Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
24XXX SOUTHEAST 146TH STREET
KING COUNTY (ISSAQUAH), WASHINGTON

ES-7551

15365 N.E. 90th Street, Suite 100 | Redmond, WA 98052
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

MR. LEV SHABALOV

December 9, 2020

Kyler T. Kelly
Senior Staff Geologist

12/09/2020

Keven D. Hoffmann, P.E.
Senior Project Manager

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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
e-mail: info@geoprofessional.org www.geoprofessional.org

Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

December 9, 2020
ES-7551

Mr. Lev Shabalov
14205 Southeast 36th Street, Suite 100
Bellevue, Washington 98006

Dear Mr. Shabalov:

Earth Solutions NW, LLC (ESNW), is pleased to present this report of geotechnical consulting services. Based on the results of our investigation, the proposed single-family residence is feasible from a geotechnical standpoint. Our study indicates the site is underlain by medium dense to dense glacially consolidated gravels and sands.

The proposed residential structure may be constructed on conventional continuous and spread foundations supported on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil suitable for support of the foundations will likely be first encountered between depths of about two to four feet below existing grades. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill or overexcavation and replacement with suitable structural fill will be necessary.

To mitigate the on-site erosion hazard, appropriate temporary and permanent erosion and sediment control measures should be incorporated into final designs. Appropriate buffers and/or setbacks from steep slopes on site should be considered in the final layout.

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

Kyler T. Kelly
Senior Staff Geologist

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GEOTECHNICAL ENGINEERING STUDY
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KING COUNTY (ISSAQUAH), WASHINGTON

ES-7551

INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed single-family residence to be located along the north side of Southeast 146th Street, approximately 860 feet north and east of the intersection with 245th Avenue Southeast, in the Issaquah area of unincorporated King County, Washington. The purpose of this study was to develop geotechnical recommendations for the proposed project. The scope of services for completing this study included the following:

- Excavating test pits to characterize soil and groundwater conditions.
- Laboratory testing of representative soil samples.
- Conducting engineering analyses.

The following documents and maps were reviewed as part of preparing this study:

- Topographic Boundary Survey, prepared by Encompass Engineering & Surveying, dated November 25, 2020.
- King County Code (KCC), Title 21A.24: Critical Areas.
- King County iMap.
- Surficial Geologic Map of the Maple Valley Quadrangle, Washington, by Derek B. Booth, dated 1995.
- King County Liquefaction Susceptibility Map, endorsed by the King County Flood Control District, dated May 2010.
- Web Soil Survey (WSS) online resource, maintained by the Natural Resources Conservation Service (NRCS) under the United States Department of Agriculture (USDA).

Project Description

We understand a single-family residence and related site improvements have been proposed for the subject site. Site ingress and egress will be provided by Southeast 146th Street. We expect dispersion or another Low-impact Development (LID) technique will be used to manage stormwater from new impervious surfaces. A series of grade modifications will be necessary to achieve finish grade elevation.

At the time of report submission, specific building load plans were not available for review; however, based on our experience with similar developments, the proposed residential structure will likely be two to three stories and constructed using relatively lightly loaded wood framing supported on conventional foundations. Perimeter footing loads will likely be about 1 to 2 kips per lineal foot (klf). Slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

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

SITE CONDITIONS

Surface

The subject site is located along the north side of Southeast 146th Street, approximately 860 feet north and east of the intersection with 245th Avenue Southeast, in the Issaquah area of unincorporated King County, Washington. The approximate location of the site is depicted on the Vicinity Map (Plate 1). The property consists of one tax parcel (King County Parcel Number 5561401300), totaling about 0.84 acres.

The property is currently undeveloped and densely vegetated with mature trees and undergrowth. The property is bordered to the west by single-family residences, to the south by Southeast 146th Street, and to the east and north by undeveloped, forested land.

Site topography descends from south to north, with estimated slope gradients of between 15 to 40 percent and with isolated areas sloped in excess of 40 percent. We estimate about 50 to 60 feet of elevation change occurs across the entire site.

Subsurface

An ESNW representative observed, logged, and sampled five test pits, excavated at accessible locations within the property boundaries, on October 23, 2020. The test pits were excavated using a mini trackhoe and operator retained by our firm. The test pits were completed to assess and classify site soils as well as to characterize groundwater conditions within accessible areas of the site. The approximate locations of the test pits are illustrated on the Test Pit Location Plan (Plate 2). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative samples collected at the test pit locations were analyzed in general accordance with Unified Soil Classification System (USCS) and USDA methods and procedures.

Topsoil

Topsoil was observed extending to depths of approximately 12 to 24 inches below the existing ground surface (bgs). The topsoil thickness was variable, with vegetation roots extending below the topsoil zone into the underlying weathered native soil. The topsoil was characterized by dark brown color and the presence of fine organic material.

Native Soil

Underlying topsoil, the native soil was classified as well-graded gravel with sand, poorly graded gravel with sand, and poorly graded gravely with silt and sand (USCS: GW, GP, and GP-GM, respectively). The native soil was observed primarily in a medium dense to dense and damp to moist condition, extending to the exploration terminus of about eight and one-half feet bgs.

Geologic Setting

The referenced geologic map identifies pre-Fraser glacial sedimentary deposits (Qpf) across the site and surrounding area. As described on the geologic map, pre-Fraser glacial sedimentary deposits are typically weakly oxidized to moderately oxidized sand and gravel, lacustrine sediments containing local peat layers, and moderately oxidized to strongly oxidized diamict composed of silty matrix and rounded gravel clasts.

The referenced WSS resource identifies Alderwood and Kitsap series soils (Map Unit: AkF) across the site and surrounding area. Soils of the Alderwood series are typically comprised of glacial soils, which are present in ridge and hill landforms. Soils of the Kitsap series are typically comprised of lacustrine deposits, which are present in terraces.

Based on our field observations, soils likely to be exposed during grading activities will consist of glacially consolidated gravels and sands.

Groundwater

Groundwater seepage was not encountered at the test pit locations during our exploration on October 23, 2020. Zones of perched groundwater seepage are common within glacially consolidated soils, and in our opinion, such seepage zones should be anticipated depending on the time of year grading operations take place. 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 and elevations are higher during the winter, spring, and early summer months.

GEOLOGIC HAZARD AREAS ASSESSMENT

The subject property was evaluated for the presence of geologic hazard areas in general accordance with KCC Title 21A.24. Based on our review, the subject site is located within an erosion hazard area. Isolated steep slope hazard areas are also mapped within the property boundaries.

Slope Reconnaissance

During our October 2020 site investigation, we traversed accessible portions of the property to identify potential signs of instability. The slopes along the subject site are predominantly overgrown with mature trees, saplings, and groundcover consisting primarily of ferns. No signs of recent large-scale erosion or soil movement were observed during our slope reconnaissance.

Erosion Hazard Areas

KCC 21A.06.415 defines erosion hazard areas as areas underlain by soils that are subject to severe erosion when disturbed. These soils include, but are not limited to, those classified as having a severe to very severe erosion hazard according to the USDA Soil Conservation Service, the 1990 Snoqualmie Pass Area Soil Survey, the 1973 King County Soils Survey, or any subsequent revisions or addition by or to these sources. Soils that are subject to severe erosion when disturbed include any of the following when occurring on slopes inclined at 15 percent or more:

- Alderwood gravely sandy loam (AgD).
- Alderwood and Kitsap soils (AkF).
- Beausite gravely sandy loam (BeD and BeF).
- Kitsap silt loam (KpD).
- Ovall gravely loam (OvD and OvF).
- Ragnar fine sandy loam (RaD).
- The Ragnar-Indianola Association (RdE).

As outlined in the *Geologic Setting* section of this study, Alderwood and Kitsap series soils are mapped on site. These soils are typically associated with moderate to high erosion hazard potential, especially during the wetter, winter months. Provided that appropriate temporary and permanent erosion and sediment control (ESC) measures are incorporated into final designs, erosion potential can be adequately mitigated both during and after construction. Site-specific erosion and sediment control (ESC) measures are typically prepared by the project civil engineer during the appropriate phase of design. ESNW did not observe surficial evidence of either shallow or deep-seated slope instability during our October 2020 site reconnaissance.

Steep Slope Hazard Areas

KCC 21A.06.1230 defines a steep slope hazard area as an area on a slope of 40 percent or more within a vertical elevation change of at least 10 feet. A “slope” is delineated by establishing its toe and top and is measured by averaging the inclination over at least 10 feet of vertical relief.

Based on review of the referenced topographic survey, areas meeting this definition are present on the southern property border, along Southeast 146th Street. An isolated steep slope area is also present along the east-central portion of the site.

Buffer and Setback Distances

Based on our field observations, it is our opinion a reduced buffer (from the standard buffer of 50 feet) from the top or toe of a designated steep slope is appropriate from a geotechnical standpoint. This opinion is based on the presence of competent, dense native deposits at depth and the absence of indications that shallow or deep-seated slumps and/or failures occur (or have previously occurred) on the slope.

From a geotechnical standpoint, we recommend a 25-foot buffer be incorporated into the plans. The buffer should be measured from the top or toe of a designated steep slope, which is defined as the distinct topographic break that separates slopes inclined at less than 40 percent from slopes inclined at 40 percent or more. In addition, we recommend a 15-foot structural buffer setback be incorporated into final designs. The structural buffer setback should be measured from the edge of the steep slope buffer. A total structural setback of 40 feet, as measured from the delineated steep slope break, should be incorporated into the plans.

Per KCC 21A.24.310, alterations of slopes may be approved where slopes are 40 percent or steeper and less than 20 feet in height. As project plans develop, ESNW should be contacted to review the site layout and provide additional recommendations pertaining to the feasibility of slope alteration exemptions.

KCC 21A.24.310 states that alterations of steep slope areas are allowed if the slope was created through previous legal grading activities. Any slope which remains 40 percent or steeper following site development activities shall be subject to all requirements for steep slopes. Based on our slope reconnaissance and review of the topographic survey, the southern slope of the subject site appears to be oversteepened as a result of previous legal grading activities and may be exempt from steep slope hazard area development standards.

DISCUSSION AND RECOMMENDATIONS

General

Based on our investigation, construction of the proposed single-family residence is feasible from a geotechnical standpoint. The primary geotechnical considerations for the proposal are associated with structural fill placement and compaction, erosion and sediment control, and foundation design. Maintaining slope and area stability throughout earthwork and grading activities is also an important geotechnical consideration.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and performing clearing and site stripping. Subsequent earthwork activities will involve site grading, retaining wall preparation and construction (where necessary), and related infrastructure improvements.

Temporary Erosion Control

The following temporary erosion control measures should be considered:

- 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 appropriate portions of the site perimeter.

- When not in use, soil stockpiles should be covered or otherwise protected to reduce the potential for soil erosion, especially during periods of wet weather.

- Temporary measures for controlling surface water runoff, such as interceptor trenches, sumps, or interceptor 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 site soils.

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

Temporary Excavations and Slopes

Most excavation activities across the site are likely to expose medium dense to dense native soil. Based on the soil conditions observed at the test pit locations, the following allowable temporary slope inclinations, as a function of horizontal to vertical (H:V) inclination, may be used. The applicable Federal Occupation Safety and Health Administration (OSHA) and Washington Industrial Safety and Health Act (WISHA) soil classifications are also provided:

- Areas exposing groundwater seepage 1.5H:1V (Type C)

- Loose native soil; areas of fill 1.5H:1V (Type C)

- Medium dense to dense native soil 1H:1V (Type B)

The presence of perched groundwater may cause localized sloughing of the temporary slopes due to excess seepage forces. The contractor should be prepared to encounter groundwater seepage during excavation activities. 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. Permanent slopes should be planted with vegetation (which helps to enhance stability and minimize erosion) and should maintain a gradient of 2H:1V or flatter.

In-situ and Imported Soil

On-site soil exposed during grading activities will likely consist of glacially consolidated gravels and sands. The glacially consolidated gravels and sands are slightly moisture sensitive and may not be suitable for use as structural fill unless the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. 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 export of soil that cannot be successfully compacted as structural fill if grading activities take place during periods of rainfall activity. We recommend avoiding construction-equipment tracking across on-site soil and generally active site work during periods of heavy rainfall, as such disturbance has the potential to degrade the on-site soil beyond a workable state.

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 (minimum) — 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

With respect to underground utility installations and backfill, local jurisdictions may dictate the soil type(s) and compaction requirements. Unsuitable material or debris must be removed from structural areas if encountered.

Preliminary Foundation and Septic Drainfield Siting

Relatively uniform soil conditions were encountered during the October 2020 field exploration, as summarized previously in this report. On the basis of relatively uniform soil conditions and the lack of significant groundwater seepage, it is our opinion that the siting of the foundation and septic drainfield is best deferred to the project civil engineer and/or licensed on-site wastewater treatment system designer, respectively. Presumably, improvements will be sited as near as possible to Southeast 146th Street, since grades descend from south to north. Impacts from the proposed improvements to the steepest site areas should be avoided unless slope alterations or regrading (per KCC 21A.24.310) will be pursued as part of the overall design. ESNW can provide supplementary consulting services with respect to the siting of improvements as project plans develop, upon request.

Foundations

The proposed residential structure may be constructed on conventional continuous and spread foundations supported on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil suitable for support of the foundations will likely be first encountered between depths of about two to four feet bgs. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill or overexcavation and replacement with suitable structural fill will be necessary.

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

- 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 may 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 settlement should occur during construction when dead loads are applied.

Seismic Design

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. In accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class D should be used for design.

The referenced liquefaction susceptibility map indicates the subject site maintains very low liquefaction susceptibility. Liquefaction is a phenomenon where saturated, loose, and sandy 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 relative density of the native soil and the absence of a perennial, shallow groundwater table were the primary bases for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structure should be supported on well-compacted, firm, and unyielding subgrades. Where feasible, native soil exposed at the slab-on-grade subgrade levels can likely be compacted in situ to the specifications of structural fill if groundwater seepage does not interfere with compaction activities. 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 at least four inches of free-draining crushed rock or gravel should be placed below the slabs. The free-draining material should have 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). In areas where slab moisture is undesirable, installation of vapor barriers below the slabs should be considered. If a vapor barrier is to be utilized, it should be a material specifically intended for use as a vapor barrier and should be installed per the specifications of the manufacturer.

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 6H psf†

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

The above design parameters 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 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 a less permeable soil, if desired. 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 3. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Zones of perched groundwater seepage should be anticipated in general site excavations depending on the time of year grading operations take place. Temporary measures to control surface water runoff during construction would likely involve passive elements such as 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 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 4.

Infiltration Feasibility

As indicated in the *Subsurface* section of this report, native soils encountered during our fieldwork were characterized primarily as glacially consolidated gravels and sands. Based on the results of USDA textural analyses performed on representative soil samples, native soils may also be classified as extremely gravelly coarse sand and extremely gravelly coarse sandy loam.

From a geotechnical standpoint, it is our opinion that the native gravels and sands are considered suitable for the infiltration of on-site stormwater. The low soil variability and low fines contents within the gravels and sands are the bases of this opinion. Where infiltration facilities are incorporated into final designs, ESNW should be contacted to provide site-specific and/or targeted infiltration design recommendations. Supplementary fieldwork, such as in-situ field testing, should be completed to determine a long-term design infiltration rate.

Dispersion Feasibility

Based on our observations during the October 2020 field exploration, full dispersion is feasible from a geotechnical standpoint. The erosion potential of the sloped vegetated flow paths can be considered low provided proper vegetation is maintained. This opinion is based on the relatively stable nature of the native soils, which is not likely to be affected adversely from a dispersion scheme. We anticipate a portion of the outflow will infiltrate into the weathered substratum as interflow.

The length of the flow path and potential impact of surface runoff should be evaluated by the stormwater designer. Periodic observations should be made to both confirm adequate performance and complete adjustments (as needed) to ensure off-site impacts are mitigated.

Utility Support and Trench Backfill

Native soil encountered at the test pit locations will generally be suitable for support of utilities. Organic-rich soil is not considered suitable for direct support of utilities and should be removed (and replaced with suitable structural fill) if encountered at utility subgrades.

Native soil encountered within the utility trench excavations may be suitable for re-use as structural backfill provided the soil is a suitable granular material that 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, especially where groundwater seepage is encountered. Each section of utility lines must be adequately supported in the bedding material. Utility trench backfill should be placed and compacted to the specifications of structural fill as previously detailed in this report or to the applicable specifications of King County or another responsible jurisdiction or agency.

LIMITATIONS

This study has been prepared for the exclusive use of Mr. Lev Shabalov and his 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 soil and groundwater conditions observed at the test pit 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 final project plans 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

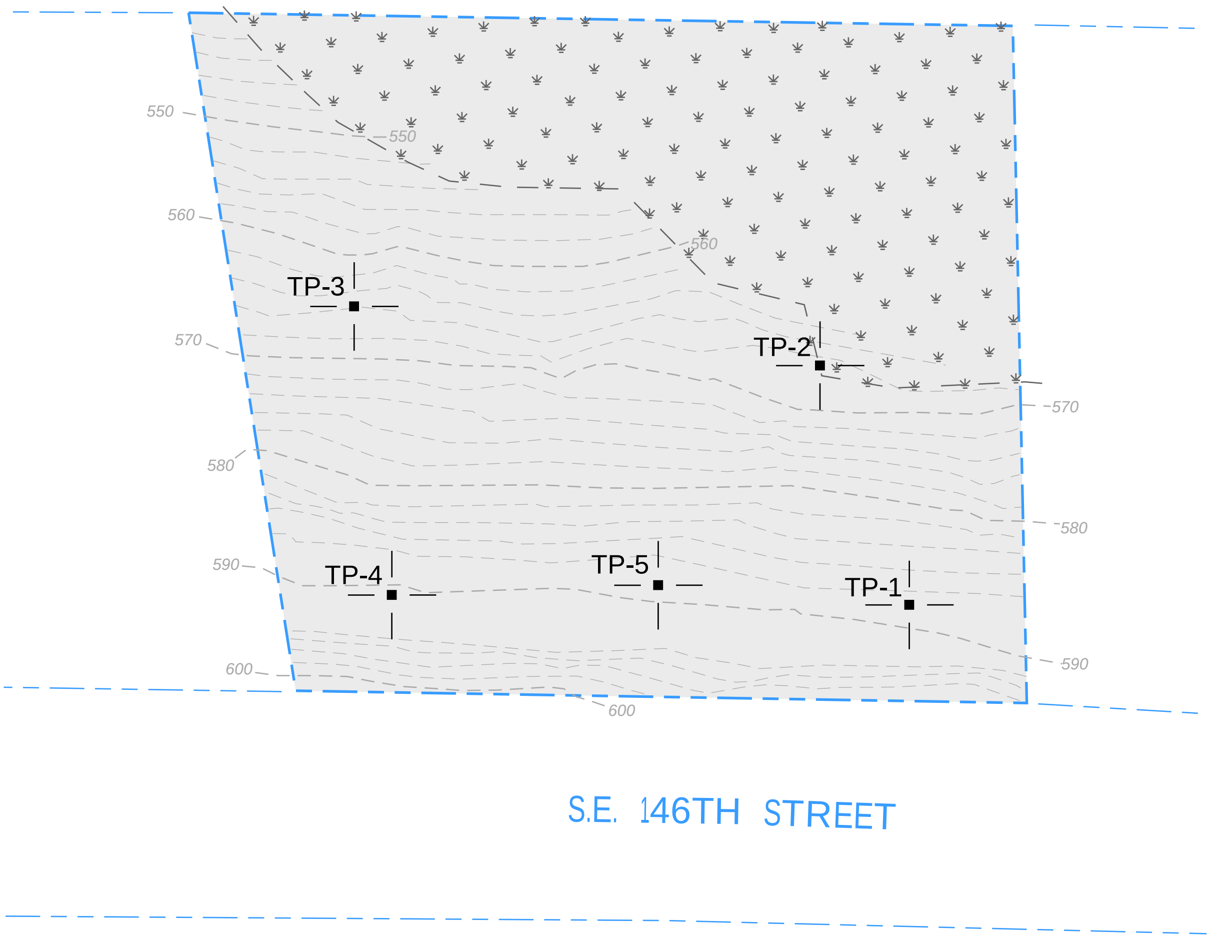
Earth Solutions NW LLC

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

Vicinity Map
Shabalov SFR
King County (Issaquah), Washington

Drwn. MRS	Date 11/18/2020	Proj. No. 7551
Checked KTK	Date Nov. 2020	Plate 1

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.

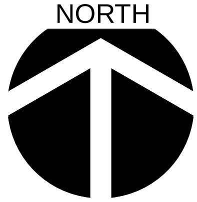


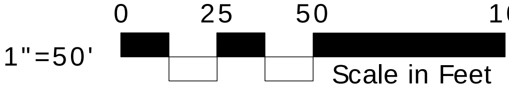
LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-7551, Oct. 2020

Subject Site

Wetland (Delineated by Others)





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.

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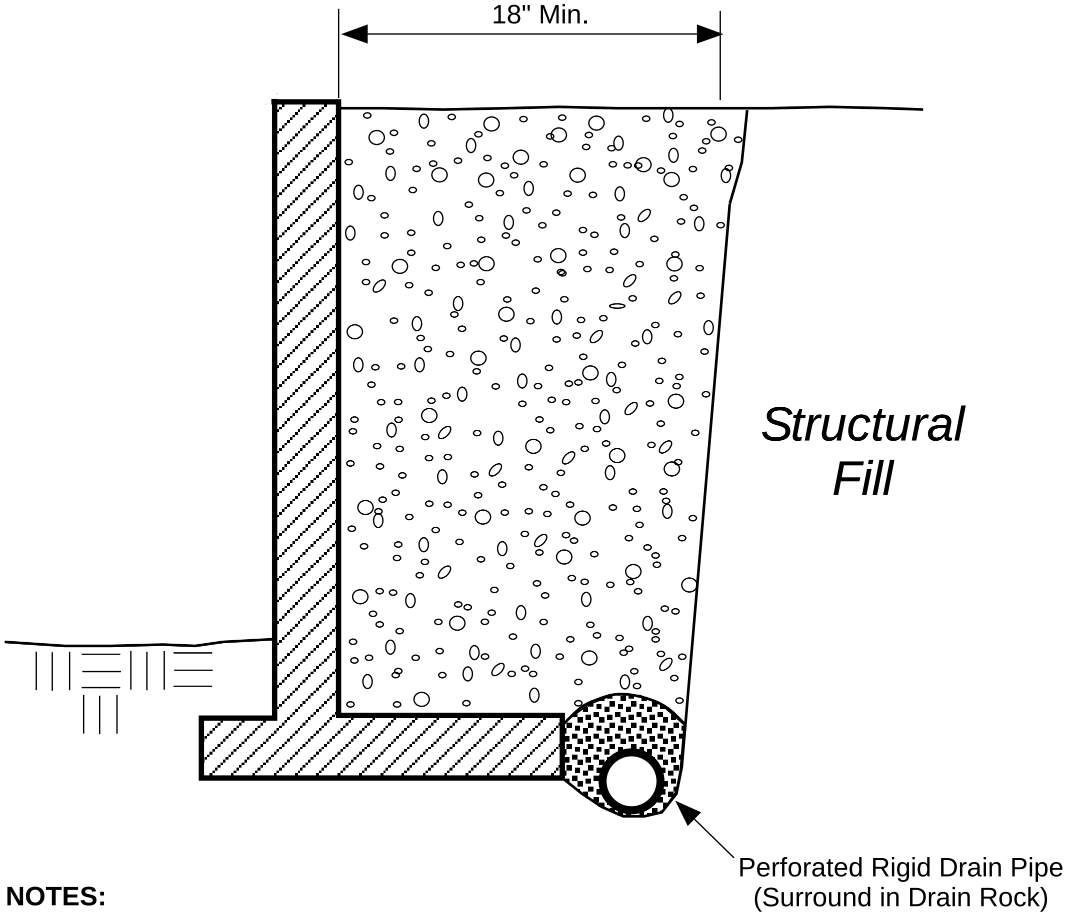
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Test Pit Location Plan
Shabalov SFR
King County (Issaquah), Washington

Drwn. MRS	Date 11/30/2020	Proj. No. 7551
Checked KTK	Date Nov. 2020	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:

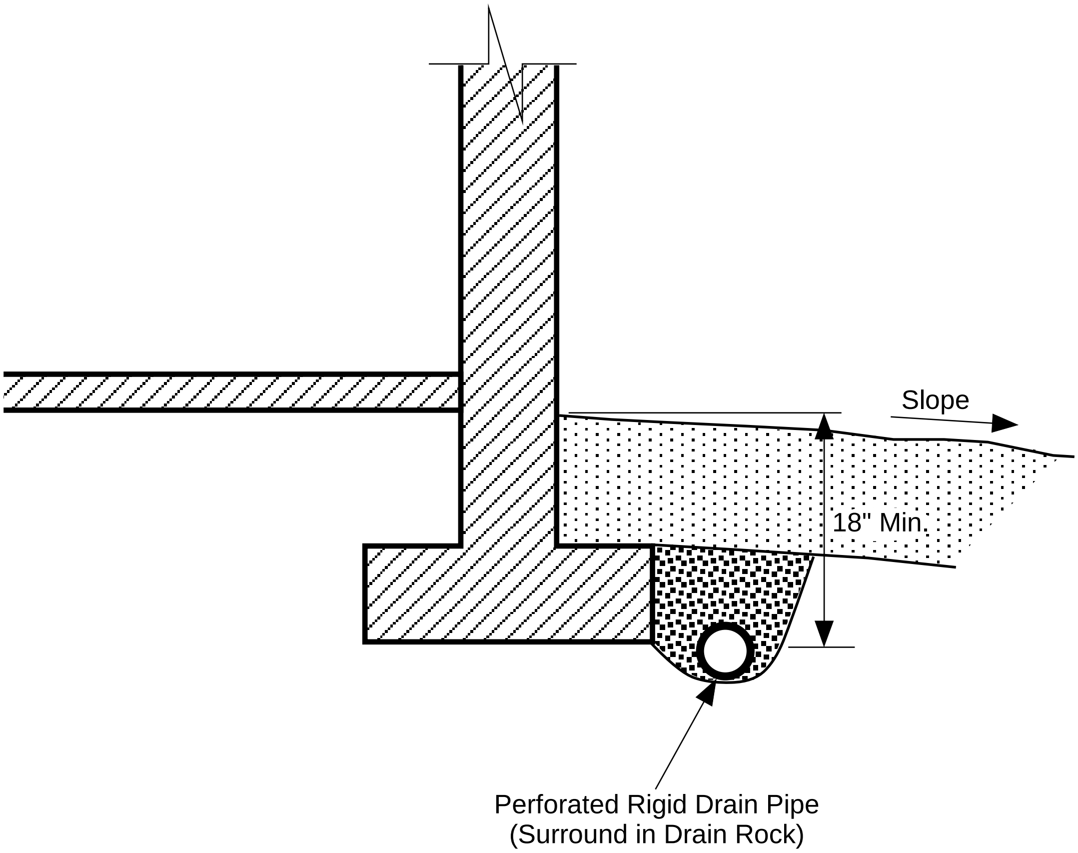
Free-draining Structural Backfill

1-inch Drain Rock

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

Retaining Wall Drainage Detail
Shabalov SFR
King County (Issaquah), Washington

Drwn. MRS	Date 11/17/2020	Proj. No. 7551
Checked KTK	Date Nov. 2020	Plate 3

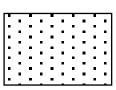


NOTES:

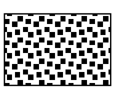
- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:



Surface Seal: native soil or other low-permeability material.



1-inch Drain Rock

Earth Solutions NWLLC

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

Footing Drain Detail
Shabalov SFR
King County (Issaquah), Washington

Drwn. MRS	Date 11/17/2020	Proj. No. 7551
Checked KTK	Date Nov. 2020	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

ES-7551

Subsurface conditions at the subject site were explored on October 23, 2020, by excavating five test pits using a mini trackhoe and operator retained by ESNW. The approximate locations of the test pits are illustrated on Plate 2 of this study. The test pitlogs are provided in this Appendix. The test pits were advanced to a maximum depth of approximately eight and one-half 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.

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

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

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-7551 **PROJECT NAME** Shabalov SFR
DATE STARTED 10/23/20 **COMPLETED** 10/23/20 **GROUND ELEVATION** 588 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**
EXCAVATION METHOD **AT TIME OF EXCAVATION** ---
LOGGED BY KTK **CHECKED BY** KDH **AT END OF EXCAVATION** ---
NOTES Depth of Topsoil & Sod 18": forest duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, trace roots to 5' -large cobbles to BOH	
1.5						586.5
		MC = 7.6% Fines = 1.8%	GW		Brown well-graded GRAVEL with sand, medium dense, moist [USDA Classification: extremely gravelly coarse SAND] -slight caving to 5'	
5		MC = 6.1%			-becomes dense	
8.0		MC = 5.5%				580.0

Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 2.5 to 5.0 feet.

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

TEST PIT NUMBER TP-2

PROJECT NUMBER ES-7551
PROJECT NAME Shabalov SFR
DATE STARTED 10/23/20 **COMPLETED** 10/23/20
GROUND ELEVATION 580 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY KTK **CHECKED BY** KDH
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 24": forest duff
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth	Elevation
0			TPSL		Dark brown TOPSOIL, trace roots to 4' -slight caving to 5' -large cobbles to BOH	2.0	578.0
5		MC = 11.4% MC = 5.3% Fines = 4.3%	GP		Brown poorly graded GRAVEL with sand, medium dense, moist -becomes gray, dense [USDA Classification: extremely gravelly coarse sandy LOAM]	6.5	573.5

Test pit terminated at 6.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to 5.0 feet.

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

TEST PIT NUMBER TP-3

PROJECT NUMBER ES-7551
PROJECT NAME Shabalov SFR
DATE STARTED 10/23/20 **COMPLETED** 10/23/20
GROUND ELEVATION 568 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY KTK **CHECKED BY** KDH
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 18": forest duff
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, roots to 6' -large cobbles to BOH, slight caving to BOH	
1.5						566.5
		MC = 5.0% Fines = 3.5%	GP		Brown poorly graded GRAVEL with sand, medium dense, moist [USDA Classification: extremely gravelly coarse sandy LOAM]	
5		MC = 1.7%			-becomes gray, damp	
					-becomes dense	
8.5		MC = 2.3%				559.5

Test pit terminated at 8.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH.

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

TEST PIT NUMBER TP-4

PROJECT NUMBER ES-7551
PROJECT NAME Shabalov SFR
DATE STARTED 10/23/20 **COMPLETED** 10/23/20
GROUND ELEVATION 590 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY KTK **CHECKED BY** KDH
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 24": forest duff
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	Elevation
0			TPSL		Dark brown TOPSOIL, trace roots to 5' -moderate caving to BOH, large cobbles and boulders to BOH	
2.0						588.0
		MC = 8.0%	GP-GM		Brown poorly graded GRAVEL with silt and sand, medium dense, moist	
5						
		MC = 10.1% Fines = 6.3%			-becomes gray [USDA Classification: extremely gravelly coarse sandy LOAM]	
7.5		MC = 8.8%				582.5

Test pit terminated at 7.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH.

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

TEST PIT NUMBER TP-5

PROJECT NUMBER ES-7551
PROJECT NAME Shabalov SFR
DATE STARTED 10/23/20 **COMPLETED** 10/23/20
GROUND ELEVATION 590 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY KTK **CHECKED BY** KDH
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 12": forest duff
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL	1.0	Dark brown TOPSOIL, trace roots to 4.5', large cobbles to BOH -slight caving to BOH	589.0
		MC = 4.5%	GP		Brown poorly graded GRAVEL with sand, medium dense, moist	
5		MC = 5.9% Fines = 3.7%			[USDA Classification: extremely gravelly coarse sandy LOAM] -becomes gray, dense	
		MC = 6.5%		7.5		582.5

Test pit terminated at 7.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH.

Appendix B

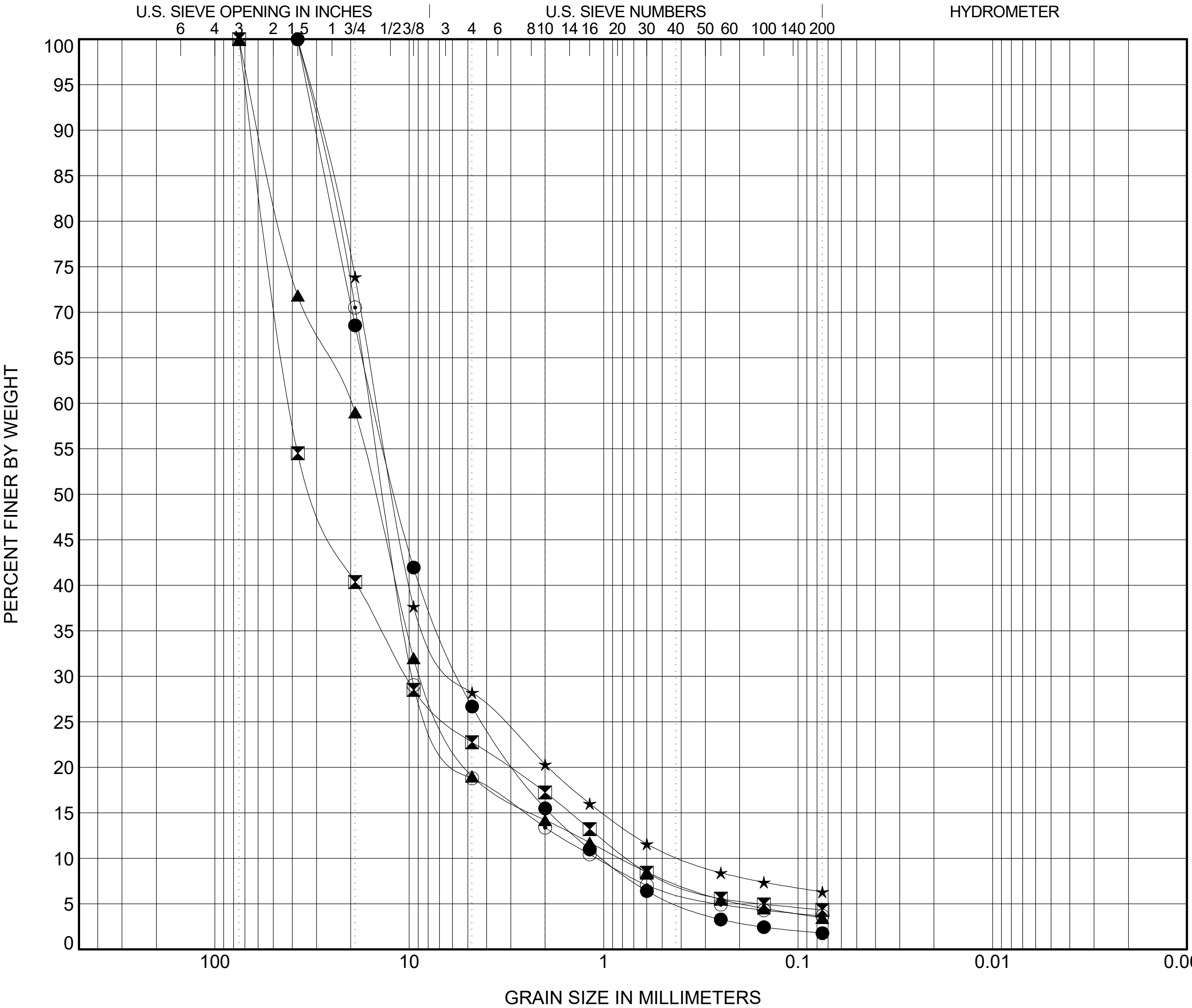
Laboratory Test Results

ES-7551

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-7551 **PROJECT NAME** Shabalov SFR



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	**TP-01**	**2.50ft.**	**USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.**	**1.97**	**14.91**
⧗	**TP-02**	**6.50ft.**	**USDA: Gray Extremely Gravelly Coarse Sandy Loam. USCS: GP with Sand.**	**3.52**	**54.42**
▲	**TP-03**	**2.00ft.**	**USDA: Brown Extremely Gravelly Coarse Sandy Loam. USCS: GP with Sand.**	**4.42**	**24.34**
★	**TP-04**	**6.00ft.**	**USDA: Gray Extremely Gravelly Coarse Sandy Loam. USCS: GP-GM with Sand.**	**5.20**	**37.62**
⊙	**TP-05**	**4.50ft.**	**USDA: Gray Extremely Gravelly Coarse Sandy Loam. USCS: GP with Sand.**	**5.41**	**14.74**

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	**TP-01**	**2.5ft.**	**37.5**	**15.203**	**5.522**	**1.02**				**1.8**	
⧗	**TP-02**	**6.5ft.**	**75**	**40.77**	**10.363**	**0.749**				**4.3**	
▲	**TP-03**	**2.0ft.**	**75**	**20.039**	**8.537**	**0.823**				**3.5**	
★	**TP-04**	**6.0ft.**	**37.5**	**14.566**	**5.413**	**0.387**				**6.3**	
⊙	**TP-05**	**4.5ft.**	**37.5**	**15.939**	**9.656**	**1.081**				**3.7**	

GRAIN SIZE USDA ES-7551 SHABALOV SFR.GPJ GINT US LAB.GDT 11/3/20

Report Distribution

ES-7551

EMAIL ONLY	**Mr. Lev Shabalov** **14205 Southeast 36th Street, Suite 100** **Bellevue, Washington 98006**
EMAIL ONLY	**Encompass Engineering & Surveying** **165 Northeast Juniper Street, Suite 201** **Issaquah, Washington 98027** **Attention: Ms. Heather Tatro**