
Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

# GEOTECHNICAL ENGINEERING STUDY
# PROPOSED WOODLANDS AT REDONDO CREEK
# RESIDENTIAL DEVELOPMENT
# 3023X - 20TH AVENUE SOUTH
# FEDERAL WAY, WASHINGTON

RESUBMITTED

Apr 09 2020

**ES-6637**

CITY OF FEDERAL WAY
COMMUNITY DEVELOPMENT

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**PREPARED FOR**

**RMJ HOLDINGS, LLC**

**October 3, 2019**
**Updated March 25, 2020**


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# GEOTECHNICAL ENGINEERING STUDY
# PROPOSED WOODLANDS AT REDONDO CREEK RESIDENTIAL DEVELOPMENT
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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

October 3, 2019
Updated March 25, 2020
ES-6637

RMJ Holdings, LLC
9675 Southeast 36th Street, Suite 105
Mercer Island, Washington 98040

Attention: Mr. Dmitriy Mayzlin

Dear Mr. Mayzlin:

Earth Solutions NW, LLC (ESNW) is pleased to present this report in support of a planned residential development in Federal Way, Washington". Based on the results of our investigation, the proposed project is feasible from a geotechnical standpoint. Our study indicates the site is underlain primarily by glacial till deposits. During our subsurface exploration completed on April 12, 2019, groundwater seepage was not encountered at the test pit locations. However, it is our opinion the contractor should be prepared to respond to discrete zones of groundwater seepage during construction.

The proposed residential structures should be constructed on conventional continuous and spread footing foundations bearing upon competent native soil, recompacted native soil, or new structural fill placed directly on a competent native soil subgrade. In general, competent native soil suitable for support of foundations will likely be encountered within the upper two to four feet of 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.

Based on our field observations of the glacial till deposits, infiltration is not feasible from a geotechnical standpoint. The majority of glacial till deposits observed at the test pit locations were medium dense to dense and contained significant silt content and are considered impervious for practicable stormwater design purposes. Conventional methods of stormwater management, such as on-site detention, dispersion, and/or connecting to existing stormwater collection systems, may prove more practical.

Pertinent geotechnical 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**

Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

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**FEDERAL WAY, WASHINGTON**

**ES-6637**

## INTRODUCTION

### General

This geotechnical engineering study (study) was prepared for the proposed residential development to be constructed northwest of the intersection between South 304th Street and 20th Avenue South, in Federal Way, 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:

- Excavation of test pits for purposes of characterizing site soil conditions;
- Laboratory testing of soil samples collected at the test pit locations;
- Engineering analyses, and;
- Preparation of this report.

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

- Preliminary Grading Plan, Sheet PP-04, prepared by ESM Consulting Engineers, LLC, dated March 12, 2020;
- Soils and Slope Exhibit prepared by ESM Consulting Engineers, LLC, dated 2018;
- Lidar-revised Geologic Map of the Poverty Bay 7.5' Quadrangle, King and Pierce Counties, Washington, prepared by R.W. Tabor et al., dated 2014;
- King County Liquefaction Susceptibility Map, endorsed by the King County Flood Control District, dated May 2010;
- Critical Areas Map, prepared by the City of Federal Way, Washington, dated May 2016;
- Chapter 19.145 of the Federal Way Revised Code (FWRC), and;
- Online Web Soil Survey (WSS) resource, provided by the United States Department of Agriculture (USDA), Natural Resources Conservation Service.

## Project Description

The preliminary site layout indicates that 68 new single-family residences and associated infrastructure improvements will be constructed. Level lots will be used where existing grades are relatively level and daylight basements will be used where gradients are sloped. We anticipate retaining walls and/or rockeries will likely be incorporated into final designs to accommodate grade transitions, where necessary.

At the time of report submission, specific building load and grading plans were not available for review; however, we anticipate the proposed structures will be two to three stories in height and constructed utilizing relatively lightly loaded wood framing supported on a conventional foundation system. Perimeter footing loads will likely be 1 to 2 kips per lineal foot. Slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

The proposed development will incorporate a stormwater detention pond in the northwest corner of the site.

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 that our geotechnical recommendations have been incorporated into the plans.

# SITE CONDITIONS

## Surface

The subject site is located northwest of the intersection between South 304th Street and 20th Avenue South, in Federal Way, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The property is comprised of two tax parcels (King County Parcel Nos. 042104-9012 and -9221) totaling about 22.2 acres. The site is bordered to the north by single-family residences, to the east by single-family residences and 20th Avenue South, to the south by South 304th Street, and to the west by wetland buffer area and Highway 99. The site is currently vacant and vegetated with moderate to heavy forest and undergrowth. The site topography is characterized by a moderate westward facing slope spanning the property that descends to a natural stream area. The slope grade reaches approximately 15 percent or slightly greater near the wetland buffer where a stream is located.

## Subsurface

A representative of ESNW observed, logged, and sampled eight test pits, excavated at accessible locations within the site boundaries, on April 12, 2019 using a trackhoe and operator retained by ESNW. The test pits were completed for purposes of assessing soil and groundwater conditions within areas proposed for new development. 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 United States Department of Agriculture (USDA) methods and procedures.

### Topsoil and Fill

Topsoil was encountered at most test pits and extended to depths of about 6 to 12 inches. The topsoil was characterized by the observed dark brown hue, the presence of fine organics, and moderate root intrusions.

Fill was not encountered during our exploration. We do not anticipate fill to be encountered at the subject property. If fill is encountered during construction, ESNW can evaluate fill deposits, as necessary.

### Native Soil

Underlying topsoil and fill, native soils were encountered primarily as silty sand with gravel, (USCS: SM). The native deposits were generally medium dense to very dense. Soils were generally encountered in a dense, unweathered condition beginning at about three and one-half feet Native soils were primarily encountered in a damp condition and extended to the maximum exploration depth of approximately 16 feet below the existing ground surface (bgs).

### Geologic Setting

The referenced geologic map resource identifies Vashon glacial till (Qvt) deposits as the primary native soil unit underlying the subject site. As reported on the geologic map resource, the glacial till consists of a nonsorted mixture of silt, sand, pebbles, cobbles, and boulders and is referred to locally as “hardpan.” The till was deposited directly from the glacier as it advanced over bedrock and older Quaternary sediment. The referenced WSS resource identifies Alderwood series soils with varying slopes (Map Unit Symbols: AgB, AgC, and AgD) as the primary soil units underlying the subject site. Seattle muck deposits (Map Unit: Sk) is mapped within the wetland buffer area. The Alderwood series was formed in glacial till and is located along ridges, upland plateau areas and hills. Based on our field observations, on-site native soils are generally consistent with glacial till (Qvt) deposits.

### Groundwater

During our subsurface exploration completed on April 12, 2019, groundwater seepage was not encountered below existing grades. However, it is our opinion the contractor should anticipate, and be prepared to respond to, localized zones of perched groundwater seepage during construction. Groundwater seepage is common within relatively permeable lenses and/or at the transition between weathered and unweathered dense to very dense native soil deposits. It should be noted that 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 wet season (October through April).

## Environmentally Critical Areas

Based on our review of the Federal Way Revised Code (FWRC) Section 19.145 – Environmentally Critical Areas and the referenced critical areas map, the site is mapped within a geologically hazardous area (erosion). Based on the available map data and field observations, erosion hazard areas present on the subject site are delineated on Plate 2.

### Erosion Hazard Areas

The central portion of the site contains slopes that are inclined at 15 percent or greater and are underlain by Alderwood series (AgD) soils. These conditions meet the criteria for erosion hazard as defined by the FWRC. There are no buffers associated with erosion hazard areas per FWRE Section 19.145.240 and protection mechanisms are related to temporary and permanent erosion control measures. The current conceptual site plan indicates that some areas designated as erosion hazards will be developed. In our opinion, temporary erosion control measures should be designed to prevent silt-laden water to be discharged from the construction area. Erosion control measures are discussed later in this report and provide general recommendations for protecting site and surrounding areas from erosion related impacts. In any case, erosion control measures should be actively maintained to ensure proper performance. Specific recommendations for erosion control are provided later in this report. Provided the recommendations in this report are incorporated into the plans, in our opinion, the proposed project will not decrease slope stability on adjacent properties. The stormwater management plans should ensure that discharge does not exceed pre-development conditions or applicable regulatory conditions. The temporary and permanent erosion control measures shall ensure that the adjacent wetland/stream corridor is adequately protected from erosion or related instability.

## DISCUSSION AND RECOMMENDATIONS

### General

Based on the results of our investigation, in our opinion, construction of the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation support, slab-on-grade subgrade support, the suitability of using on site soils as structural fill, and grading activities within erosion hazard areas.

The proposed residential structures may be constructed on conventional continuous and spread footing foundations bearing upon competent native soil, recompacted native soil, or new structural fill placed directly on competent native soils. In general, competent native soil suitable for support of foundations will likely be encountered within the upper two to four feet of 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.

Due to the dense condition and relatively high percentage of fines of the glacial till deposits across the site, infiltration is not feasible from a geotechnical standpoint. We understand that a stormwater detention pond will be constructed adjacent to the wetland buffer area.

This study has been prepared for the exclusive use of RMJ Holdings, LLC and their representatives. A warranty is neither expressed nor implied. 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

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, performing clearing and site stripping, and removing structural improvements. Subsequent earthwork activities will involve site grading and related infrastructure improvements.

### Temporary Erosion Control

The following temporary erosion control measures are offered:

- Temporary construction entrances and drive lanes, consisting of at least 12 inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access entrance surface. Placing geotextile fabric underneath the quarry spalls will provide greater stability, if needed.

- Silt fencing should be placed around the site perimeter.

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

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

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

Additional Best Management Practices (BMPs), as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities. Temporary erosion control measures must be actively monitored and may be modified during construction as site conditions require, to ensure proper performance.

### Stripping

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

**Excavations and Slopes**

Excavation activities are likely to expose both medium dense soil (within the upper two to four feet bgs) and dense soil at depth. 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:

- Loose to medium dense soil 1.5H:1V (Type C)
- Areas containing groundwater seepage 1.5H:1V (Type C)
- Medium dense or dense glacial till 1H:1V (Type B)

Steeper inclinations within native, undisturbed soils may be considered, and must be subsequently designed, by ESNW at the time of construction. Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion, and should maintain a gradient of 2H:1V or flatter. The presence of perched groundwater may cause localized sloughing of temporary slopes due to excess seepage forces. 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.

**In-situ and Imported Soils**

On-site soils are moisture sensitive, and successful use of on-site soils as structural fill will largely be dictated by the moisture content at the time of placement and compaction. Remedial measures, such as soil aeration and/or cement treatment (where approved by the local jurisdiction or utility district), may be necessary as part of site grading and earthwork activities. If the on-site soils 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, particularly if grading activities take place during periods of extended rainfall activity. In general, soils with fines contents greater than 5 percent typically degrade rapidly when exposed to periods of rainfall.

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

**Structural Fill**

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, utility trench, and retaining wall backfill areas. 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 D1557). More stringent compaction specifications may be required for utility trench backfill zones depending on the responsible utility district or jurisdiction.

## Foundations

The proposed residential structures can be constructed on conventional continuous and spread footing foundations bearing upon competent native soil, recompacted native soil, or new structural fill. In general, competent native soil suitable for support of foundations will likely be encountered within the upper two to four feet of 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. Provided the foundations will be supported as prescribed, 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, as dead loads are applied.

## Seismic Design

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. Based on the soil conditions encountered at the test pit locations, 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 to low” liquefaction susceptibility. Liquefaction is a phenomenon where saturated and loose soils suddenly lose internal strength in response to increased pore water pressures resulting from an earthquake or other intense ground shaking. In our opinion, native site soils are not susceptible to liquefaction. The relative densities of the native soils and the absence of a uniformly established, shallow groundwater table were the primary bases for this consideration.

## Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structures should be supported on firm and unyielding subgrades comprised of competent native soil, compacted structural fill, or new structural fill. Unstable or yielding areas of the subgrades should be recompacted, or overexcavated and replaced with suitable structural fill, prior to slab construction.

A capillary break, consisting of a minimum of four inches of free-draining crushed rock or gravel, should be placed below slabs-on-grade. 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 designed for use as a vapor barrier and should be installed in accordance with 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 (yielding 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, where applicable.

Retaining walls should be backfilled with free-draining material or suitable sheet drainage 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 can 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.

### Rockeries

Based on review of the referenced grading plan, rockeries will be used to accommodate grade changes across the site. Final rockery heights and alignments were not completed at the time of this report, but the conceptual configuration shown on the grading plan is generally acceptable from a geotechnical standpoint. Most interior rockeries will be of low height; however, a taller rockery is proposed along the east project area. This rockery, while taller than prescriptive code allows, will reduce the overall grading required to construct the building pads and site infrastructure. In our opinion, the proposed walls including the taller wall proposed along the east project area will not increase impacts to adjacent sensitive areas. ESNW can provide a formal rockery design, upon request.

## Drainage

Discrete zones of perched groundwater seepage should be anticipated in site excavations depending on the time of year grading operations take place, particularly within deeper excavations for utilities. 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 be designed to direct surface water away from the new structures and/or slopes. Water must not be allowed to pond adjacent to the new structure and/or slopes. In our opinion, foundation drains should be installed along the building perimeter footings. A typical foundation drain detail is provided on Plate 4.

### Preliminary Infiltration Feasibility

As indicated in the *Subsurface* section of this study, native soils encountered during our fieldwork were characterized primarily as medium dense to very dense glacial till deposits. Given the compact nature and relatively high fines contents of the glacial till across the site, infiltration is not feasible from a geotechnical standpoint. Conventional methods of stormwater management, such as on-site detention and connecting to existing stormwater collection systems, may prove more practical.

## Utility Support and Trench Backfill

In our opinion, native soils may generally be suitable for support of utilities. Both organic-rich soil and fill are considered unsuitable for direct support of utilities and should be removed at utility grades, if encountered. Remedial measures, such as overexcavation and replacement with structural fill and/or installation of geotextile fabric, may be necessary in some areas to provide support for utilities. Groundwater may be encountered within deeper utility excavations, and caving of trench walls may occur where groundwater is encountered. Temporary construction dewatering, as well as temporary trench shoring, may be necessary during utility excavation and installation as conditions warrant.

In general, native soils may not be suitable for use as structural backfill throughout utility trench excavations, unless the soils are at (or slightly above) the optimum moisture content at the time of placement and compaction. Structural trench backfill should not be placed dry of the optimum moisture content. Each section of the site utility lines must be adequately supported in appropriate 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 the City of Federal Way or other responsible jurisdiction or agency.

**Preliminary Pavement Sections**

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

For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

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

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

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

- Three inches of HMA placed over six inches of crushed rock base (CRB), or;

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

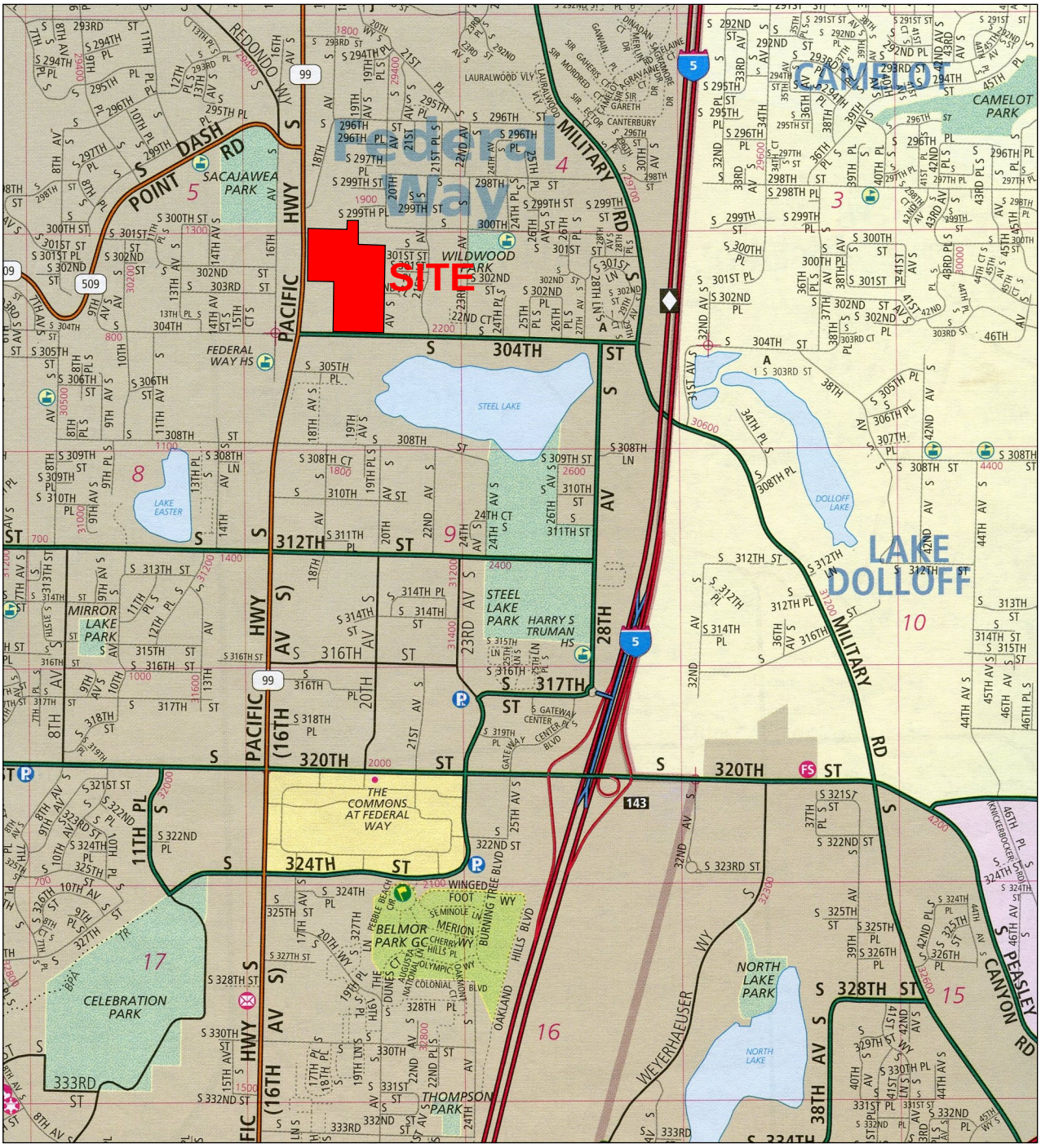
The HMA, ATB and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557. Final pavement design recommendations, including recommendations for heavy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

## LIMITATIONS

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. A warranty is neither expressed nor implied. 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
Map 745
By The Thomas Guide
Rand McNally
32nd Edition

NORTH

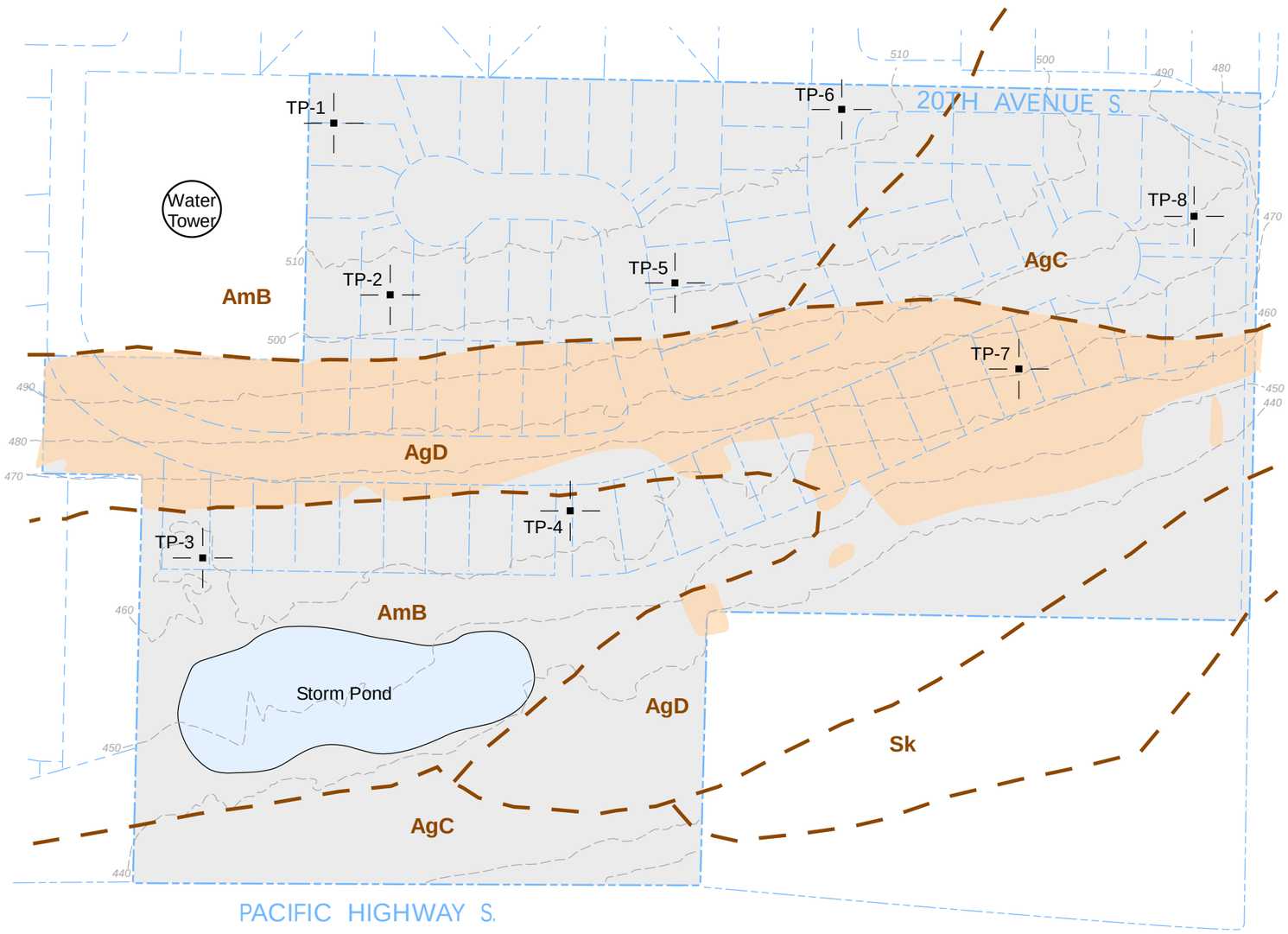
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

# Vicinity Map
# Danilchik Property
# Federal Way, Washington

| | | |
|---|---|---|
| Drwn. CAM | Date 04/25/2019 | Proj. No. 6637 |
| Checked SES | Date April 2019 | Plate 1 |




**LEGEND**

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-6637, April 2019

Subject Site

15% + Slope in AgD Soils

NORTH

1"=150'

0 75 150 300

Scale in Feet

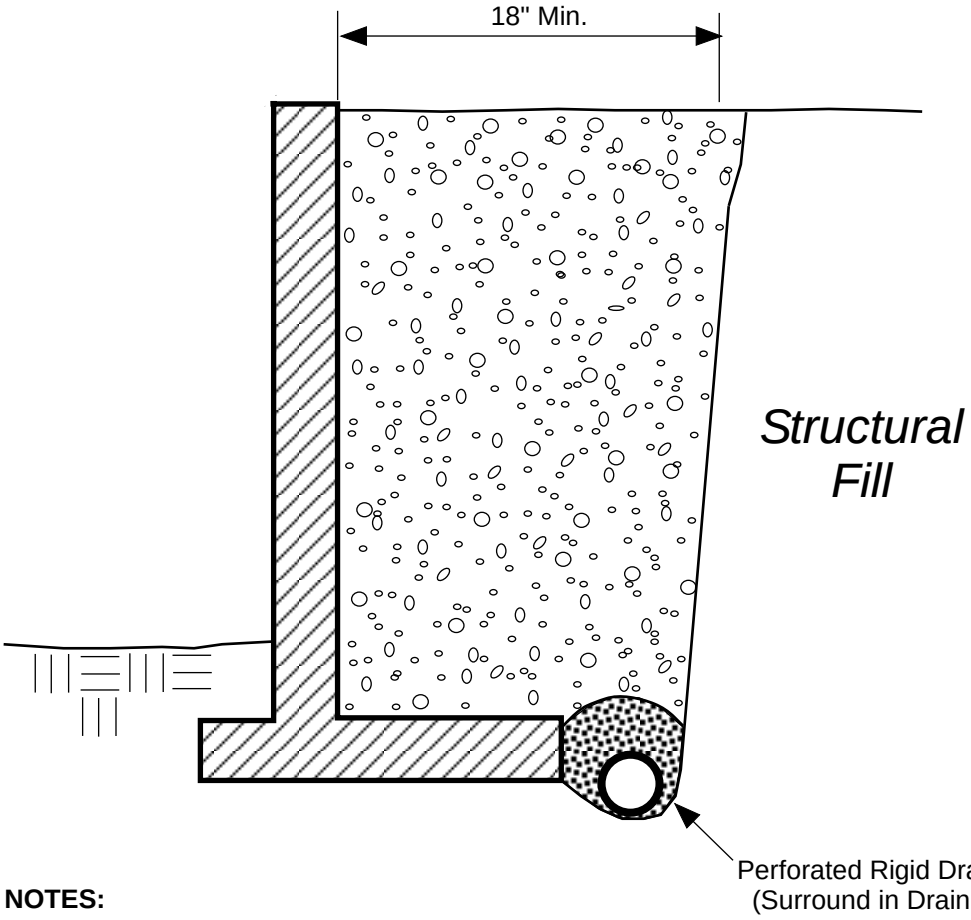
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided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

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

# Test Pit Location Plan
Danilchik Property
Federal Way, Washington

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

| | |
|---|---|
| Drwn. By | MRS |
| Checked By | SSR |
| Date | 09/30/2019 |
| Proj. No. | 6637 |
| 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:**

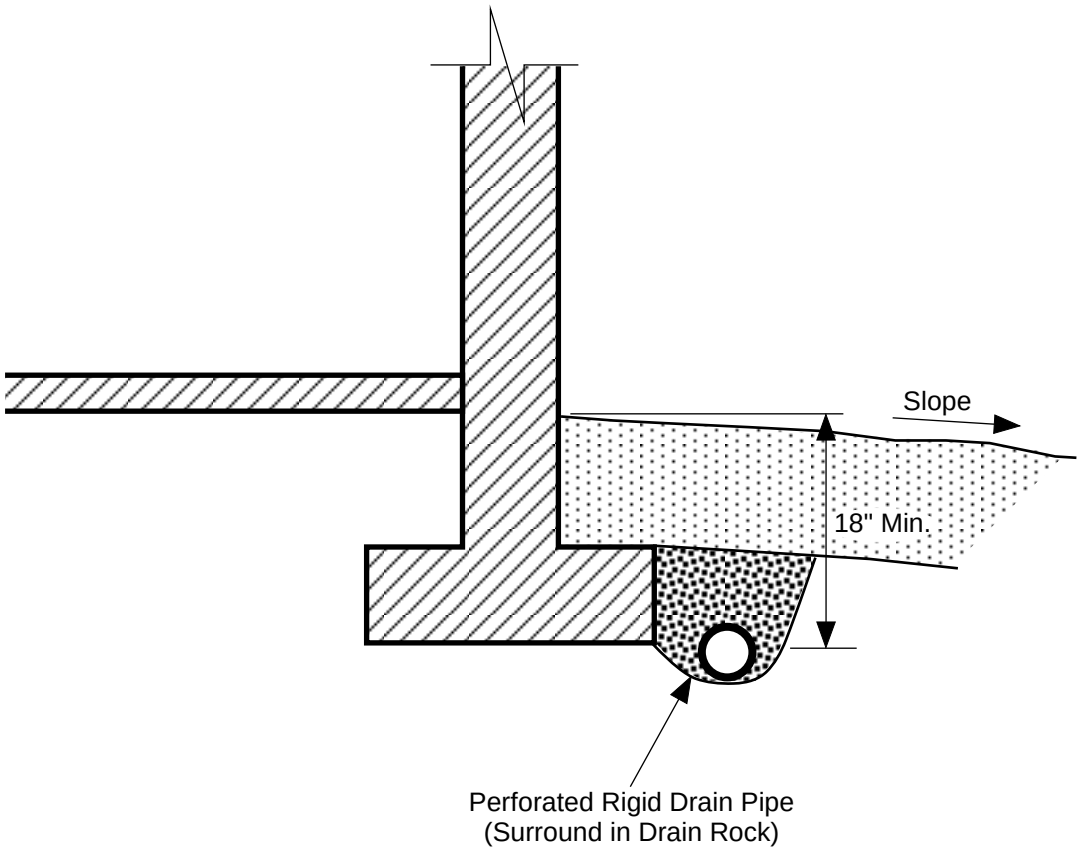
Free-draining Structural Backfill

1-inch Drain Rock

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

Retaining Wall Drainage Detail
Danilchik Property
Federal Way, Washington

| | | |
|---|---|---|
| Drwn. CAM | Date 04/26/2019 | Proj. No. 6637 |
| Checked SES | Date April 2019 | 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 NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Footing Drain Detail
Danilchik Property
Federal Way, Washington

| | | |
|---|---|---|
| Drwn. CAM | Date 04/26/2019 | Proj. No. 6637 |
| Checked SES | Date April 2019 | Plate 4 |

## Appendix A

## Subsurface Exploration
## Test Pit Logs

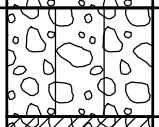
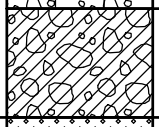
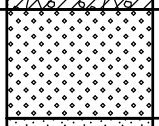
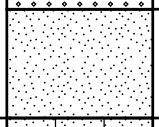
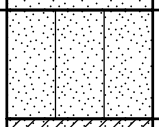
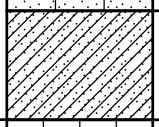
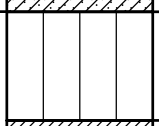
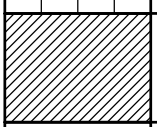
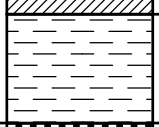
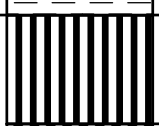
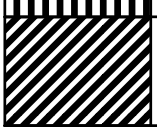
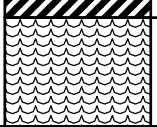
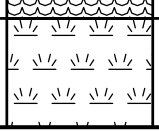
## ES-6637

Subsurface conditions at the subject site were explored on April 12, 2019 by excavating eight test pits using a trackhoe and operator retained by our firm. The approximate locations of the test pits are illustrated on Plate 2 of this study. The test pit logs are provided in this Appendix. The maximum exploration depth was approximately 16 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 | | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| | | | GRAPH | LETTER | |
| COARSE GRAINED SOILS<br>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVEL AND GRAVELLY SOILS<br>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | CLEAN GRAVELS<br>(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<br>(APPRECIABLE AMOUNT OF FINES) |  | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | |  | GC | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES |
| | SAND AND SANDY SOILS<br>MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE | CLEAN SANDS<br>(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<br>(APPRECIABLE AMOUNT OF FINES) |  | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | |  | SC | CLAYEY SANDS, SAND - CLAY MIXTURES |
| FINE GRAINED SOILS<br>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
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Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

# TEST PIT NUMBER TP-1



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 516 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 12": duff **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | TPSL | | Dark brown TOPSOIL, root intrusions to 1' |
| | | | | 1.0 | 515.0 |
| | | | | | Brown silty SAND with gravel, medium dense, damp |
| | | MC = 9.40%<br>Fines = 26.10% | | | -becomes gray, dense to very dense (unweathered till)<br>[USDA Classification: very gravelly sandy LOAM] |
| 5 | | | SM | | |
| | | MC = 6.20% | | | |
| | | | | | -becomes very dense |
| 10 | | | | | |
| | | MC = 5.60% | | 11.5 | 504.5 |
| | | | | | Test pit terminated at 11.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

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# TEST PIT NUMBER TP-2



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 504 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 12": duff **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | |
|---|---|---|---|---|---|---|
| 0 | | | TPSL | | TOPSOIL | |
| | | | | | 1.0 | 503.0 |
| | | | | | Brown silty SAND with gravel, medium dense, moist | |
| | | MC = 10.20% | | | | |
| | | MC = 4.80% | | | -becomes gray, dense to very dense, damp | |
| 5 | | | SM | | | |
| | | MC = 9.90% | | | | |
| | | MC = 7.00%<br>Fines = 34.10% | | | 9.0 [USDA Classification: very gravelly LOAM] | 495.0 |
| | | | | | Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. | |

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Redmond, Washington 98052
Telephone: 425-449-4704
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# TEST PIT NUMBER TP-3



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 470 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 12" **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | TPSL | | TOPSOIL |
| 1.0 | | | | | 469.0 |
| | | | | | Brown silty SAND with gravel, medium dense, damp |
| | | MC = 9.10% | | | |
| 5 | | | SM | | -becomes gray, dense to very dense |
| | | | | | -becomes moist |
| 9.0 | | MC = 11.90% | | | 461.0 |
| | | | | | Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

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-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 470 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 12": duff **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | TPSL | | TOPSOIL |
| 1.0 | | | | | 469.0 |
| | | | | | Brown silty SAND, medium dense, moist |
| | | MC = 11.40% | | | |
| | | MC = 9.50% | | | -becomes gray, dense to very dense, damp |
| 5 | | | | | |
| | | | SM | | -increasing silt |
| 10 | | | | | |
| | | | | | -increasing sand |
| | | MC = 4.20% | | | |
| 15 | | | | | |
| | | MC = 7.20%<br>Fines = 19.40% | | | [USDA Classification: very gravelly sandy LOAM] |
| 15.5 | | | | | 454.5 |
| | | | | | Test pit terminated at 15.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

Earth Solutions NW, LLC
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# TEST PIT NUMBER TP-5



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 502 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 12": duff **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | TPSL | | Dark brown TOPSOIL, minimal root intrusions |
| | | | | | 1.0 501.0 |
| | | | | | Brown silty SAND with gravel, medium dense, damp |
| | | MC = 13.00% | | | |
| 5 | | | | | -becomes gray, dense to very dense |
| | | | SM | | |
| | | MC = 11.20% | | | |
| 10 | | | | | |
| | | MC = 8.10% | | | 12.5 489.5 |
| | | | | | Test pit terminated at 12.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

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# TEST PIT NUMBER TP-6



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 512 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Surface Conditions: gravel fill **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | GP | 0.5 | Gray poorly graded GRAVEL (Fill) 511.5 |
| | | | | | Brown silty SAND with gravel, medium dense, moist |
| | | MC = 11.70% | | | |
| | | | | | -becomes gray, dense to very dense |
| 5 | | | | | |
| | | | SM | | |
| | | MC = 12.30%<br>Fines = 49.20% | | | -becomes very dense<br>[USDA Classification: gravelly LOAM] |
| 10 | | | | | |
| | | | | | -becomes damp |
| | | MC = 7.40% | | 14.0 | 498.0 |
| | | | | | Test pit terminated at 14.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

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# TEST PIT NUMBER TP-7



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/12/19 **COMPLETED** 4/12/19 **GROUND ELEVATION** 492 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | TPSL | 0.5 | TOPSOIL 491.5 |
| | | | | | Brown silty SAND with gravel, medium dense, wet |
| | | MC = 19.80% | | | |
| | | | | | -becomes gray, dense to very dense, moist |
| 5 | | | SM | | |
| 10 | | MC = 10.00% | | 10.0 | 482.0 |
| | | | | | Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

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-8



**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property

**DATE STARTED** 4/16/19 **COMPLETED** 4/16/19 **GROUND ELEVATION** 490 ft **TEST PIT SIZE**

**EXCAVATION CONTRACTOR** NW Excavating **GROUND WATER LEVELS:**

**EXCAVATION METHOD** **AT TIME OF EXCAVATION** ---

**LOGGED BY** SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

**NOTES** Depth of Topsoil & Sod 12" **AFTER EXCAVATION** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|
| 0 | | | TPSL | | Dark brown TOPSOIL, root intrusions to 1.5' |
| | | | | 1.0 | 489.0 |
| | | | | | Brown silty SAND with gravel, medium dense, damp |
| 5 | | | | | -becomes gray, dense to very dense |
| 10 | | | SM | | |
| 15 | | MC = 10.30% | | | |
| | | MC = 8.70%<br>Fines = 15.80% | | 16.0 | [USDA Classification: slightly gravelly loamy SAND] |
| | | | | | 474.0 |
| | | | | | Test pit terminated at 16.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. |

# Appendix B

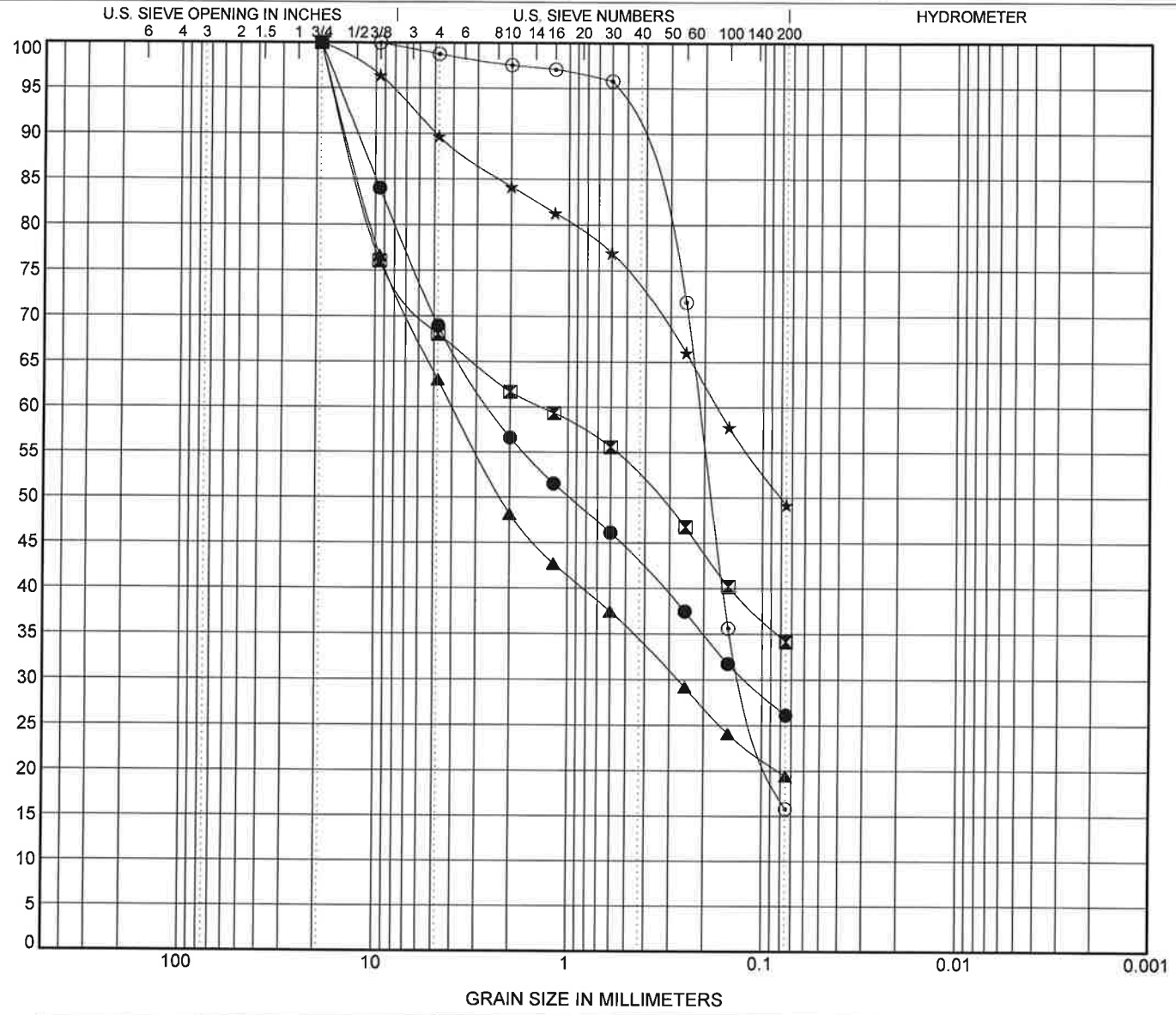
# Laboratory Test Results

# ES-6637

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

# GRAIN SIZE DISTRIBUTION

**PROJECT NUMBER** ES-6637 **PROJECT NAME** Danilchik Property




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | Cc | Cu |
|---|---|---|---|---|
| ● TP-01 | 3.50ft. | USDA: Brown Very Gravelly Sandy Loam. USCS: SM with Gravel. | | |
| ⊠ TP-02 | 9.00ft. | USDA: Gray Very Gravelly Loam. USCS: SM with Gravel. | | |
| ▲ TP-04 | 15.50ft. | USDA: Gray Very Gravelly Sandy Loam. USCS: SM with Gravel. | | |
| ★ TP-06 | 8.00ft. | USDA: Gray Gravelly Loam. USCS: SM. | | |
| ⊙ TP-08 | 16.00ft. | USDA: Gray Slightly Gravelly Loamy Sand. USCS: SM. | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | LL | PL | PI | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● TP-01 | 3.5ft. | 19 | 2.539 | 0.121 | | | | | 26.1 | |
| ⊠ TP-02 | 9.0ft. | 19 | 1.373 | | | | | | 34.1 | |
| ▲ TP-04 | 15.5ft. | 19 | 3.989 | 0.273 | | | | | 19.4 | |
| ★ TP-06 | 8.0ft. | 19 | 0.172 | | | | | | 49.2 | |
| ⊙ TP-08 | 16.0ft. | 9.5 | 0.212 | 0.123 | | | | | 15.8 | |

GRAIN SIZE USDA ES-6637 DANILCHIK PROPERTY.GPJ GINT US LAB.GDT 4/26/19

**Report Distribution**

**ES-6637**

**EMAIL ONLY**

**RMJ Holdings, LLC**
**9675 Southeast 36th Street, Suite 105**
**Mercer Island, Washington 98040**

**Attention: Mr. Dmitriy Mayzlin**

**EMAIL ONLY**

**ESM Consulting Engineers, Inc.**
**33400 – 8th Avenue South, Suite 205**
**Federal Way, Washington 98003**

**Attention: Ms. Savanna Nagorski**