Geologic Map of Washington, Northwest Quadrant, Dragovich, Logan, et al, 2002;
- Washington State USDA Soil Conservation Survey (SCS);
- Topographic Survey, ALL Land Surveying, LLC, Anthony Rojas, Dated April 10, 2023, and;
- Client Provided Site Plan.

Project Description

We understand the east side of the yard on the subject property will be redeveloped with new lake-side hardscape features following the demolition of the existing retaining walls that occupied the subject site at the time of this report production. New engineered retaining walls are planned in order to create a “terraced” landscape area which descends towards the lakeshore and docks similar to what was in-place during this report production.

Given the topographic change in the lake-side area of the yard we anticipate grading activities may involve cuts, walls, and fills of up to five feet to establish the final design grades.

The subject site sits at the toe of a slope complex which descends from East Mercer Way towards the east, and the Lake Washington shoreline. The residence consists of daylit construction, where the area around the house descends from the toe of the shared driveway slope elevation, approximately ten feet to the backyard elevation. The project area consists of the east yard on the property. The yard is relatively flat in nature where grades are at the same elevation as the lower level of the daylit house. Grades then descend slightly towards the Lake Washington surface elevation to the east of the yard, where the slope to the lake is broken by a series of two retaining walls with total elevation change on the order of about 12 feet.

Review of Mercer Island geologic hazard mapping reveals the site possesses potential landslide hazards, seismic hazard (liquefaction) near the shoreline, and protected slopes on the north and south sides of the docks on the lakeshore. The site redevelopment requires a landslide hazard assessment, and ESNW will provide both the landslide hazard assessment and liquefaction hazard assessment.

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

SITE CONDITIONS

Surface

The property is located at the terminus of a shared driveway on the east side of Easter Mercer Way, and south of Southeast 61st Place in Mercer Island, Washington. The site is roughly rectangular in shape and is currently developed with a single-family residence. The site is located on the shore of Lake Washington.

The site is developed with a single-family residence and general landscape areas. The site is roughly flat in nature across the yard located on the east side of the existing residence, then descends about 12 feet towards the Lake Washington elevation on the east side of the site. The slope to the lake is broken by two retaining walls, and the residential structure serves to retain the hillside above the project area.

Subsurface

ESNW representatives observed, logged and sampled one hand-auger boring and two hollow-stem borings using a drill rig and operators contracted by ESNW across accessible portions of the site. The hand-auger borings were advanced using hand tools, and advanced to a maximum depth of four feet, and the hollow-stem auger borings were advanced to a maximum of 18.5 feet. The approximate location of the borings is depicted on the Subsurface Exploration Plan (Plate 2). Please refer to the soil logs provided in Appendix A for a more detailed description of the subsurface conditions.

Topsoil

Topsoil was encountered at the test locations on the order of seven to eight inches in thickness. Where topsoil is encountered during site grading activities, it is not suitable for use as structural fill nor should it be mixed with material to be used as structural fill. Topsoil or otherwise unsuitable material can be used in landscaping areas if desired.

Fill

Fill soil was not encountered at test locations. Fill soil may likely be encountered surrounding the existing buildings, roads, and utility alignments, and will have to be evaluated during construction for use as structural fill.

Native Soil

Underlying the topsoil at the test locations, native soils consisting of silty sand with gravel (Unified Soil Classification, SM) and poorly graded sand with silt (SP-SM) were encountered. The native soils were observed in a medium dense grading to very dense condition. These soil types were observed extending to the maximum exploration depth of 18.5 feet below existing grades. The soil density was observed to increase with depth.

Geologic Setting

Based on our review of the geologic maps, the site is located in an area comprised of Lake Deposits (Ql) along the shoreline, and Pre-Olympia glacial till deposits (Qpogt) upslope from the shoreline. The referenced SCS soil survey describes Kitsap silt loam, 15 to 30 percent slopes (KpD) series soils for the site and surrounding area. Kitsap silt loam series soils are typified by lacustrine deposits sometimes with a minor amount of volcanic ash deposits. The native soil observed at the test locations are consistent with glacial till deposits, and are in-line with the geologic map descriptions for the area.

Groundwater

Groundwater seepage was observed at test location B-2 at a depth of 15 feet during the fieldwork (March 2023). ESNW classified the seepage as perched in a layer of soil which has less fines than the material sited above. Seepage should be expected in deeper excavations at this site; particularly during the winter, spring, and early summer months. Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the wetter, winter months. However, the groundwater table was not observed on the subject site.

ENVIRONMENTALLY CRITICAL AREA ASSESSMENT

As part of our report preparation, we assessed the site for potential critical areas utilizing the City of Mercer Island geologic hazard maps available on-line. Steep slopes are present on the west side of the property are not proposed to be modified, and the daylit residence which is sited to the west of the project area provides slope support for the slopes located to the west of the residence via engineered foundations and stem walls. The existing retaining walls at the shoreline are on the order of three and one-half feet in height and are terraced and separated by 20 feet. The proposed re-grading and wall construction on the east side of the site will roughly mimic the current site layout with wall heights similar to those in-place during this report production. As such, the stability characteristics of the site grades/slopes will not be drastically modified by the demolition of the existing walls and replacement with new engineered retaining walls.

The City of Mercer Island municipal code requires the following for a critical areas study:

1. *Disclosure of the presence of critical areas, including a delineation and type or category of critical area, on the development proposal site and any mapped or identifiable critical areas on or off site within the distance equal to the largest potential required buffer applicable to the development proposal area on the applicant's property;*

The entirety of the subject site and surrounding area/neighborhoods are described as possessing a Landslide Hazard Area (known or suspect), Landslide and Mass Wasting Deposits, Slopes 15 percent and higher, Seismic Hazard Area (Known or Suspect), and a High Potential for Seismically Induced Ground Failures.

The slopes on the west side of the project area located on the east side of the existing residence are located along the lake shore where grades descend about 12 feet from the flat back yard area towards Lake Washington surface elevation. Based on our review of the site survey, the steepest section of slopes outside of the existing retaining walls is inclined at about 24 percent. These sections of slope are sited north and south of the existing retaining walls, consist of slopes on the order of 12 feet in height, and are underlain by dense to very dense silty sand with gravel underlain by poorly graded sand with silt in a very dense condition.

Based on the homogenous, and very dense nature of the site underlying the site, lack of groundwater, and fines content of the site soils, it is our opinion that there are no geologic hazards on the subject site. ESNW performed a liquefaction analysis using the subsurface information from the borings. The analysis indicates liquefaction would not occur as a result of the design earthquake. The criteria for landslide hazard is not met in this instance, nor is there a risk of seismically induced settlement or lateral spread affecting the project area.

2. *A topographic and boundary survey;*

Please see Plate 2 which demonstrates topographic information.

3. *A statement specifying the accuracy of the report and all assumptions made and relied upon;*

This report can be relied upon for design of the proposed landscape features in our professional opinion. The report was authored with site-specific information gleaned through subsurface and surface explorations on March 28, 2023.

4. *A description of the methodologies used to conduct the critical area study, including references;*

ESNW representatives were on-site in March of 2023 to obtain subsurface data through excavation and observation of one hand-auger boring and two hollow stem auger borings surrounding the existing residential structure and in the general project area. The borings were advanced to 18.5 feet maximum depth, and terminated in very dense native soil. We also reviewed the geologic maps for the region (referenced previously), and the Web Soil Survey.

5. *A scale map of the development proposal site;*

ESNW has provided a site plan. The subject slope is located on the west side of the residence along the lake shore depicted on Plate 2.

6. *Photographic records of the site before the proposed alteration occurs;*

ESNW has provided as an attachment in Appendix C.

7. *An assessment of the probable effects to critical areas and associated buffers, including impacts caused by the development proposal and associated alterations to the subject property and impacts to other properties and any critical areas or buffers located on them resulting from the development of the site and the proposed development;*

ESNW has analyzed the proposed site re-development from a slope stability standpoint. The planned landscaping and hardscaping will not increase instability on and around the subject site as the planned alterations for the slopes on the east side of the residence will be similar to what is in-place and will be engineered to withstand applicable surcharges, including a seismic surcharge. Additionally, the buffers from the slope on the subject site will remain similar in many respects which will not result in any alteration in the stability characteristics of the slopes on and off-site. The slope stability related to slopes on the west side of the project area will not be affected due to the presence of the house foundation and retaining walls.

8. *A description of mitigation sequencing implementation described in section 19.07.100 including steps taken to avoid and minimize critical areas impacts to the greatest extent feasible;*

In our opinion, as long as best management practices (BMP) are utilized during and after construction for stormwater management and erosion control measures, there will be no impacts to the critical areas on the site.

9. *Detailed studies, as required by this chapter, for individual critical area types in order to ensure critical area protection;*

ESNW has evaluated the slopes on the subject site, and have determined they are stable in their current state. The primary basis for this opinion is the homogony of the geologic deposits within the subsurface and their relative density.

10. *Assessment of potential impacts that may occur on adjacent sites, such as sedimentation or erosion, where applicable; and*

ESNW has evaluated the currently available plan, and there will be no change in the sedimentation or erosion risks on adjacent sites given appropriate BMPs are employed during and after construction. This should consist of grading the site such that there is no net increase in the volume of water running towards the east side of the site. This can be achieved through grading and installation of stormwater features that collect and vector surface water to approved discharge points.

11. *A post-design memorandum prepared by a qualified professional confirming that the proposed improvements comply with the design recommendations.*

ESNW can provide upon request.

It is our opinion that there are no geologic hazards located on the subject site. We base this opinion on the subsurface data collected during our fieldwork, our review of the topographic survey for the subject site, and geologic hazard map. The soils appear to be uniform across the entirety of the subject site. There is no evidence of more permeable soil types (such as sand and clean gravel) sited above the poorly graded sand with silt deposits, which would be cause for concern over soil mobilization in the future on the subject site.

We recommend foundation elements for the new walls be seated in the firm native material, anticipated to be encountered at depths below three feet. Additionally Best Management Practices (BMP) will need to be employed during and after site development. This includes site grading to minimize erosion and soil mobilization, temporary erosion control measures during construction, and permanent vegetation to protect sloped areas from the effects of erosive forces.

DISCUSSION AND RECOMMENDATIONS

General

In our opinion, construction of the proposed structures is feasible from a geotechnical standpoint. The proposed hardscape features can be supported on conventional continuous and spread footing foundations bearing on competent native soils or new structural fill. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with a suitable structural fill material will be necessary. Recommendations for foundation design, site preparation, drainage, and other pertinent geotechnical recommendations are provided in the following sections of this study.

This study has been prepared for the exclusive use of Anthony Rojas and representatives. No warranty, expressed or implied, is made. This study has been prepared in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area.

Site Preparation and Earthwork

Site preparation activities will involve demolition of the existing retaining walls, site clearing and stripping, and implementation of temporary erosion control measures. The primary geotechnical considerations associated with site preparation activities include erosion control installation, subgrade preparation, retaining wall construction, and underground utility installations (where necessary).

Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls (potentially placed over geotextile) can be considered in order to minimize off-site soil tracking and to provide a stable access entrance surface. Erosion control measures should consist of silt fencing placed along the down gradient side of the site as far away from the shoreline as feasible. Soil stockpiles should be covered or otherwise protected to reduce soil erosion. Temporary sedimentation ponds or other approaches for controlling surface water runoff should be in place prior to beginning earthwork activities.

Where encountered, topsoil and organic-rich soil is not suitable for foundation support, nor is it suitable for use as structural fill. Topsoil or organic-rich soil can be used in non-structural areas if desired. Over-stripping of the site, however, should be avoided. A representative of ESNW should observe the initial stripping operations, to provide recommendations for stripping depths based on the soil conditions exposed during stripping.

Structural fill soils placed throughout foundation, slab, and pavement areas should be placed over a firm base. Loose or otherwise unsuitable areas of native soil exposed at subgrade elevations should be compacted to structural fill requirements or overexcavated and replaced with a suitable structural fill material. Where structural fill soils are used to construct foundation subgrade areas, the soil should be compacted to the requirements of structural fill described in the following section. Foundation subgrade areas should be protected from disturbance, construction traffic, and excessive moisture. Where instability develops below structural fill areas, use of a woven geotextile below the structural fill areas may be required. A representative of ESNW should observe structural fill placement in foundation, slab, and pavement areas.

The process of removing existing structures may produce voids where foundations for the existing walls were present. Complete restoration of voids caused by the removal of existing structures must be executed as part of overall subgrade preparation activities. The following guidelines for preparing building subgrade areas should be incorporated into the final design:

- Complete removal of all foundation elements, walls, footing drains, sewer and storm drainage pipes, etc. within the footprint of the existing retaining walls.

- Where voids and related demolition disturbances extend below planned subgrade elevations, restoration of these areas should be completed. Structural fill should be used to restore voids or unstable areas resulting from the removal of existing structural improvements.

- Where pipes for stormwater and sanitary sewer are encountered, they should be plugged and abandoned.

- Recompact, or overexcavate and replace, areas of existing fill, if present, exposed at wall subgrade elevations. ESNW should confirm subgrade conditions and the required level of recompaction, or overexcavation and replacement, during site preparation activities. Overexcavations should extend into competent native soils, and structural fill should be used to restore subgrades areas.

- ESNW should confirm the overall suitability of prepared subgrade areas following site preparation activities.

In-situ Soils

The soils encountered at the test sites have a moderate to high sensitivity to moisture and were generally in a moist condition at the time of the exploration (March 2023). In this respect, the in-situ soils may not be suitable for use as structural fill if the soil moisture content is more than about 3 percent above the optimum level at the time of construction. In general, soils encountered during the site excavations that are excessively over the optimum moisture content will require moisture conditioning prior to placement and compaction. Conversely, soils that are below the optimum moisture content will require moisture conditioning through the addition of water prior to use as structural fill. If the in-situ soils are determined to not be suitable for use as structural fill, then use of a suitable imported soil may be necessary. In our opinion, a contingency should be included in the project budget for exporting unsuitable soil and importing structural fill; or moisture conditioning recommendations can be provided upon request based on field observations during the construction phase of on-site work.

Imported Soils

Imported soil intended for use as structural fill should consist of a well graded granular soil with a moisture content that is at or near 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 defined as the percent passing the #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, and roadway areas. Fills placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas are also considered structural fill. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D-1557). Additionally, more stringent compaction specifications may be required for utility trench backfill zones, depending on the responsible utility district or jurisdiction.

Foundations

Based on the results of our study, the proposed retaining walls can be supported on conventional spread and continuous footings bearing on competent native soils, competent existing fill or new structural fill. Based on the soil conditions encountered at the test sites, competent native soils suitable for support of foundations should be encountered at depths of three feet below existing surface elevations in most areas. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with structural fill, may be necessary.

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

- Allowable soil bearing capacity 2,500 psf
- Passive earth pressure 300 pcf (equivalent fluid)
- Coefficient of friction 0.40

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

Seismic Design Considerations

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 locations, the parameters and values provided below are recommended for seismic design per the 2018 IBC.

Parameter	**Value**
Site Class	D*
Mapped short period spectral response acceleration, S_S (g)	1.448
Mapped 1-second period spectral response acceleration, S_1 (g)	0.502
Short period site coefficient, F_a	1.000
Long period site coefficient, F_v	1.798
Adjusted short period spectral response acceleration, S_{MS} (g)	1.448
Adjusted 1-second period spectral response acceleration, S_{M1} (g)	0.902
Design short period spectral response acceleration, S_{DS} (g)	0.966
Design 1-second period spectral response acceleration, S_{D1} (g)	0.602

* *Assumes very dense soil conditions, encountered to a maximum depth of 18.5 feet bgs during the March 2023 field exploration, remain very dense to at least 100 feet bgs. Based on our experience with the project geologic setting (lacustrine deposits) across the Puget Sound region, soil conditions are likely consistent with this assumption.*

Further discussion between the project structural engineer, the project owner (or their representative), and ESNW may be prudent to determine the possible impacts to the structural design due to increased earthquake load requirements under the 2018 IBC. ESNW can provide additional consulting services to aid with design efforts, including supplementary geotechnical and geophysical investigation, upon request.

Liquefaction is a phenomenon where saturated or loose soil suddenly loses internal strength and behaves as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or another intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered negligible. The absence of a shallow groundwater table and the very dense and homogenous characteristics of the native soil were the primary bases for this opinion.

Retaining Walls

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

• Active earth pressure (yielding condition)	35 pcf (equivalent fluid)
• At-rest earth pressure (restrained condition)	55 pcf
• Traffic surcharge for passenger vehicles (where applicable)	70 psf (rectangular distribution)
• Passive earth pressure	300 pcf (equivalent fluid)
• Coefficient of friction	0.40
• Seismic surcharge (active condition)	8H (where H equals retained height)

Additional surcharge loading from adjacent foundations, sloped backfill, or other loads should be included in the retaining wall design. Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Retaining walls should be backfilled with free draining material that extends along the height of the wall, and a distance of at least 18 inches behind the wall. 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. A typical retaining wall drainage detail is provided on Plate 3.

Drainage

Seepage may be encountered in excavations on the site, particularly during winter, spring, and early summer months. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches and sumps. ESNW should be consulted during preliminary grading to identify areas of seepage and to provide recommendations to reduce the potential for instability related to seepage effects.

Finish grades must slope away from the existing building at an inclination of at least 2 percent for a distance of at ten feet or as adjacent building setbacks allow. In addition, surface water should be controlled utilizing best management practices (BMP) during, and after, construction on the subject site.

Excavations and Slopes

The Federal Occupation Safety and Health Administration (OSHA) and the Washington Industrial Safety and Health Act (WISHA) provide soil classification in terms of temporary slope inclinations. Based on the soil conditions encountered at the test locations, existing fill, loose native soil and any soil where groundwater seepage is exposed, are classified as Type C by OSHA/WISHA. Temporary slopes over four feet in height in Type C soils must be sloped no steeper than 1.5H:1V (Horizontal:Vertical). The presence of perched groundwater may cause caving of the temporary slopes due to hydrostatic pressure. The dense to very dense native silty sand soils observed are classified as Type A. Temporary slopes over four feet in height in Type A soils must be sloped no steeper than 0.75H:1V. Temporary excavations with inclinations steeper than those described may be acceptable from a geotechnical standpoint. ESNW should be consulted during the design phase to provide recommendations for steeper temporary excavations if necessary. ESNW should observe site excavations to confirm the soil type and allowable slope inclination. If the recommended temporary slope inclination cannot be achieved, temporary shoring may be necessary to support excavations.

Permanent slopes should maintain a gradient of 2H:1V, or flatter, and should be planted with vegetation to enhance stability and to minimize erosion. A representative of ESNW should observe temporary and permanent slopes to confirm the slope inclinations, and to provide additional excavation and slope recommendations, as necessary.

Utility Support and Trench Backfill

In our opinion, the soils anticipated to be exposed in utility excavations should generally be suitable for support of utilities. Organic or highly compressible soils encountered in the trench excavations should not be used for supporting utilities. The on-site soil may not be suitable for use as trench backfill if the soil moisture content is too high at the time of compaction. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report, or to the applicable City of Mercer Island specifications. Seepage should be anticipated within utility trench excavations. Caving of the trench sidewalls should also be anticipated given the nature of the site soil where groundwater is present.

LIMITATIONS

The recommendations and conclusions provided in this geotechnical engineering 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. A warranty is not expressed or implied. Variations in the soil and groundwater conditions observed at the test locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions in this geotechnical engineering 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.

Reference:
King County, Washington
OpenStreetMap.org

NORTH

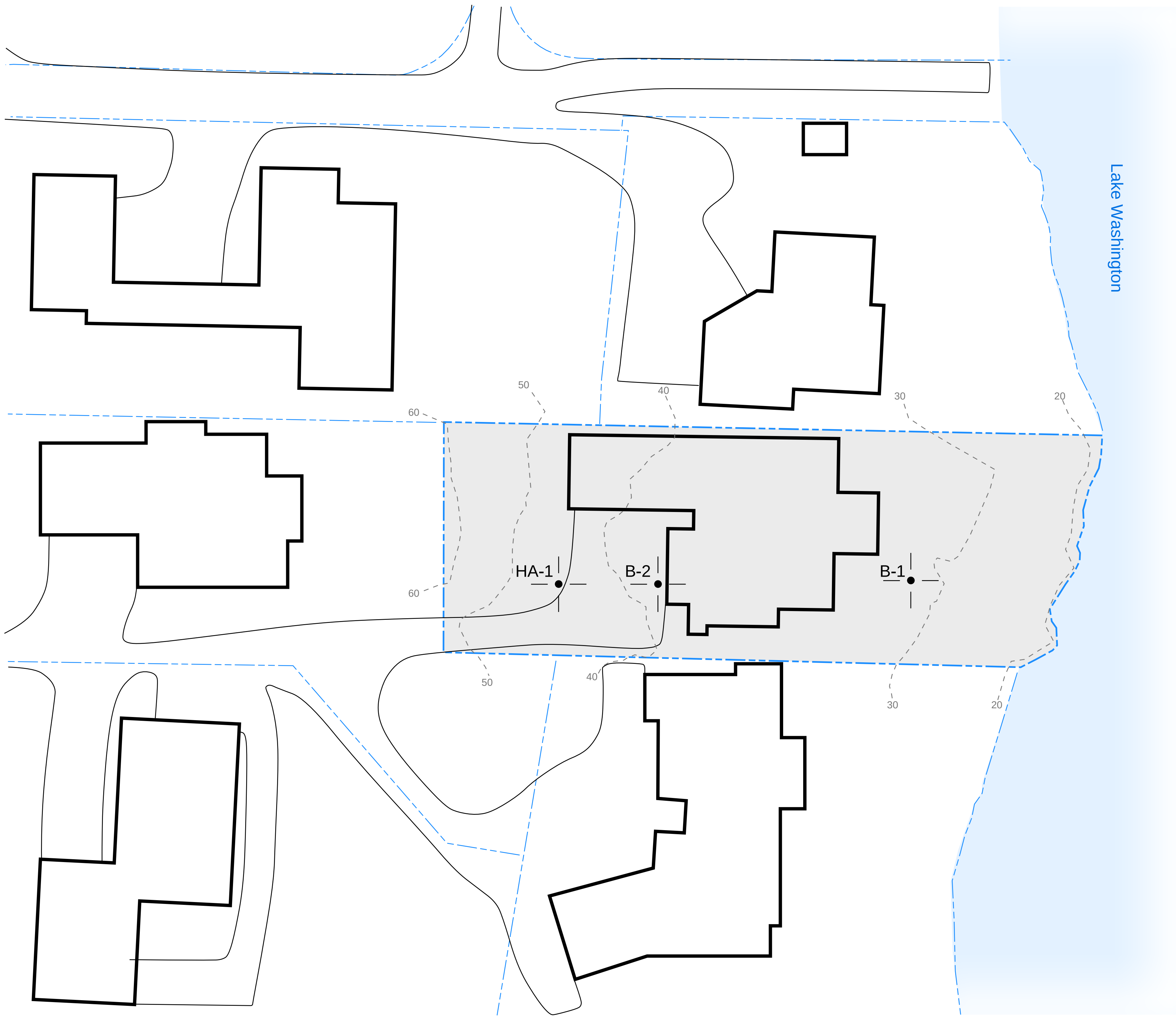
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Rojas Residence
Mercer Island, Washington

Drawn MRS	Date 04/20/2023	Proj. No. 9013
Checked BCS	Date April 2023	Plate 1



LEGEND

HA-1 — Approximate Location of ESNW Hand Auger Boring, Proj. No. ES-9013, Mar. 2023

B-1 — Approximate Location of ESNW Boring, Proj. No. ES-9013, Mar. 2023

Subject Site

Existing Building

NORTH

NOT - TO - SCALE

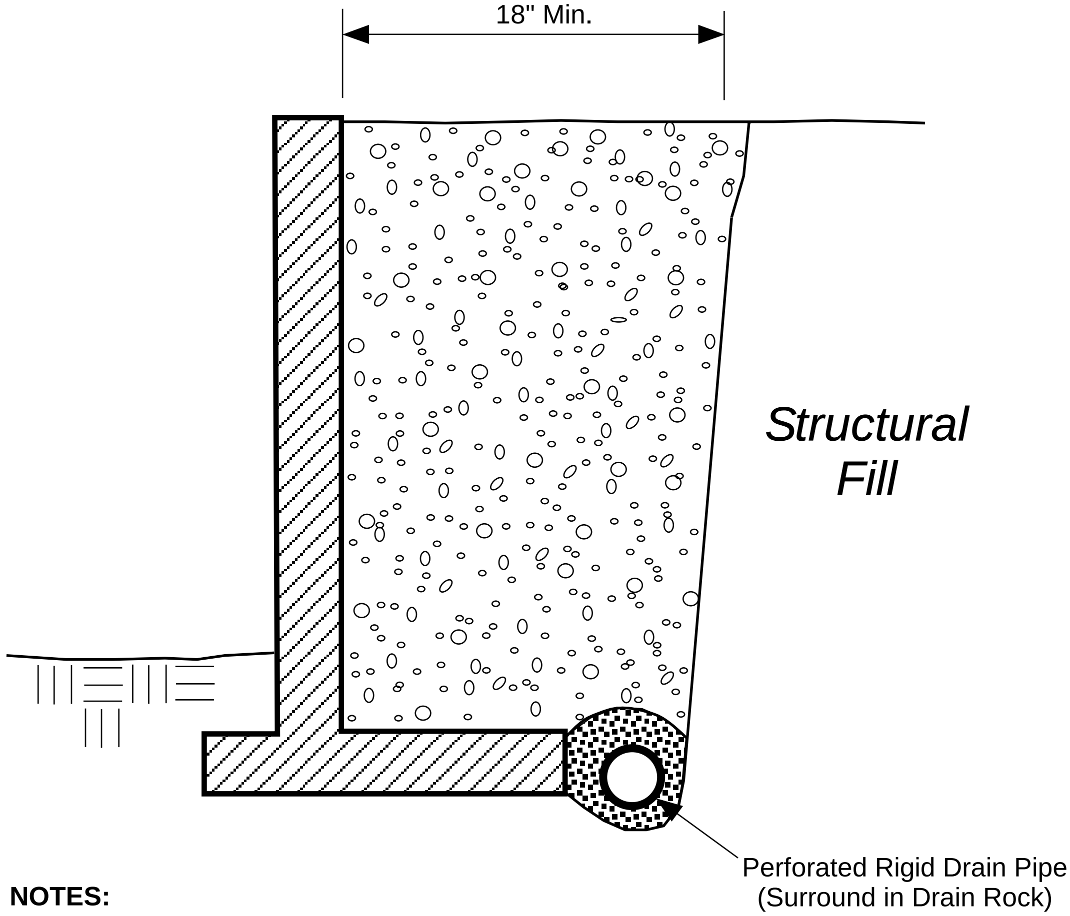
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided 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
Rojas Residence
Mercer Island, Washington

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

Drawn	MRS
Checked	BCS
Date	04/19/2023
Proj. No.	9013
Plate	2



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

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

Retaining Wall Drainage Detail
Rojas Residence
Mercer Island, Washington

Drawn MRS	Date 04/20/2023	Proj. No. 9013
Checked BCS	Date April 2023	Plate 3

Appendix A

Subsurface Exploration
Boring and Hand Auger Boring Logs

ES-9013

The subsurface conditions at the site were explored by excavating a total of one hand-auger borings and two hollow-stem borings across accessible portions of the property. The subsurface explorations were completed in March of 2023. The approximate test locations are illustrated on Plate 2 of this report. Logs of the borings are provided in this Appendix. The borings were excavated to a maximum depth of 18.5 feet below existing grades.

Major Divisions		Fines	USCS Symbol	Description
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

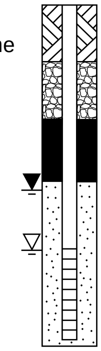
Wet - Water visible but not free draining, likely above optimum MC

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.

Earth Solutions NWLLC

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EXPLORATION LOG KEY

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

BORING NUMBER B-1

PROJECT NUMBER ES-9013
PROJECT NAME Rojas Residence
DATE STARTED 3/28/23 **COMPLETED** 3/28/23
GROUND ELEVATION
DRILLING CONTRACTOR Geologic Drill Partners
LATITUDE 47.54668 **LONGITUDE** -122.20957
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
∇ **AT TIME OF DRILLING**
SURFACE CONDITIONS Lawn grass
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	MATERIAL DESCRIPTION
0.0					SM	Brown silty SAND, medium dense, moist
2.5	SS	0	3-5-10 (15)			-no recovery, silty sand cuttings (brown) -relic roots
5.0	SS	67	19-26-35 (61)	MC = 13.3		-very dense, slow drilling, water added to borehole
7.5	SS	89	40-50/3"	MC = 13.9 Fines = 31.9		[USDA Classification: slightly gravelly fine sandy LOAM]
10.0	SS	85	50/6"	MC = 4.4		
10.5						

Boring terminated at 10.5 feet below existing grade. No groundwater encountered during drilling. Boring backfilled with bentonite chips and cuttings.

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

Earth Solutions NW, LLC
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Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

BORING NUMBER B-2

PROJECT NUMBER ES-9013 **PROJECT NAME** Rojas Residence
DATE STARTED 3/28/23 **COMPLETED** 3/28/23 **GROUND ELEVATION**
DRILLING CONTRACTOR Geologic Drill Partners **LATITUDE** 47.54667 **LONGITUDE** -122.2099
LOGGED BY BCS **CHECKED BY** SHA **GROUND WATER LEVEL:**
NOTES ∇ **AT TIME OF DRILLING**
SURFACE CONDITIONS Asphalt Pavement **AFTER DRILLING**

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					Fill	0.6	ASPHALT pavement -base coarse
					SM		Gray silty SAND, dense, moist
							-scattered gravel
2.5	SS	89	45-15-20 (35)	MC = 6.8			-glacial till
5.0	SS	100	18-26-40 (66)	MC = 9.5			-becomes very dense
7.5	SS	100	50/3"	MC = 6.1			-decreasing fines
10.0	SS	100	30-35-50/6"	MC = 5.3 Fines = 7.1	SP-SM	10.0	Gray poorly graded SAND with silt, very dense, damp to moist [USDA Classification: slightly gravelly SAND] -trace silt, scattered gravel -outwash sand
12.5							-rig chatter
15.0							

(Continued Next Page)

Earth Solutions NW, LLC
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Telephone: 425-449-4704
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BORING NUMBER B-2

PROJECT NUMBER ES-9013
PROJECT NAME Rojas Residence
DATE STARTED 3/28/23 **COMPLETED** 3/28/23
GROUND ELEVATION
DRILLING CONTRACTOR Geologic Drill Partners
LATITUDE 47.54667 **LONGITUDE** -122.2099
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
AT TIME OF DRILLING
SURFACE CONDITIONS Asphalt Pavement
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
15.0	SS	100	25-30-33 (63)	MC = 16.2 Fines = 9.8	SP-SM		Gray poorly graded SAND with silt, very dense, damp to moist *(continued)* -becomes wet [USDA Classification: slightly gravelly SAND]
17.5							-rig chatter, auger binding -no recovery
						18.5	

Boring terminated at 18.5 feet below existing grade. Groundwater seepage encountered at 15.0 feet during drilling.

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 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

BORING NUMBER HA-1

PROJECT NUMBER ES-9013
PROJECT NAME Rojas Residence
DATE STARTED 3/28/23 **COMPLETED** 3/28/23
GROUND ELEVATION
DRILLING CONTRACTOR ESNW Rep
LATITUDE 47.54668 **LONGITUDE** -122.21001
LOGGED BY BCS **CHECKED BY** SHA
GROUND WATER LEVEL:
NOTES
∇ **AT TIME OF DRILLING**
SURFACE CONDITIONS Landscape beds
AFTER DRILLING

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			TPSL	0.6	Dark brown TOPSOIL
		MC = 9.6	SM	1.5	Gray silty SAND, dense, moist (Native) -scattered gravel

Hand auger boring terminated at 1.5 feet below existing. 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

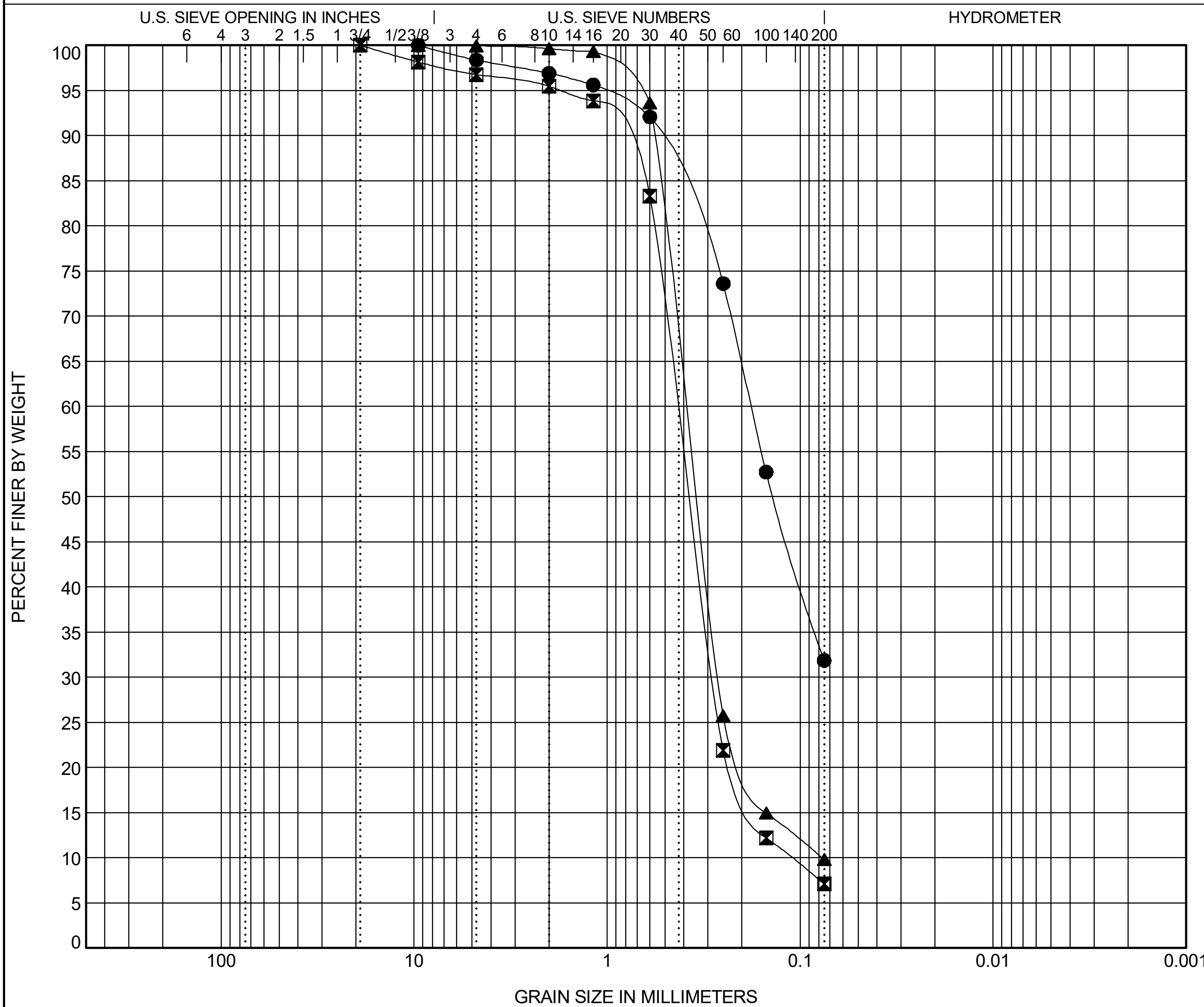
Laboratory Test Results

ES-9013

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-9013 **PROJECT NAME** Rojas Residence



Specimen Identification			Classification	Cc	Cu
●	B-01	7.50ft.	USDA: Brown Slightly Gravelly Fine Sandy Loam. USCS: SM.		
⊠	B-02	10.00ft.	USDA: Brown Slightly Gravelly Sand. USCS: SP-SM.	1.65	3.87
▲	B-02	15.00ft.	USDA: Brown Slightly Gravelly Sand. USCS: SP-SM.	2.34	5.07

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	B-01	7.5ft.	9.5	0.179						31.9	
⊠	B-02	10.0ft.	19	0.43	0.281	0.111				7.1	
▲	B-02	15.0ft.	9.5	0.389	0.264	0.077				9.8	

GRAIN SIZE USDA ES-9013 ROJAS RESIDENCE.GPJ GINT US LAB.GDT 4/7/23

Report Distribution

ES-9013

<u>**EMAIL ONLY**</u>

Anthony Rojas
6236 East Mercer Way
Mercer Island, Washington 98040