Earth Solutions NW LLC

Geotechnical Engineering
Geology
Environmental Scientists
Construction Monitoring

GEOTECHNICAL ENGINEERING STUDY
MERCER ISLAND LONG PLAT
4320 & 4332 ISLAND CREST WAY
MERCER ISLAND, WASHINGTON

ES-5332

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PREPARED FOR

MERCERTECH INTERNATIONAL, LLC

July 10, 2017

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Important Information About Your

Geotechnical Engineering Report

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

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of 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 equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in-this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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Earth Solutions NW LLC

• Geotechnical Engineering
• Construction Monitoring
• Environmental Sciences

July 10, 2017
ES-5332

Mercertech International, LLC
4320 Island Crest Way
Mercer Island, Washington 98040

Attention: Mr. Alan Chiu

Dear Mr. Chiu:

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, Proposed Mercer Island Long Plat, 4320 and 4332 Island Crest Way, Mercer Island, Washington". Based on the results of the geotechnical investigation, the proposed residential development is feasible from a geotechnical standpoint. The soil underlying the site consists predominantly of native weathered and unweathered glacial till deposits. Groundwater seepage was pervasive and shallow, and will likely be exposed in most excavations on this site. The proposed residential structures may be supported on conventional foundations bearing on competent native soils or on structural fill placed as part of site grading activities. Recommendations for foundation design, earthwork, and other pertinent geotechnical recommendations are provided in this report.

If you have any questions regarding the content of this geotechnical engineering study, please contact us.

Sincerely,

EARTH SOLUTIONS NW, LLC

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

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GEOTECHNICAL ENGINEERING STUDY
MERCER ISLAND LONG PLAT
4320 & 4332 ISLAND CREST WAY
MERCER ISLAND, WASHINGTON

ES-5332

INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed residential plat to be completed at 4320 and 4332 Island Crest Way in Mercer Island, Washington. The purpose of this study was to provide geotechnical recommendations for currently proposed development plans. Our scope of services for completing this study included the following:

- Completing test pits for purposes of characterizing site soils;
- Completing laboratory testing of soil samples collected at the test pit locations;
- Conducting engineering analyses, and;
- Preparation of this report.

The following documents and maps were reviewed as part of our study preparation:

- Topographic Survey, prepared by PLS, Inc., dated December 15, 2016;
- Geologic Map of Mercer Island 1:12,000-scale, Washington, by Kathy G. Troost, October 2006, 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 the property will be subdivided into a residential plat and general infrastructure improvements. Much of the site has been mapped as a wetland area/buffer that will limit the development area toward Island Crest Way. At the time of report submission, specific building load and grading plans were not available for review; however, based on our experience with similar developments, the proposed structures will likely be two to three stories in height and constructed utilizing relatively lightly loaded wood framing supported on conventional foundations. Perimeter footing loads will likely be 1 to 2 kips per lineal foot (klf). Retaining walls and/or rockeries may be utilized in some areas to accommodate grade transitions, where necessary. Stormwater will likely be managed using detention/treatment methods, with infiltration incorporated to the extent feasible.

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 been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located just east of the intersection between Woodbrook Lane between Island Crest Way in Mercer Island, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The property is comprised of two adjoining tax parcels (King County Parcel No. 182405-9031) totaling about 1.7 acres.

The site is bordered to the north, south, and east by single-family residences, to the west by Island Crest Way. Two single-family residences and associated improvements currently occupy the site and will be demolished to create residential lots. In general, site topography slopes to the west with a shallow natural drainage channel that transects the site from east to west. Slope gradients ascend to the east through several residential properties. Vegetation consists primarily of tall grass, trees, and wetland foliage.

Subsurface

A representative of ESNW observed, logged, and sampled three test pits, excavated at accessible locations within the property boundaries, on June 8, 2017 using a mini-trackhoe and operator retained by our firm. The test pits were completed for purposes of assessment and classification of site soils as well as characterization of groundwater conditions within areas proposed for new development. The approximate locations of the test pits are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were evaluated in accordance with both Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil and transitional mineral deposits were encountered generally within the upper one-half to three feet of existing grades at the test pit locations. The topsoil was characterized by dark brown color, the presence of fine organic material, and small root intrusions.

Fill was encountered at TP-1, extending to a depth of approximately one-half feet bgs. The fill was characterized primarily as a crushed rock used as a wearing course, and was encountered in a medium dense and damp condition. Where encountered, fill should be evaluated by ESNW during subsequent construction activities.

Native Soil

Underlying topsoil and fill, native soils consisted primarily of medium dense to dense, silty sand with gravel (USCS: SM), silty gravel with sand (UCSC: GM) and silt (USCS: ML). The composition of the native soils is consistent with that of Vashon subglacial till. The maximum exploration depth was approximately nine feet bgs.

Geologic Setting

The referenced geologic map resource identifies Vashon subglacial till (Qvt) across the site and surrounding areas. As reported on the geologic map resource, Vashon subglacial till consists primarily of a nonsorted mixture of silt, sand, and sub-rounded to well-rounded gravels, commonly referred to as "hardpan." The till was deposited directly from the glacier as it advanced over bedrock and older Quaternary sediment. The referenced WSS resource identifies Arents, Alderwood material (Map Unit Symbol: AmC) as the primary soil unit underlying the subject site. The Alderwood series was formed in glacial till plains. Based on our field observations, native soils on the subject site are consistent with the geologic setting outlined in this section.

Groundwater

During our subsurface exploration completed on June 8, 2017, light to medium, perched groundwater seepage was encountered at a depth of approximately one-and-one-half to seven feet bgs at TP-1 and TP-3. As such, the contractor should anticipate, and be prepared to respond to, zones of perched groundwater seepage during construction. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches, sumps, and dewatering pumps. Groundwater seepage is common within Vashon subglacial till, especially within relatively permeable lenses and/or atop dense to very dense, unweathered deposits. Seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the wetter, winter months.

Geological Hazardous Areas

We reviewed Section 19.07.060 – Geologic Hazardous Areas of the Unified Land Development Code (LDC). We also reviewed the Mercer Island Seismic and Landslide Hazard Maps. Based on our review, there are no geologic hazardous areas within the proposed development envelope of the site. There are potential landslide hazard areas to the east, but these are removed from the development area a sufficient distance such that no adverse impacts are anticipated. On this basis, standard development BMPs will provide an adequate level of safety from potential geologic hazardous areas.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation support, slab-on-grade subgrade support, the suitability of using native soils as structural fill, installation of site utilities, and construction of stormwater management facilities.

In our opinion, the typical residential structures may 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 new foundations, will likely be encountered within the upper two to three 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 a suitable structural fill material, will be necessary.

Due to the high fines content of the native soil and groundwater seepage, large-scale infiltration facilities are likely not feasible from a geotechnical standpoint. Small-scale low impact development (LID) infiltration BMPs (such as rain gardens, bio-swales, or permeable pavers) may be feasible depending largely on the proposed grading scheme. ESNW can provide supplementary stormwater management recommendations as project plans develop.

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

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and performing site clearing and site stripping (as necessary). Subsequent earthwork procedures will involve mass grading (expectedly minor) and related infrastructure improvements.

Temporary Erosion Control

Prior to the installation of either initial or final pavement sections, temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered in order to both minimize off-site soil tracking and provide a stable access surface for construction vehicles. Geotextile fabric may also be placed under the quarry spalls for greater stability of the temporary construction entrance. Erosion control measures should consist of silt fencing placed around appropriate portions of the site perimeter. Soil stockpiles should be covered or otherwise protected to reduce the potential for soil erosion during periods of wet weather. Temporary approaches for controlling surface water runoff should be established prior to beginning earthwork activities. Additional Best Management Practices (BMPs), as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities, as necessary.

Stripping

Topsoil was encountered generally within the upper 4 to 12 inches of existing grades at the test pit locations. Depending on final grading plans, the higher-mineral-content transitional soils below the topsoil may be considered for use in some applications. ESNW will coordinate with the design team and contractor(s), as necessary, to utilize on-site soils to the extent feasible.

In-situ and Imported Soils

From a geotechnical standpoint, native soils may not be suitable for use as structural fill due to high fines contents. An imported granular material should be used for structural fill applications if the native soils cannot be used as structural fill at the time of grading.

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).

Subgrade Preparation

Foundation and slabs-on-grade should be placed on competent bearing subgrades. Loose or unsuitable soil conditions encountered below areas of footing and slab elements should be remedied as recommended in this report. Uniform compaction of the foundation and slab subgrade areas (where necessary) will establish a relatively consistent subgrade condition below the foundation and slab elements. ESNW should observe the foundation and slab subgrade prior to placing formwork. Supplemental recommendations for subgrade improvement may be provided at the time of construction and would likely include further mechanical compaction effort and/or overexcavation and replacement with suitable structural fill.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fill placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas is considered structural fill as well. 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, as relative compaction of at least 95 percent is typically required for utility trench backfill zones.

Foundations

In our opinion, the proposed residential structures may be supported 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 new foundations, will be encountered at depths of two to three feet of existing grades. Loose or unsuitable soil conditions exposed at foundation subgrade elevations should be compacted to the specifications of structural fill or overexcavation and replaced with a suitable structural fill. Organic-rich material encountered at structural subgrade elevations should be removed, and grades should be restored with structural fill.

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 the settlements 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. 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 seismic hazard map indicates the site is not mapped within this overlay. Liquefaction is a phenomenon where saturated or loose soils suddenly lose internal strength and behave as a fluid. This behavior is in response to soil grain contraction and increased pore water pressures resulting from an earthquake or other intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered low. The soil gradation and relative density is the primary basis for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed structures should be supported on a well-compacted, firm and unyielding subgrade. Where feasible, native soils exposed at the slab-on-grade subgrade level can likely be compacted in situ to the specifications of structural fill. Unstable or yielding areas of the subgrade should be recompacted, or overexcavated and replaced with suitable structural fill, prior to construction of the slab.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining crushed rock or gravel 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 a vapor barrier below the slab should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed 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 loads should be included in the retaining wall design, where applicable.

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 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.

Drainage

During our subsurface exploration completed on June 8, 2017, groundwater was encountered generally at depths of approximately 1.5 to 7 feet bgs at test pit locations TP-1 and TP-3. As such, the groundwater table will likely be encountered within deeper site excavations, such as excavations for new utilities and stormwater facilities (where necessary). Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches, sumps, and dewatering pumps. 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. Based on the soil and groundwater conditions observed at the test pit locations, dewatering of excavations extending below four to eight feet bgs would be likely necessary, particularly if grading occurs during the wetter, winter and early spring months.

Finish grades must be designed to direct surface drain water away from structures. Water must not be allowed to pond adjacent to structures, slopes, or walls. A typical foundation drain detail is provided on Plate 4.

Infiltration Feasibility

As indicated in the *Subsurface* section of this report, native soils are largely characterized as medium dense to dense, glacial till deposits. Based on the results of USDA textural analyses, the native gravels further classify primarily as gravelly loam, loamy sand and loam with fines contents ranging from about 24 to 91 percent.

Due to the high fines contents, high relative density of the native soils and the presence of shallow perched groundwater conditions, infiltration is not practical. Limited LID applications may be feasible depending largely on the locations and grading activities planned for the site. ESNW should review LID applications once the project designs have progressed.

Excavations and Slopes

The Federal Occupation Safety and Health Administration (OSHA) and the Washington Industrial Safety and Health Act (WISHA) provide soil classification in terms of temporary slope inclinations. Soils that exhibit high compressive strengths are allowed steeper temporary slope inclinations than are soils that exhibit lower strength characteristics.

Based on the soil conditions encountered at the test pit locations, on-site soils would be classified as Type C by OSHA and WISHA. Temporary slopes over four feet in height in Type C soils must be sloped no steeper than one-and-one-half horizontal to one vertical (1.5H:1V). ESNW should observe site excavations to confirm soil types and allowable slope inclinations. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations.

Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion, and should maintain a gradient of 2H:1V or flatter. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions. Supplementary excavation and slope recommendations may be provided at the time of construction, as necessary.

Preliminary Pavement Sections

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

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

- A minimum of two inches of hot mix asphalt (HMA) placed over four inches of crushed rock base (CRB), or;
- A minimum of two inches of HMA placed over three inches of asphalt-treated base (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, main access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by Mercer Island may supersede the recommendations provided in this report.

Utility Support and Trench Backfill

In our opinion, native soils will generally be suitable for support of utilities. Organic-rich soils are not considered suitable for direct support of utilities and may require removal 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 in order to provide support for utilities. Groundwater will likely be encountered within 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.

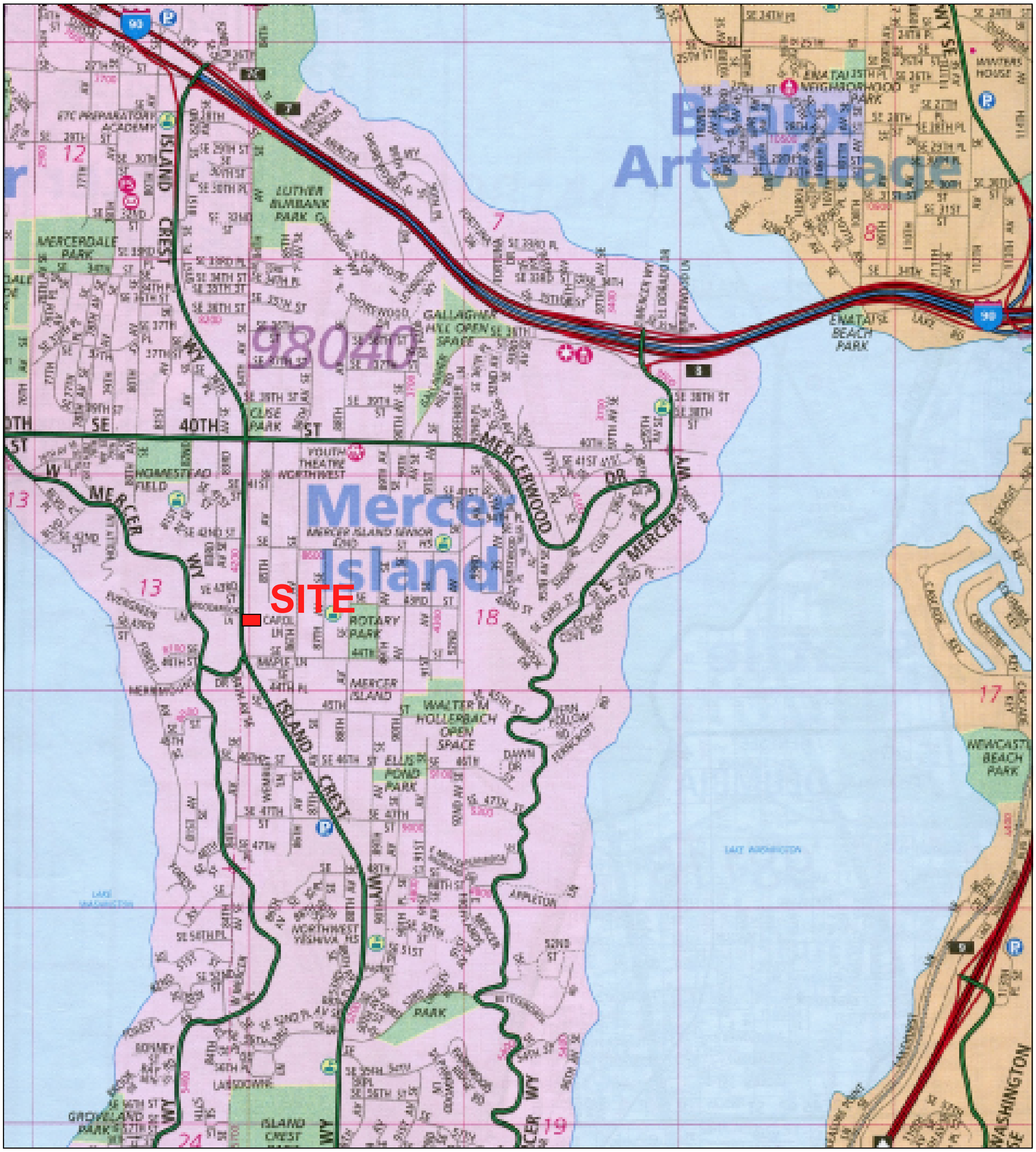
In general, native soils may not be suitable for use as structural backfill throughout utility trench excavations, unless the soils are at (or slightly above) the optimum moisture content at the time of placement and compaction. Structural trench backfill should not be placed dry of the optimum moisture 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 Mercer Island or other responsible jurisdiction or agency.

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 study. ESNW should also be retained to provide testing and consultation services during construction.



Reference:
King County, Washington
Map 596
By The Thomas Guide
Rand McNally
32nd Edition

NORTH

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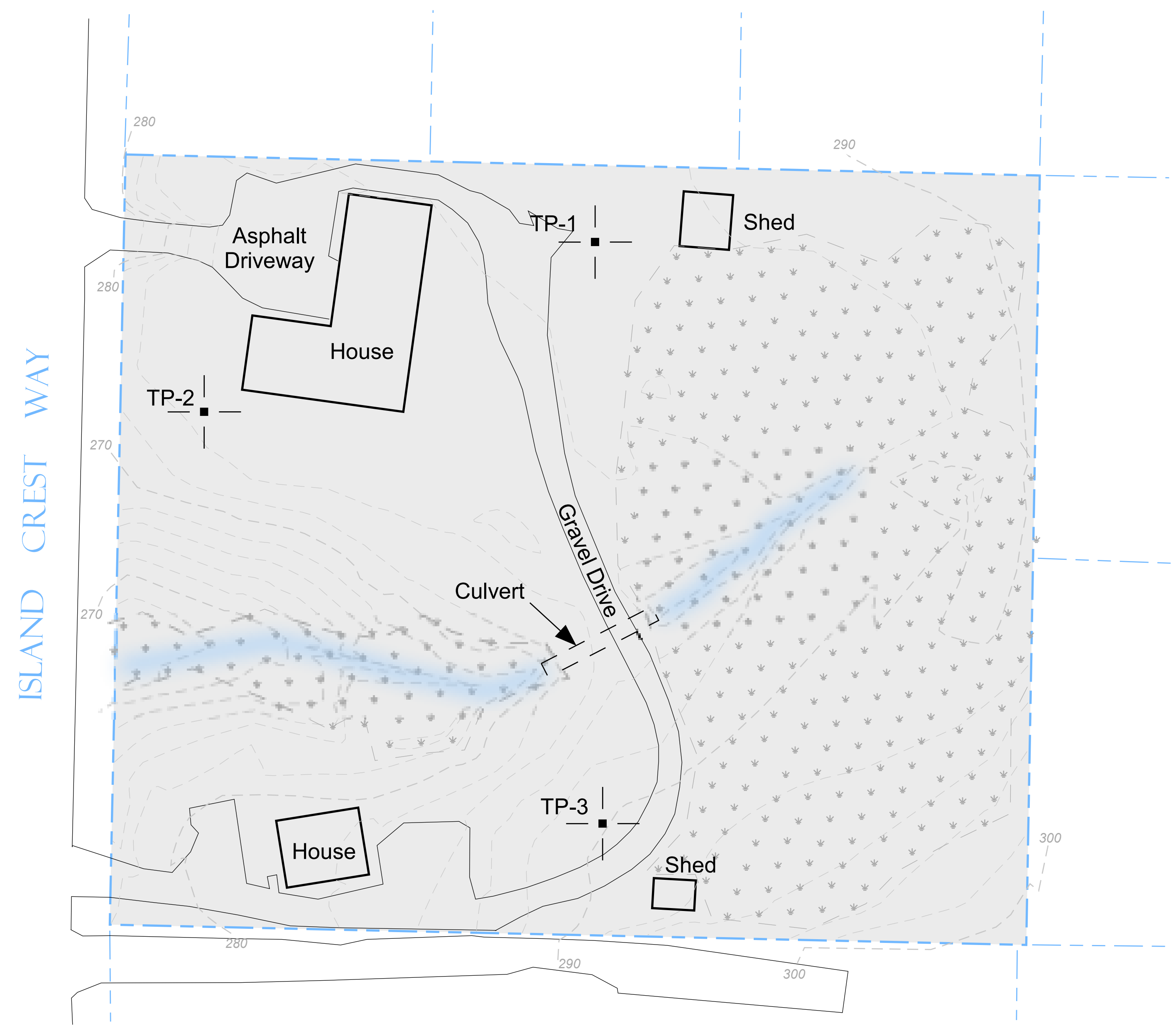
Earth Solutions NW LLC

Earth Solutions NWLLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Vicinity Map
Mercer Island Long Plat
Mercer Island, Washington

Drwn. MRS	Date 07/05/2017	Proj. No. 5332
Checked TJD	Date July 2017	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-5332, June 2017

Subject Site

Wetland (Delineated by Others)

NORTH

0 25 50 100
1"=50'
Scale in Feet

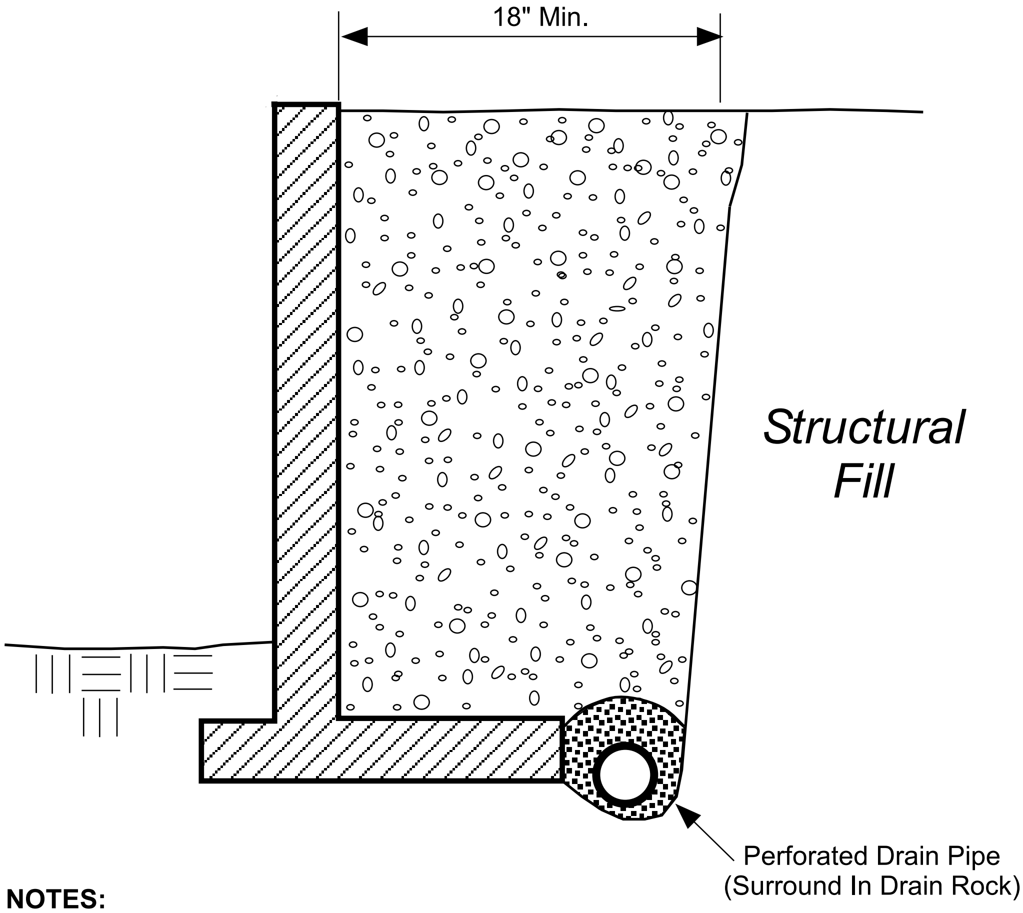
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided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

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Drwn. By	MRS
Checked By	TJD
Date	07/05/2017
Proj. No.	5332
Plate	2

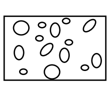


NOTES:

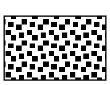
- Free Draining Backfill should consist of soil having less than 5 percent fines. Percent passing #4 should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free Draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1" Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:



Free Draining Structural Backfill



1 inch Drain Rock

Earth Solutions NW LLC
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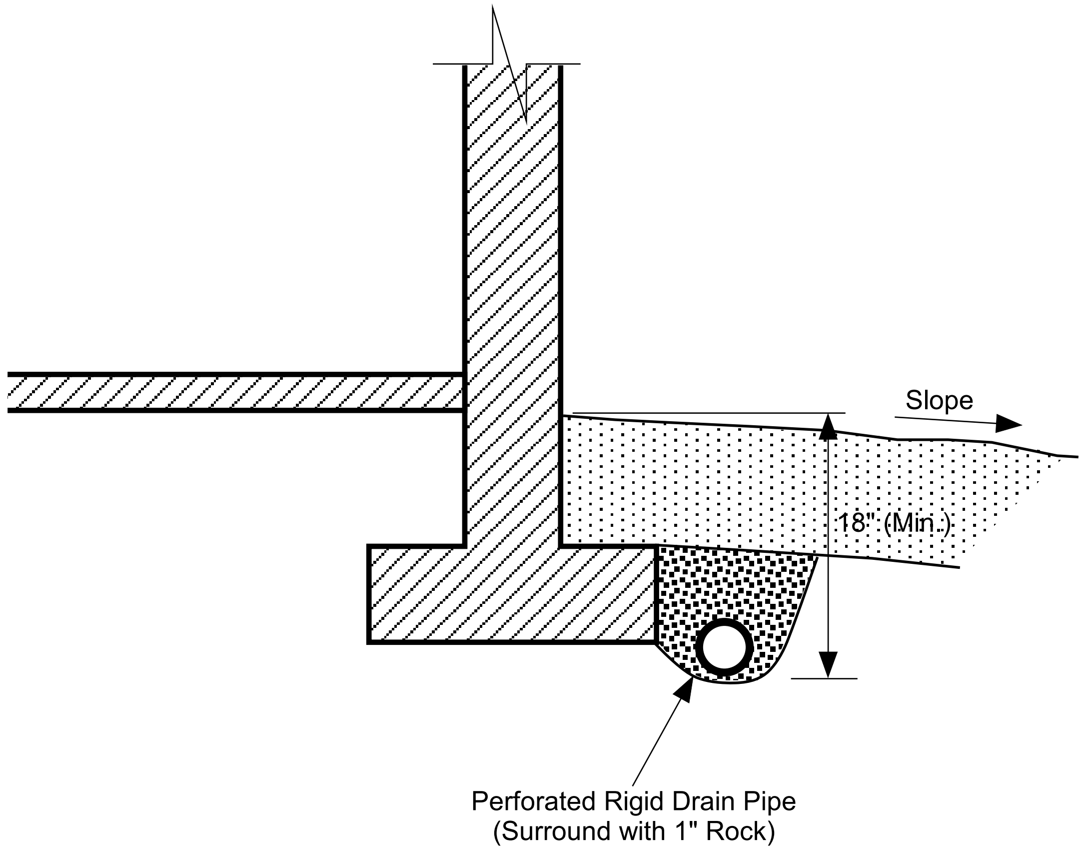
RETAINING WALL DRAINAGE DETAIL
Mercer Island Long Plat
Mercer Island, Washington

Drwn. CAM	Date 07/12/2017	Proj. No. 5332
Checked TJD	Date July 2017	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" Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

FOOTING DRAIN DETAIL
Mercer Island Long Plat
Mercer Island, Washington

Drwn. CAM	Date 07/12/2017	Proj. No. 5332
Checked TJD	Date July 2017	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

ES-5332

Subsurface conditions at the subject site were explored on June 8, 2017 by excavating three test pits using a mini-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 test pits were advanced to a maximum depth of approximately nine 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.

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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
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TEST PIT NUMBER TP-1

CLIENT Mercertech International
PROJECT NAME Mercer Island Plat
PROJECT NUMBER 5332
PROJECT LOCATION Mercer Island, Washington
DATE STARTED 6/8/17 **COMPLETED** 6/8/17
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY TJD **CHECKED BY**
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 2": grass and rock
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			ROCK	0.5	Crushed ROCK, medium dense, damp (Fill)
			SM		Reddish brown silty SAND with gravel, loose to medium dense, moist
		MC = 10.00%			-becomes medium dense, moist -mottled texture from 2.5' to 7' -becomes gray
		MC = 9.20% Fines = 29.40%			[USDA Classification: gravelly sandy LOAM]
					-light groundwater seepage, sand lense
5					
					-light to medium groundwater seepage -black sand lense
		MC = 16.30%		8.0	
		MC = 25.10%	ML	8.5	Gray SILT with sand, medium stiff to stiff, moist -perched groundwater at BOH

Test pit terminated at 8.5 feet below existing grade. Groundwater seepage encountered at 4.0 and 6.5 feet during excavation. No caving observed.

Bottom of test pit at 8.5 feet.

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TEST PIT NUMBER TP-2

CLIENT Mercertech International
PROJECT NAME Mercer Island Plat
PROJECT NUMBER 5332
PROJECT LOCATION Mercer Island, Washington
DATE STARTED 6/8/17 **COMPLETED** 6/8/17
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY TJD **CHECKED BY**
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 4"- 6": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0			TPSL		0.5	Dark brown silty SAND, loose, moist
		MC = 12.50%	SM		2.5	Brown silty SAND with gravel, medium dense, moist -roots to 2.5'
5		MC = 25.60% Fines = 75.90% MC = 29.40% Fines = 69.90% MC = 27.70%	ML		9.0	Gray SILT with sand, medium stiff to stiff, moist -decreasing gravel content [USDA Classification: slightly gravelly LOAM] -iron oxide staining from 4.5' to 6.5' -becomes bluish gray from 5.5' to 6.5' -scattered root intrusions to 6' [USDA Classification: LOAM] -becomes gray

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

Bottom of test pit at 9.0 feet.

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TEST PIT NUMBER TP-3

CLIENT Mercertech International
PROJECT NAME Mercer Island Plat
PROJECT NUMBER 5332
PROJECT LOCATION Mercer Island, Washington
DATE STARTED 6/8/17 **COMPLETED** 6/8/17
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY TJD **CHECKED BY**
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 8"- 12": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	Dark brown silty SAND, loose, moist -roots from 1.5' to 2'
		MC = 10.20% Fines = 23.60%	GM	2.5	Brown silty GRAVEL with sand, medium dense, moist -light groundwater seepage, mottled texture from 1.5' to 2.5' [USDA Classification: very gravelly LOAM]
5		MC = 24.80% Fines = 90.80% MC = 25.10%	ML	8.0	Gray SILT with sand, medium stiff to stiff, moist -mottled texture -weak to moderate cementation [USDA Classification: LOAM] -decreasing gravel content -black sand lense at 7' -light groundwater seepage from 7' to 7.5' -perched groundwater at BOH
					Test pit terminated at 8.0 feet below existing grade. Groundwater seepage encountered at 1.5 and 7.0 feet during excavation. No caving observed. Bottom of test pit at 8.0 feet.

Appendix B

Laboratory Test Results

ES-5332

Earth Solutions NW, LLC
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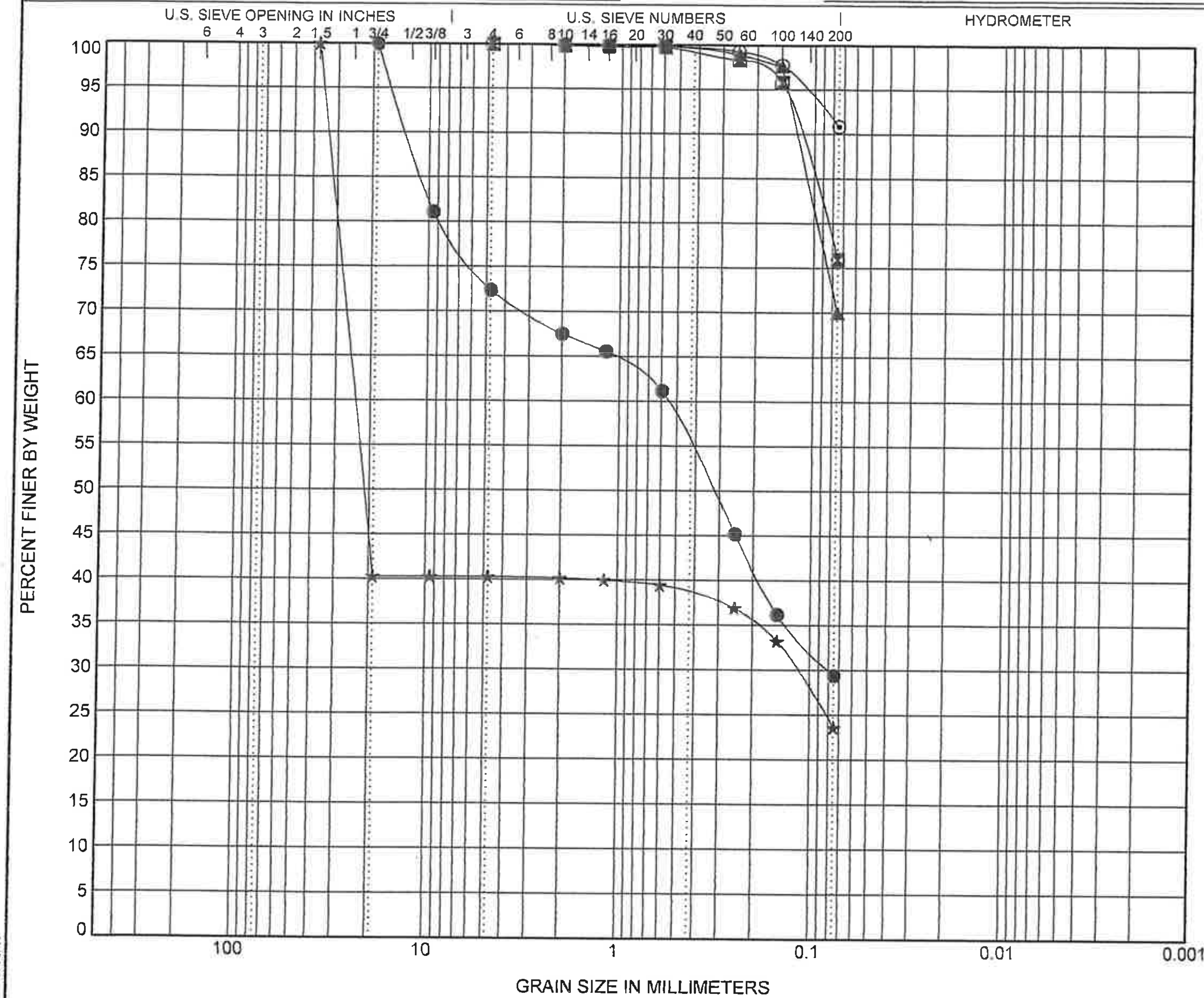
GRAIN SIZE DISTRIBUTION

CLIENT Mercertech International LLC

PROJECT NAME Mercer Island Plat

PROJECT NUMBER ES-5332

PROJECT LOCATION Mercer Island



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	Cc	Cu
● TP-1	3.00ft.	USDA: Gray Gravelly Sandy Loam. USCS: SM with Gravel.		
⊠ TP-2	4.00ft.	USDA: Gray Slightly Gravelly Loam. USCS: ML.		
▲ TP-2	6.00ft.	USDA: Gray Loam. USCS: Sandy ML.		
★ TP-3	2.00ft.	USDA: Gray Very Gravelly Loam. USCS: GM with Sand.		
⊙ TP-3	4.00ft.	USDA: Gray Loam. USCS: ML.		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-1	3.0ft.	19	0.563	0.08					29.4	
⊠ TP-2	4.0ft.	4.75							75.9	
▲ TP-2	6.0ft.	2							69.9	
★ TP-3	2.0ft.	37.5	23.784	0.119					23.6	
⊙ TP-3	4.0ft.	2							90.8	

Report Distribution

ES-5332

<u>EMAIL ONLY</u>

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4320 Island Crest Way
Mercer Island, Washington 98040

Attention: Mr. Alan Chiu