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CITY OF MUKILTEO

RILEYGROUP

GEOTECHNICAL ENGINEERING REPORT

PREPARED BY:

THE RILEY GROUP, INC.
17522 BOTHELL WAY NORTHEAST
BOTHELL, WASHINGTON 98011

PREPARED FOR:

BRIAN COLE
9326 EVERGREEN WAY
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RGI PROJECT NO. 2018-113

MUKILTEO BEVERLY PARK
12900 BEVERLY PARK ROAD
MUKILTEO, WASHINGTON

MAY 4, 2018

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RILEYGROUP

May 4, 2018

Brian Cole
9326 Evergreen Way
Everett, Washington 98204

Subject: **Geotechnical Engineering Report**
Mukilteo Beverly Park
12900 Beverly Park Road
Mukilteo, Washington
RGI Project No. 2018-113

Dear Mr. Brian Cole:

As requested, The Riley Group, Inc. (RGI) has performed a Geotechnical Engineering Report (GER) for the Mukilteo Beverly Park located at 12900 Beverly Park Road, Mukilteo, Washington. Our services were completed in accordance with our proposal PRP2018-105 and authorized by you on April 27, 2018. The information in this GER is based on our understanding of the proposed construction, and the soil and groundwater conditions encountered in the test pits and hand auger completed by RGI at the site on March 20, 2018.

RGI recommends that you submit the project plans and specifications to RGI for a general review so that we may confirm that the recommendations in this GER are interpreted and implemented properly in the construction documents. RGI also recommends that a representative of our firm be present on site during portions of the project construction to confirm that the soil and groundwater conditions are consistent with those that form the basis for the engineering recommendations in this GER.

If you have any questions or require additional information, please contact us.

Respectfully submitted,

THE RILEY GROUP, INC.

KRISTINA MARIE WELLER
STATE OF WASHINGTON
33182
REGISTERED
PROFESSIONAL ENGINEER

5/4/18

Collin McCracken, GIT
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LIST OF FIGURES AND APPENDICES

Executive Summary

This Executive Summary should be used in conjunction with the entire Geotechnical Engineering Report (GER) for design and/or construction purposes. It should be recognized that specific details were not included or fully developed in this section, and the GER must be read in its entirety for a comprehensive understanding of the items contained herein. Section 7.0 should be read for an understanding of limitations.

RGI's geotechnical scope of work included the advancement of 3 test pits and 1 hand auger to approximate depths of 8 feet below existing site grades.

Based on the information obtained from our subsurface exploration, the site is suitable for development of the proposed project. The following geotechnical considerations were identified:

Soil Conditions: The soils encountered during field exploration include medium dense silty sand with trace gravel over dense glacial till.

Groundwater: No groundwater seepage was encountered during our subsurface exploration.

Foundations: Foundations for the proposed building may be supported on conventional spread footings bearing on medium dense to dense native soil or structural fill.

Slab-on-grade: Slab-on-grade floors and slabs for the proposed building can be supported on medium dense to dense native soil or structural fill.

Pavements: The following pavement sections are recommended:

- **For heavy truck traffic areas**: 3 inches of Hot Mix Asphalt (HMA) over 6 inches of crushed rock base (CRB)
- **For general parking areas**: 2 inches of HMA over 4 inches of CRB
- **For concrete pavement areas**: 5 inches of concrete over 4 inches of CRB

1.0 Introduction

This Geotechnical Engineering Report (GER) presents the results of the geotechnical engineering services provided for the Mukilteo Beverly Park in Mukilteo, Washington. The purpose of this evaluation is to assess subsurface conditions and provide geotechnical recommendations for the proposed construction.. Our scope of services included field explorations, laboratory testing, engineering analyses, and preparation of this GER.

The recommendations in the following sections of this GER are based upon our current understanding of the proposed site development as outlined below. If actual features vary or changes are made, RGI should review them in order to modify our recommendations as required. In addition, RGI requests to review the site grading plan, final design drawings and specifications when available to verify that our project understanding is correct and that our recommendations have been properly interpreted and incorporated into the project design and construction.

2.0 Project description

The project site is located at 12900 Beverly Park Road in Mukilteo, Washington. The approximate location of the site is shown on Figure 1.

The site is currently occupied by a single family residence and heavy vegetation. RGI understands the existing structure will be demolished, and the site will be developed into a commercial building and associated parking.

At the time of preparing this GER, building plans were not available for our review. Based on our experience with similar construction, RGI anticipates that the proposed building will be supported on perimeter walls with bearing loads of two to six kips per linear foot, and a series of columns with a maximum load up to 30 kips. Slab-on-grade floor loading of 250 pounds per square foot (psf) are expected.

3.0 Field Exploration and Laboratory Testing

3.1 Field Exploration

On March 20, 2018, RGI observed the excavation of 3 test pits and one hand auger. The approximate exploration locations are shown on Figure 2.

Field logs of each exploration were prepared by the geologist that continuously observed the excavation. These logs included visual classifications of the materials encountered during excavation as well as our interpretation of the subsurface conditions between samples. The test pit and hand auger logs included in Appendix A represent an interpretation of the field logs and include modifications based on laboratory observation and analysis of the samples.

3.2 LABORATORY TESTING

During the field exploration, a representative portion of each recovered sample was sealed in containers and transported to our laboratory for further visual and laboratory examination. Selected samples retrieved from the test pits and hand auger were tested for moisture content and grain size analysis to aid in soil classification and provide input for the recommendations provided in this GER. The results and descriptions of the laboratory tests are enclosed in Appendix A.

4.0 Site Conditions

4.1 SURFACE

The subject site is a rectangular-shaped parcel of land approximately 0.89 acres in size. The site is bound to the north by commercial property, to the east by residential and commercial properties, to the south by Beverly Park Road, and to the west by commercial property.

The existing site is occupied by a single family residence, trees and other vegetation. The site slopes to the north-northwest with an overall elevation difference of approximately 25 feet.

4.2 GEOLOGY

Review of the *Distribution and Description of Geologic Units in the Mukilteo Quadrangle, Washington,* by James P. Minard (1982) indicates that the soil in the project vicinity is mapped as Vashon till (Qvt), which is a non-sorted mixture of clay, silt, sand, pebbles, cobbles and boulders (diamiction), all in variable amounts. It generally is quite sandy but locally contains much clay, mostly a result of the materials overridden and incorporated in the ice until redeposited. It includes some lenses of stratified material, particularly near its base. These descriptions are generally similar to the findings in our field explorations.

4.3 SOILS

The soils encountered during field exploration include medium dense silty sand with trace gravel over dense glacial till.

More detailed descriptions of the subsurface conditions encountered are presented in the test pits and hand auger included in Appendix A. Sieve analysis was performed on two selected soil samples. Grain size distribution curves are included in Appendix A.

4.4 GROUNDWATER

No groundwater seepage was encountered during our subsurface exploration. No surface water was encountered.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the explorations were performed. In addition, perched water can develop within seams and layers contained in fill soils or higher permeability soils overlying less permeable soils following periods of heavy or prolonged precipitation. Therefore, groundwater levels during construction or at other times in the future may be higher or lower than the levels indicated on the logs. Groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.5 SEISMIC CONSIDERATIONS

Based on the 2012/2015 International Building Code (IBC), RGI recommends the follow seismic parameters for design.

Table 1 2012/2015 IBC

Parameter	Value
Site Soil Class[1]	D[2]
Site Latitude	47.8814° N
Site Longitude	122.2824° W
Short Period Spectral Response Acceleration, S_S (g)	1.403
1-Second Period Spectral Response Acceleration, S_1 (g)	0.551
Adjusted Short Period Spectral Response Acceleration, S_{MS} (g)	1.403
Adjusted 1-Second Period Spectral Response Acceleration, S_{M1} (g)	0.827

1. Note: In general accordance with Chapter 20 of ASCE 7-10. The Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.

2. Note: The 2012/2015 IBC and ASCE 7-10 require a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope of our services does not include the required 100 foot soil profile determination. Test pits extended to a maximum depth of 8 feet, and this seismic site class definition considers that similar soil continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations from a seismic event. Liquefaction mainly affects geologically recent deposits of fine-grained sands that are below the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction, thus reducing or eliminating the soil's strength.

RGI reviewed the results of the field and laboratory testing and assessed the potential for liquefaction of the site's soil during an earthquake. Since the site is underlain by glacial till, RGI considers that the possibility of liquefaction during an earthquake is minimal.

4.6 Geologic Hazard Areas

Regulated geologically hazardous areas include erosion, landslide, earthquake, or other geological hazards. Based on the definition in the Mukilteo Municipal Code, the site contains an area mapped as steep slope, in the northeast corner. The proposed development is not expected to extend to the northeast corner of the site.

5.0 Discussion and Recommendations

5.1 Geotechnical Considerations

Based on our study, the site is suitable for the proposed construction from a geotechnical standpoint. Foundations for the proposed building can be supported on conventional spread footings bearing on medium dense to dense native soil or structural fill. Slab-on-grade floors and pavements can be similarly supported.

Detailed recommendations regarding the above issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

5.2 Earthwork

Earthwork is expected to include clearing and grading the site, excavating and backfilling foundations, utility installation and backfill, and parking and slab subgrade preparation.

5.2.1 Erosion and Sediment Control

Potential sources or causes of erosion and sedimentation depend on construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. The impacts on erosion-prone areas can be reduced by implementing an erosion and sedimentation control plan. The plan should be designed in accordance with applicable city and/or county standards.

RGI recommends the following erosion control Best Management Practices (BMPs):

- Scheduling site preparation and grading for the drier summer and early fall months and undertaking activities that expose soil during periods of little or no rainfall
- Retaining existing vegetation whenever feasible
- Establishing a quarry spall construction entrance
- Installing siltation control fencing or anchored straw or coir wattles on the downhill side of work areas
- Covering soil stockpiles with anchored plastic sheeting
- Revegetating or mulching exposed soils with a minimum 3-inch thickness of straw if surfaces will be left undisturbed for more than one day during wet weather or one week in dry weather

- Directing runoff away from exposed soils and slopes
- Minimizing the length and steepness of slopes with exposed soils and cover excavation surfaces with anchored plastic sheeting (Graded and disturbed slopes should be tracked in place with the equipment running perpendicular to the slope contours so that the track marks provide a texture to help resist erosion and channeling. Some sloughing and raveling of slopes with exposed or disturbed soil should be expected.)
- Decreasing runoff velocities with check dams, straw bales or coir wattles
- Confining sediment to the project site
- Inspecting and maintaining erosion and sediment control measures frequently (The contractor should be aware that inspection and maintenance of erosion control BMPs is critical toward their satisfactory performance. Repair and/or replacement of dysfunctional erosion control elements should be anticipated.)

Permanent erosion protection should be provided by reestablishing vegetation using hydroseeding and/or landscape planting. Until the permanent erosion protection is established, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

5.2.2 STRIPPING

Stripping efforts should include removal of pavements, vegetation, organic materials, and deleterious debris from areas slated for building, pavement, and utility construction. The test pits encountered up to 14 inches of topsoil and rootmass. Deeper areas of stripping may be required in forested or heavily vegetated areas of the site.

5.2.3 EXCAVATIONS

All temporary cut slopes associated with the site and utility excavations should be adequately inclined to prevent sloughing and collapse. The site soils consist of medium dense silty sand with trace gravel over dense glacial till.

Accordingly, for excavations more than 4 feet but less than 20 feet in depth, the temporary side slopes should be laid back with a minimum slope inclination of 1H:1V (Horizontal:Vertical). If there is insufficient room to complete the excavations in this manner, or excavations greater than 20 feet in depth are planned, using temporary shoring to support the excavations should be considered. For open cuts at the site, RGI recommends:

- No traffic, construction equipment, stockpiles or building supplies are allowed at the top of cut slopes within a distance of at least five feet from the top of the cut
- Exposed soil along the slope is protected from surface erosion using waterproof tarps and/or plastic sheeting

- Construction activities are scheduled so that the length of time the temporary cut is left open is minimized
- Surface water is diverted away from the excavation
- The general condition of slopes should be observed periodically by a geotechnical engineer to confirm adequate stability and erosion control measures

In all cases, however, appropriate inclinations will depend on the actual soil and groundwater conditions encountered during earthwork. Ultimately, the site contractor must be responsible for maintaining safe excavation slopes that comply with applicable OSHA or WISHA guidelines.

5.2.4 Site Preparation

RGI anticipates that some areas of loose or soft soil will be exposed upon completion of stripping and grubbing. Proofrolling and subgrade verification should be considered an essential step in site preparation. After stripping, grubbing, and prior to placement of structural fill, RGI recommends proofrolling building and pavement subgrades and areas to receive structural fill. These areas should moisture conditioned and compacted to a firm and unyielding condition in order to achieve a minimum compaction level of 95 percent of the modified proctor maximum dry density as determined by the American Society of Testing and Materials D1557-09 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (ASTM D1557).

Proofrolling and adequate subgrade compaction can only be achieved when the soils are within approximately ± 2 percent moisture content of the optimum moisture content. Soils which appear firm after stripping and grubbing may be proofrolled with a heavy compactor, loaded double-axle dump truck, or other heavy equipment under the observation of an RGI representative. This observer will assess the subgrade conditions prior to filling. The need for or advisability of proofrolling due to soil moisture conditions should be determined at the time of construction. In wet areas it may be necessary to hand probe the exposed subgrades in lieu of proofrolling with mechanical equipment.

If fill is placed in areas of the site where existing slopes are steeper than 5:1 (Horizontal:Vertical), the area should be benched to reduce the potential for slippage between existing slopes and fills. Benches should be wide enough to accommodate compaction and earth moving equipment, and to allow placement of horizontal lifts of fill.

Subgrade soils that become disturbed due to elevated moisture conditions should be overexcavated to reveal firm, non-yielding, non-organic soils and backfilled with compacted structural fill. In order to maximize utilization of site soils as structural fill, RGI recommends that the earthwork portion of this project be completed during extended periods of warm and dry weather if possible. If earthwork is completed during the wet season (typically November through May) it will be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork will require additional mitigative measures beyond that which would be expected during the drier summer and fall months.

5.2.5 Structural Fill

Once stripping, clearing and other preparing operations are complete, cuts and fills can be made to establish desired building grades. Prior to placing fill, RGI recommends proof-rolling as described above.

RGI recommends fill below the foundation and floor slab, behind retaining walls, and below pavement and hardscape surfaces be placed in accordance with the following recommendations for structural fill. The structural fill should be placed after completion of site preparation procedures as described above.

The suitability of excavated site soils and import soils for compacted structural fill use will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (that portion passing the U.S. No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve. Soils containing more than about 5 percent fines cannot be consistently compacted to a dense, non-yielding condition when the moisture content is more than 2 percent above or below optimum. Optimum moisture content is that moisture that results in the greatest compacted dry density with a specified compactive effort.

Non-organic site soils are only considered suitable for structural fill provided that their moisture content is within about two percent of the optimum moisture level as determined by ASTM D1557. Excavated site soils may not be suitable for re-use as structural fill depending on the moisture content and weather conditions at the time of construction. If soils are stockpiled for future reuse and wet weather is anticipated, the stockpile should be protected with plastic sheeting that is securely anchored.

Even during dry weather, moisture conditioning (such as, windrowing and drying) of site soils to be reused as structural fill may be required. Even during the summer, delays in grading can occur due to excessively high moisture conditions of the soils or due to precipitation. If wet weather occurs, the upper wetted portion of the site soils may need to be scarified and allowed to dry prior to further earthwork, or may need to be wasted from the site.

The site soils are moisture sensitive and may require moisture conditioning prior to their use as structural fill and will not be useable in wet weather. If on-site soils are or become unusable, it may become necessary to import clean, granular soils to complete site work that meet the grading requirements listed in Table 2 to be used as structural fill.

Table 2 Structural Fill Gradation

U.S. Sieve Size	Percent Passing
4 inches	100
No. 4 sieve	22 to 100
No. 200 sieve	0 to 5*

*Based on minus 3/4 inch fraction.

Prior to use, an RGI representative should observe and test all materials imported to the site for use as structural fill. Structural fill materials should be placed in uniform loose layers not exceeding 12 inches and compacted as specified in Table 3. The soil's maximum density and optimum moisture should be determined by ASTM D1557.

Table 3 Structural Fill Compaction ASTM D1557

Location	Material Type	Minimum Compaction Percentage	Moisture Content Range	
Foundations	On-site granular or approved imported fill soils:	95	+2	-2
Retaining Wall Backfill	On-site granular or approved imported fill soils:	92	+2	-2
Slab-on-grade	On-site granular or approved imported fill soils:	95	+2	-2
General Fill (non-structural areas)	On-site soils or approved imported fill soils:	90	+3	-2
Pavement – Subgrade and Base Course	On-site granular or approved imported fill soils:	95	+2	-2

Placement and compaction of structural fill should be observed by RGI. A representative number of in-place density tests should be performed as the fill is being placed to confirm that the recommended level of compaction is achieved.

5.2.6 Cut and Fill Slopes

All permanent cut and fill slopes should be graded with a finished inclination no greater than 2H:1V. Upon completion of construction, the slope face should be trackwalked, compacted and vegetated, or provided with other physical means to guard against erosion. All fill placed for slope construction should meet the structural fill requirements as described in Section 5.2.5.

Final grades at the top of the slopes must promote surface drainage away from the slope crest. Water must not be allowed to flow in an uncontrolled fashion over the slope face. If it is necessary to direct surface runoff towards the slope, it should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe of the slope.

5.2.7 WET WEATHER CONSTRUCTION CONSIDERATIONS

RGI recommends that preparation for site grading and construction include procedures intended to drain ponded water, control surface water runoff, and to collect shallow subsurface seepage zones in excavations where encountered. It will not be possible to successfully compact the subgrade or utilize on-site soils as structural fill if accumulated water is not drained prior to grading or if drainage is not controlled during construction. Attempting to grade the site without adequate drainage control measures will reduce the amount of on-site soil effectively available for use, increase the amount of select import fill materials required, and ultimately increase the cost of the earthwork phases of the project. Free water should not be allowed to pond on the subgrade soils. RGI anticipates that the use of berms and shallow drainage ditches, with sumps and pumps in utility trenches, will be required for surface water control during wet weather and/or wet site conditions.

5.3 FOUNDATIONS

Following site preparation and grading, the proposed building foundation can be supported on conventional spread footings bearing on dense native soil or structural fill. Loose, organic, or other unsuitable soils may be encountered in the proposed building footprint. If unsuitable soils are encountered, they should be overexcavated and backfilled with structural fill.

Table 4 Foundation Design

Design Parameter	Value
Allowable Bearing Capacity	2,500 psf[1]
Friction Coefficient	0.30
Passive pressure (equivalent fluid pressure)	250 pcf[2]
Minimum foundation dimensions	Columns: 24 inches Walls: 16 inches

1. psf = pounds per square foot
2. pcf = pounds per cubic foot

The allowable foundation bearing pressures apply to dead loads plus design live load conditions. For short-term loads, such as wind and seismic, a 1/3 increase in this allowable capacity may be used. At perimeter locations, RGI recommends not including the upper 12 inches of soil in the computation of passive pressures because they can be affected by weather or disturbed by future grading activity. The passive pressure value assumes the foundation will be constructed neat against competent soil or backfilled with structural fill as described in Section 5.2.5. The recommended base friction and passive resistance value includes a safety factor of about 1.5.

Perimeter foundations exposed to weather should be at a minimum depth of 18 inches below final exterior grades. Interior foundations can be constructed at any convenient depth below the floor slab. Finished grade is defined as the lowest adjacent grade within 5 feet of the foundation for perimeter (or exterior) footings and finished floor level for interior footings.

With spread footing foundations designed in accordance with the recommendations in this section, maximum total and differential post-construction settlements of 1 inch and 1/2 inch, respectively, should be expected.

5.4 Retaining Walls

If retaining walls are needed in the building area or for an underground vault, RGI recommends cast-in-place concrete walls be used. The magnitude of earth pressure development on retaining walls will partly depend on the quality of the wall backfill. RGI recommends placing and compacting wall backfill as structural fill. Wall drainage will be needed behind the wall face. A typical retaining wall drainage detail is shown in Figure 3.

With wall backfill placed and compacted as recommended, and drainage properly installed, RGI recommends using the values in the following table for design.

Table 5 Retaining Wall Design

Design Parameter	Value
Allowable Bearing Capacity - Structural Fill Dense native soils	2,500 psf 4,000 psf
Active Earth Pressure (unrestrained walls)	35 pcf
At-rest Earth Pressure (restrained walls)	50 pcf

For seismic design, an additional uniform load of 7 times the wall height (H) for unrestrained walls and 14H in psf for restrained walls should be applied to the wall surface.

Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 5.3.

5.5 Slab-on-Grade Construction

Once site preparation has been completed as described in Section 5.2, suitable support for slab-on-grade construction should be provided. RGI recommends that the concrete slab be placed on top of medium dense native soil or structural fill. Immediately below the floor slab, RGI recommends placing a four-inch thick capillary break layer of clean, free-draining sand or gravel that has less than five percent passing the U.S. No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

Where moisture by vapor transmission is undesirable, an 8- to 10-millimeter thick plastic membrane should be placed on a 4-inch thick layer of clean gravel.

For the anticipated floor slab loading, we estimate post-construction floor settlements of 1/4- to 1/2-inch. For thickness design of the slab subjected to point loading from storage racks, RGI recommends using a subgrade modulus (K_S) of 150 pounds per square inch per inch of deflection.

5.6 Drainage

5.6.1 Surface

Final exterior grades should promote free and positive drainage away from the building area. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. For non-pavement locations, RGI recommends providing a minimum drainage gradient of 3 percent for a minimum distance of 10 feet from the building perimeter. In paved locations, a minimum gradient of 1 percent should be provided unless provisions are included for collection and disposal of surface water adjacent to the structure.

5.6.2 Subsurface

RGI recommends installing perimeter foundation drains. A typical footing drain detail is shown on Figure 4. The foundation drains and roof downspouts should be tightlined separately to an approved discharge facility. Subsurface drains must be laid with a gradient sufficient to promote positive flow to a controlled point of approved discharge.

5.6.3 Infiltration

RGI understands that a dispersion system is being considered for the on-site disposal of stormwater towards the wetland at the north-northwest corner of the site. Based on the surface and subsurface conditions dispersion as proposed should be feasible. The vegetation in the dispersion flow path should be maintained. We do not expect the dispersion will impact the stability of the site.

5.7 UTILITIES

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) specifications. For site utilities located within the right-of-ways, bedding and backfill should be completed in accordance with City of Mukilteo specifications. At a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 5.2.5. Where utilities occur below unimproved areas, the degree of compaction can be reduced to a minimum of 90 percent of the soil's maximum density as determined by the referenced ASTM D1557. As noted, soils excavated on site may not be suitable for use as backfill material. Imported structural fill meeting the gradation provided in Table 2 should be used for trench backfill.

5.8 PAVEMENTS

Pavement subgrades should be prepared as described in Section 5.2 and as discussed below. Regardless of the relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proof-rolled with heavy construction equipment to verify this condition.

5.8.1 FLEXIBLE PAVEMENTS

With the pavement subgrade prepared as described above, RGI recommends the following pavement sections for parking and drive areas paved with flexible asphalt concrete surfacing.

- **For truck drive areas:** 3 inches of Hot Mix Asphalt (HMA) over 6 inches of crushed rock base (CRB)
- **For parking areas:** 2 inches of HMA over 4 inches of CRB

5.8.2 CONCRETE PAVEMENTS

With the pavement subgrade prepared as described above, RGI recommends the following pavement sections for parking and drive areas paved with concrete surfacing.

- **For concrete pavement areas:** 5 inches of concrete over 4 inches of CRB

The paving materials used should conform to the WSDOT specifications for HMA, concrete paving, and CRB surfacing (9-03.9(3) Crushed Surfacing).

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability.

For optimum pavement performance, surface drainage gradients of no less than 2 percent are recommended. Also, some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

6.0 Additional Services

RGI is available to provide further geotechnical consultation throughout the design phase of the project. RGI should review the final design and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design and construction.

RGI is also available to provide geotechnical engineering and construction monitoring services during construction. The integrity of the earthwork and construction depends on proper site preparation and procedures. In addition, engineering decisions may arise in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this scope of work. If these services are desired, please let us know and we will prepare a cost proposal.

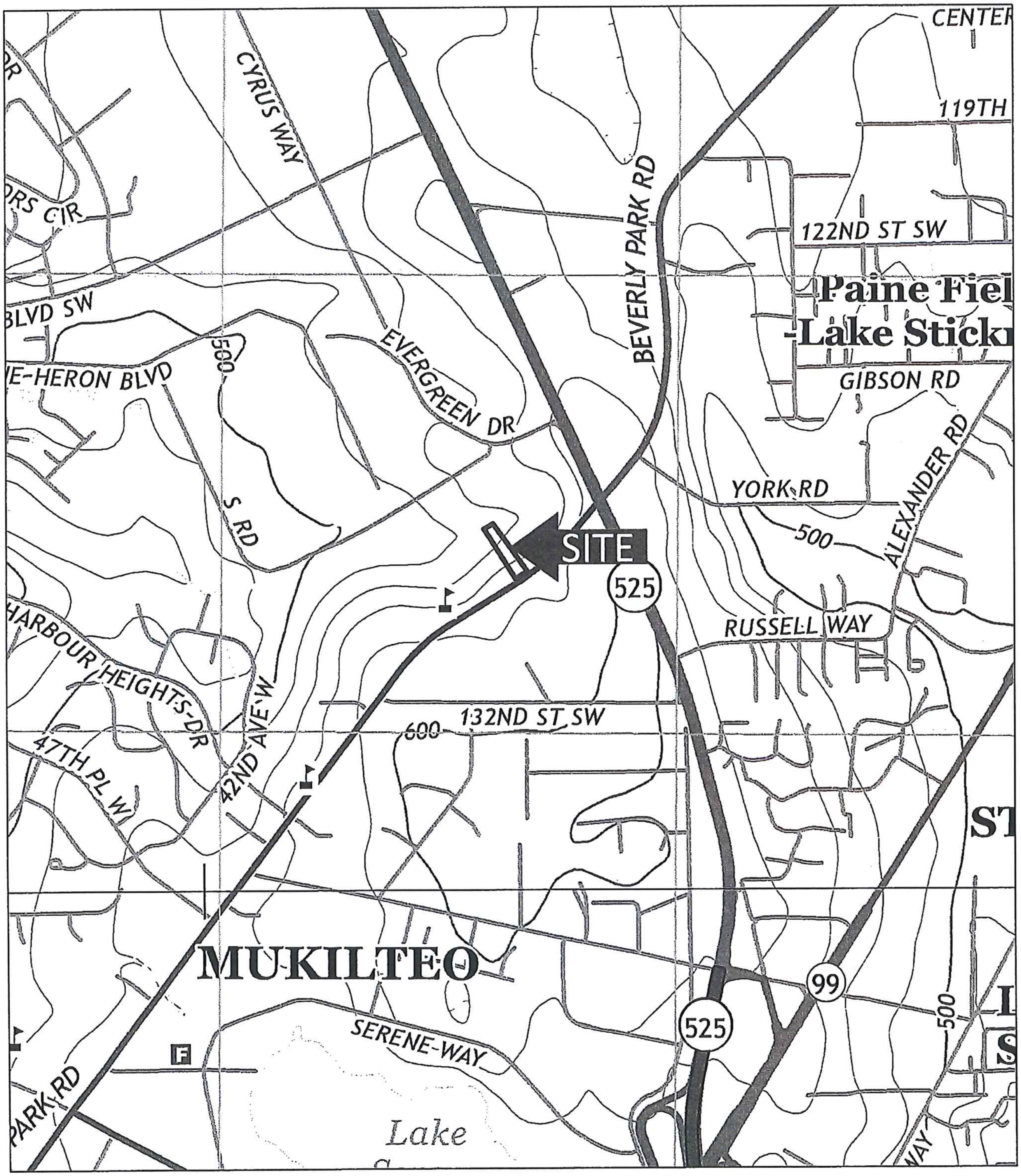
7.0 Limitations

This GER is the property of RGI, Brian Cole, and its designated agents. Within the limits of the scope and budget, this GER was prepared in accordance with generally accepted geotechnical engineering practices in the area at the time this GER was issued. This GER is intended for specific application to the Mukilteo Beverly Park project in Mukilteo, Washington, and for the exclusive use of Brian Cole and its authorized representatives. No other warranty, expressed or implied, is made. Site safety, excavation support, and dewatering requirements are the responsibility of others.

The scope of services for this project does not include either specifically or by implication any environmental or biological (for example, mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, we can provide a proposal for these services.

The analyses and recommendations presented in this GER are based upon data obtained from the explorations performed on site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, RGI should be requested to reevaluate the recommendations in this GER prior to proceeding with construction.

It is the client's responsibility to see that all parties to the project, including the designers, contractors, subcontractors, are made aware of this GER in its entirety. The use of information contained in this GER for bidding purposes should be done at the contractor's option and risk.



USGS, 2014, Issaquah, Washington
USGS, 2014, Edmonds East, Washington
7.5-Minute Quadrangle

Approximate Scale: 1"=1000'

0 500 1000 2000

N

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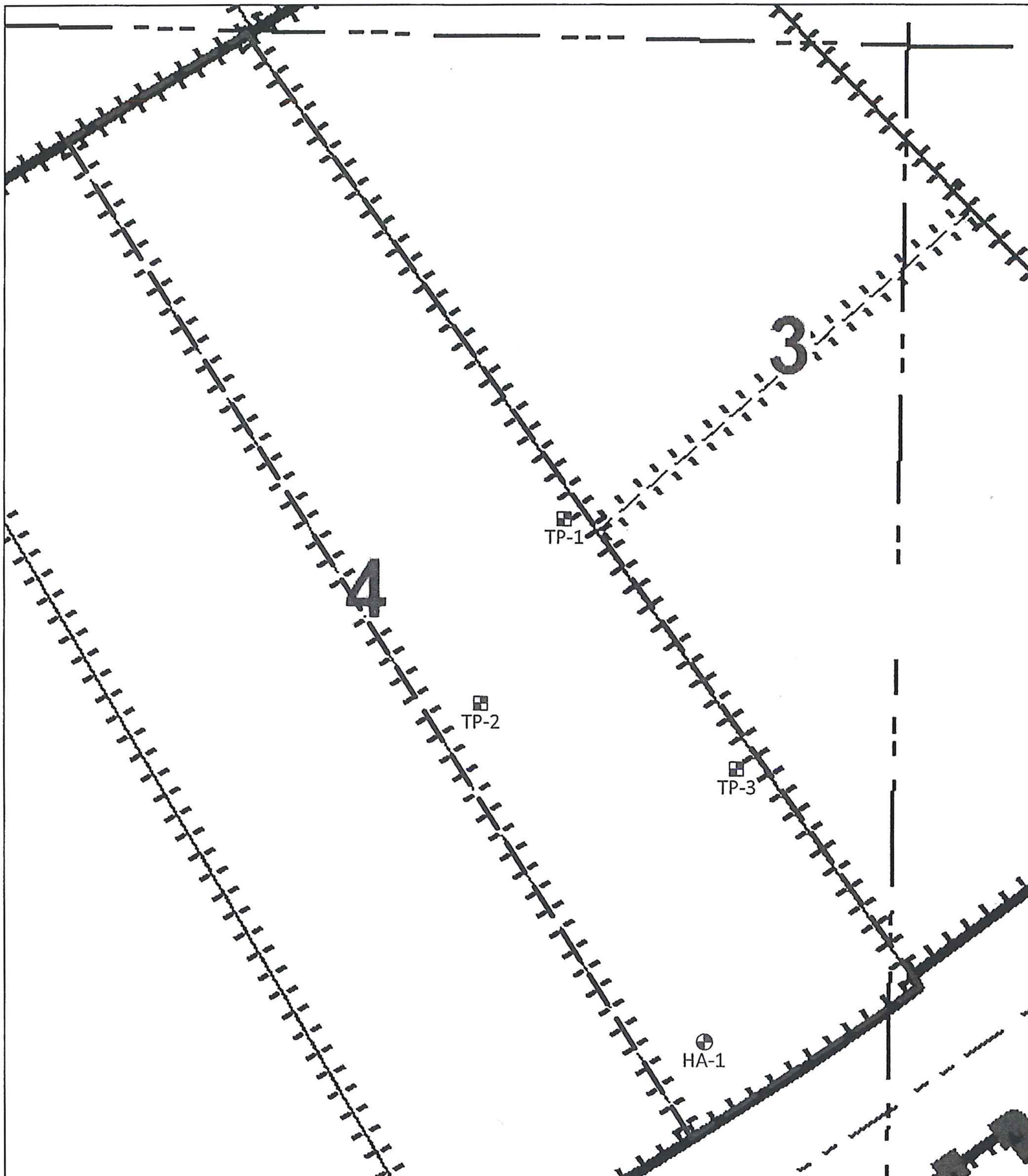
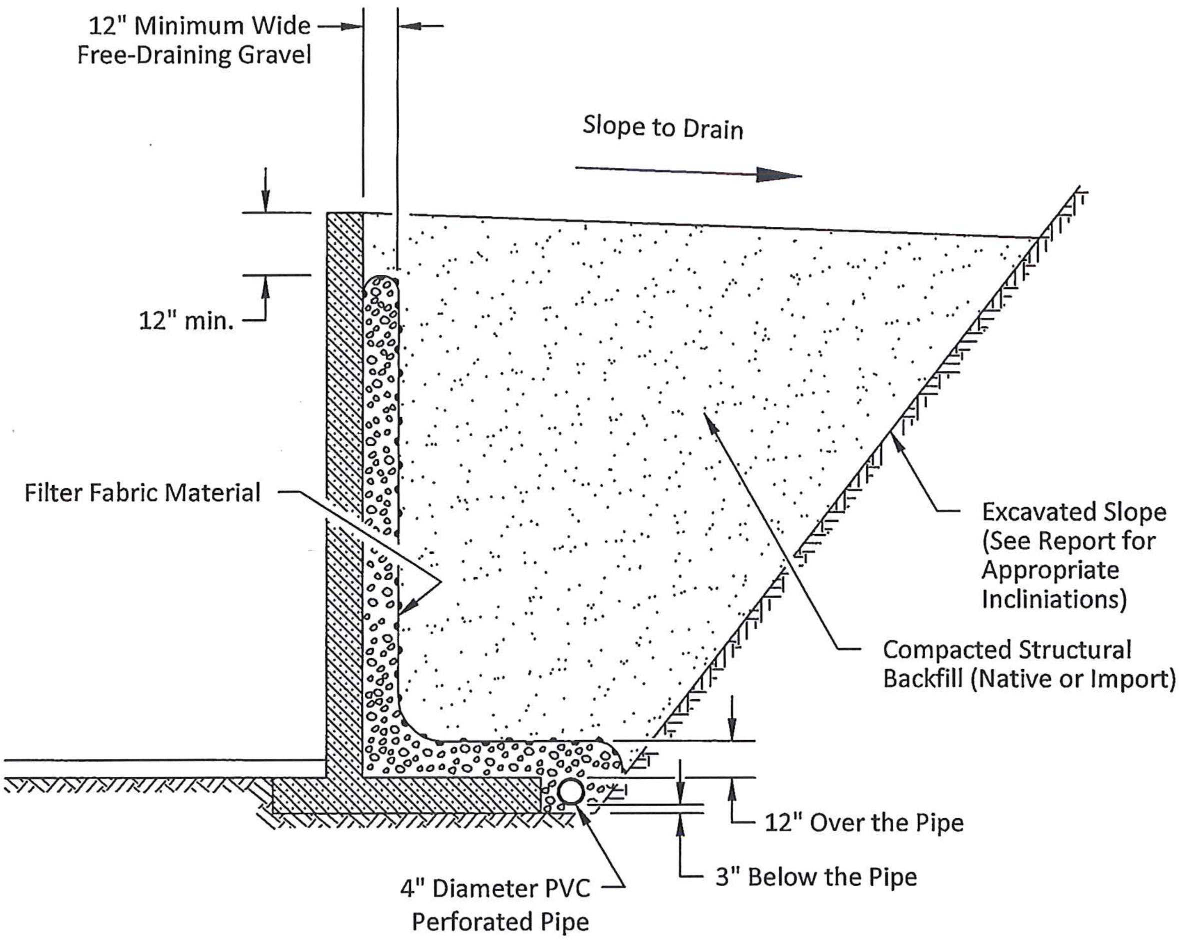
Mukilteo Beverly Park		Figure 1
RGI Project Number 2018-113	Site Vicinity Map	Date Drawn: 05/2018
Address: 12900 Beverly Park Road, Mukilteo, Washington 98275		



= Hand auger by RGI, 3/20/18
= Test pit by RGI, 3/20/18
= Site boundary

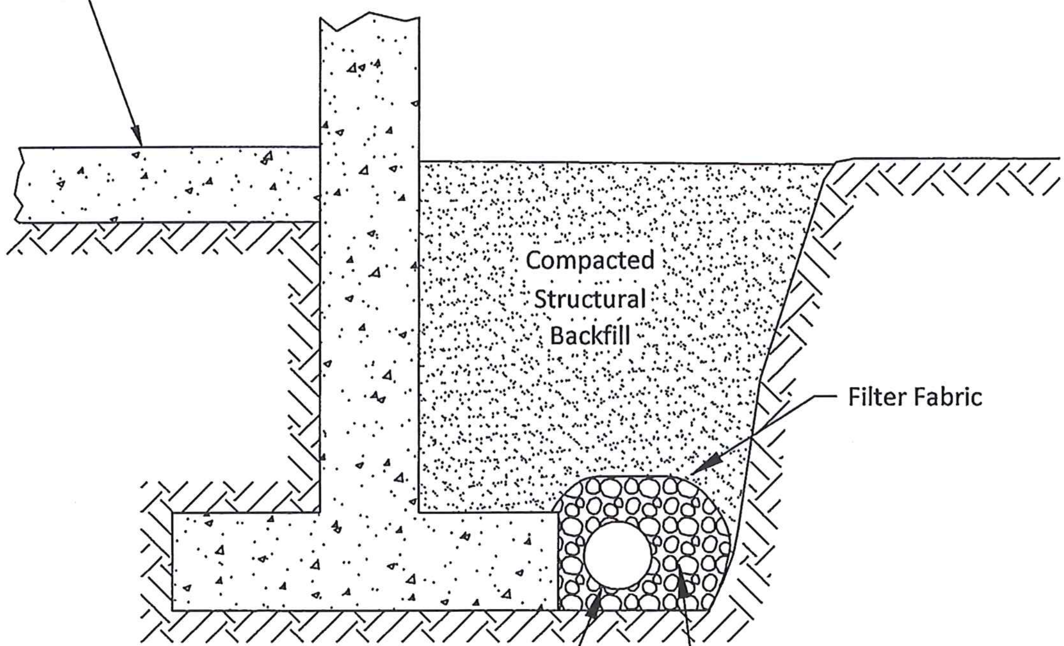
Approximate Scale: 1"=50'
0 25 50 100
N

RILEYGROUP Corporate Office 17522 Bothell Way Northeast Bothell, Washington 98011 Phone: 425.415.0551 Fax: 425.415.0311	Mukilteo Beverly Park		Figure 2
	RGI Project Number 2018-113	Geotechnical Exploration Plan	Date Drawn: 05/2018
	Address: 12900 Beverly Park Road, Mukilteo, Washington 98275		



Not to Scale

RILEYGROUP Corporate Office 17522 Bothell Way Northeast Bothell, Washington 98011 Phone: 425.415.0551 Fax: 425.415.0311	Mukilteo Beverly Park		Figure 3
	RGI Project Number 2018-113	Retaining Wall Drainage Detail	Date Drawn: 05/2018
	Address: 12900 Beverly Park Road, Mukilteo, Washington 98275		



Not to Scale

RILEYGROUP Corporate Office 17522 Bothell Way Northeast Bothell, Washington 98011 Phone: 425.415.0551 Fax: 425.415.0311	Mukilteo Beverly Park		Figure 4
	RGI Project Number 2018-113	Typical Footing Drain Detail	Date Drawn: 05/2018
	Address: 12900 Beverly Park Road, Mukilteo, Washington 98275		

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

On March 20, 2018, RGI performed field explorations using a rubber tired backhoe and a hand auger. We explored subsurface soil conditions at the site by observing the excavation of 3 test pits and one hand auger to a maximum depth of 8 feet below existing grade. The test pit and hand auger locations are shown on Figure 2. The test pit and hand auger locations were approximately determined by measurements from existing property lines and paved roads.

A geologist from our office conducted the field exploration and classified the soil conditions encountered, maintained a log of each test exploration, obtained representative soil samples, and observed pertinent site features. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS).

Representative soil samples obtained from the explorations were placed in closed containers and taken to our laboratory for further examination and testing. As a part of the laboratory testing program, the soil samples were classified in our in house laboratory based on visual observation, texture, plasticity, and the limited laboratory testing described below.

Moisture Content Determinations

Moisture content determinations were performed in accordance with ASTM D2216-10 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (ASTM D2216) on representative samples obtained from the exploration in order to aid in identification and correlation of soil types. The moisture content of typical sample was measured and is reported on the test pits logs.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses was determined using D6913-04(2009) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis (ASTM D6913) on three of the samples.

Project Name: **Mukilteo Beverly Park** Project Number: Client: **Brian Cole**	RILEYGROUP Test Pit No.: TP-1 **Sheet 1 of 1**

Date(s) Excavated: **3/20/18**	Logged By **CM**	Surface Conditions: **Brush**
Excavation Method: **Track hoe**	Bucket Size: **18"**	Total Depth of Excavation: **6 feet**
Excavator Type: **Track hoe**	Excavating Contractor: **Client**	Approximate Surface Elevation **Not surveyed**
Groundwater Level and Date Measured **Not encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **12900 Beverly Park Road Mukilteo, Washington 98275**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Tpsl		14" Topsoil and rootmass	
			TP1-1	SM		Reddisih brown silty SAND with trace gravel, moist, medium dense	29% Moisture
				SM		Gray silty SAND with trace gravel, moist, dense, slight iron oxidation at surface of layer (Till)	
			TP1-4				17% Moisture
	5						
						Test pit terminated at 6 feet bgs.	
	10						

Project Name: **Mukilteo Beverly Park** Project Number: Client: **Brian Cole**	RILEYGROUP Test Pit No.: TP-2 **Sheet 1 of 1**

Date(s) Excavated: **3/20/18**	Logged By **CM**	Surface Conditions: **Brush**
Excavation Method: **Track hoe**	Bucket Size: **18"**	Total Depth of Excavation: **5.5 feet**
Excavator Type: **Track hoe**	Excavating Contractor: **Client**	Approximate Surface Elevation **Not surveyed**
Groundwater Level and Date Measured **Not encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **12900 Beverly Park Road Mukilteo, Washington 98275**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Tpsl		12" Topsoil and rootmass	
				SM		Reddisih brown silty SAND with trace gravel, moist, medium dense	
						Becomes tan	
			TP2-2				17% Moisture
				SM		Gray silty SAND with some gravel, moist, dense, slight iron oxidation at surface of layer (Till)	
			TP2-4				18% Moisture
	5						
						Test pit terminated at 5.5 feet bgs.	
	10						

Project Name: **Mukilteo Beverly Park**	RILEYGROUP Test Pit No.: TP-3
Project Number:	**Sheet 1 of 1**
Client: **Brian Cole**	

Date(s) Excavated: **3/20/18**	Logged By **CM**	Surface Conditions: **Grass**
Excavation Method: **Track hoe**	Bucket Size: **18"**	Total Depth of Excavation: **6 feet**
Excavator Type: **Track hoe**	Excavating Contractor: **Client**	Approximate Surface Elevation **Not surveyed**
Groundwater Level and Date Measured **Not encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **12900 Beverly Park Road Mukilteo, Washington 98275**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Tpsl		11" Topsoil and rootmass	
				SM		Reddisih brown silty SAND with trace gravel, moist, medium dense	
			TP3-2				22% Moisture
				SM		Gray silty SAND with some gravel, moist, dense, slight iron oxidation at surface of layer (Till)	
	5		TP3-5				17% Moisture
						Test pit terminated at 6 feet bgs.	
	10						

Project Name: **Mukilteo Beverly Park** Project Number: Client: **Brian Cole**	RILEYGROUP — Test Pit No.: HA-1 **Sheet 1 of 1**

Date(s) Excavated: **3/20/18**	Logged By **CM**	Surface Conditions: **Grass**
Excavation Method: **Hand Auger**	Bucket Size: **4"**	Total Depth of Excavation: **3.5 feet**
Excavator Type: **Hand Auger**	Excavating Contractor: **Client**	Approximate Surface Elevation **Not surveyed**
Groundwater Level and Date Measured **Not encountered**	Sampling Method(s) **Grab**	Compaction Method **Bucket tamp**
Test Pit Backfill: **Cuttings**	Location **12900 Beverly Park Road Mukilteo, Washington 98275**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0			Tpsl		4" Topsoil and rootmass	
				SM		Reddisih brown silty SAND, moist, medium dense	
			HA1-1				21% Moisture
				SM		Gray silty SAND with some gravel, moist, dense, slight iron oxidation at surface of layer (Till)	
			HA1-3				17% Moisture
						Test pit terminated at 3.5 feet bgs.	
	5						
	10						

Project Name: **Mukilteo Beverly Park**	RILEYGROUP **Key to Logs**
Project Number:	**Sheet 1 of 1**
Client: **Brian Cole**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 USCS Symbol: USCS symbol of the subsurface material.
6 Graphic Log: Graphic depiction of the subsurface material encountered.
7 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
8 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Silty SAND (SM)

Topsoil

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Continuous
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
— — Inferred/gradational contact between strata
—?— Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Mukilteo Beverly Park		SAMPLE ID/TYPE	TP1-1
PROJECT NO.	2018-113		SAMPLE DEPTH	1'
TECH/TEST DATE	CM	3/20/2018	DATE RECEIVED	3/20/2018

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	177.8
Wt Dry Soil & Tare (gm)	(w2)	141.0
Weight of Tare (gm)	(w3)	15.7
Weight of Water (gm)	(w4=w1-w2)	36.8
Weight of Dry Soil (gm)	(w5=w2-w3)	125.3
Moisture Content (%)	(w4/w5)*100	29

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

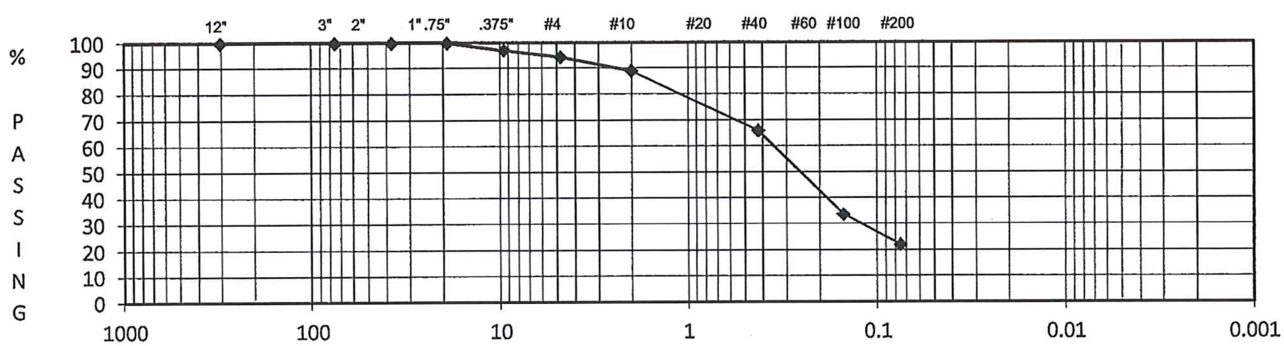
	Weight Of Sample (gm)	141.0
	Tare Weight (gm)	15.7
(W6)	Total Dry Weight (gm)	125.3

% COBBLES	0.0
% C GRAVEL	0.0
% F GRAVEL	5.7
% C SAND	5.3
% M SAND	23.1
% F SAND	43.7
% FINES	22.2
% TOTAL	100.0

D10 (mm)	
D30 (mm)	
D60 (mm)	
Cu	
Cc	

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.7	0.00	0.00	100.00	cobbles
3.0"	15.7	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.7	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	15.7	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	19.4	3.70	2.95	97.05	fine gravel
#4	22.8	7.10	5.67	94.33	coarse sand
#10	29.5	13.80	11.01	88.99	medium sand
#20					medium sand
#40	58.4	42.70	34.08	65.92	fine sand
#60					fine sand
#100	98.7	83.00	66.24	33.76	fine sand
#200	113.2	97.50	77.81	22.19	fines
PAN					silt/clay



Grain size in millimeters

DESCRIPTION	Silty SAND with trace gravel
USCS	SM

Prepared For:
Brian Cole

Reviewed By:
KMW

RILEYGROUP

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GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Mukilteo Beverly Park	SAMPLE ID/TYPE	TP1-4
PROJECT NO.	2018-113	SAMPLE DEPTH	4'
TECH/TEST DATE	CM 3/20/2018	DATE RECEIVED	3/20/2018

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	453.1
Wt Dry Soil & Tare (gm)	(w2)	388.7
Weight of Tare (gm)	(w3)	15.4
Weight of Water (gm)	(w4=w1-w2)	64.4
Weight of Dry Soil (gm)	(w5=w2-w3)	373.3
Moisture Content (%)	(w4/w5)*100	17

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

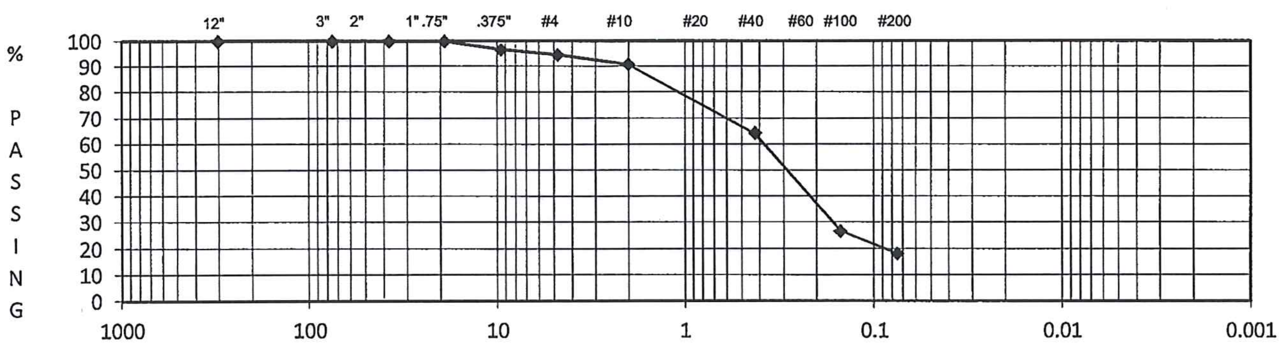
	Weight Of Sample (gm)	388.7
	Tare Weight (gm)	15.4
(W6)	Total Dry Weight (gm)	373.3

% COBBLES	0.0
% C GRAVEL	0.0
% F GRAVEL	5.4
% C SAND	3.9
% M SAND	26.6
% F SAND	46.0
% FINES	18.2
% TOTAL	100.0

D10 (mm)	
D30 (mm)	
D60 (mm)	
Cu	
Cc	

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.4	0.00	0.00	100.00	cobbles
3.0"	15.4	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.4	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	15.4	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	27.6	12.20	3.27	96.73	fine gravel
#4	35.4	20.00	5.36	94.64	coarse sand
#10	49.9	34.50	9.24	90.76	medium sand
#20					medium sand
#40	149.1	133.70	35.82	64.18	fine sand
#60					fine sand
#100	288.8	273.40	73.24	26.76	fine sand
#200	320.8	305.40	81.81	18.19	fines
PAN					silt/clay



DESCRIPTION	Silty SAND with trace gravel
USCS	SM

Prepared For:
Brian Cole

Reviewed By:
KMW

RILEYGROUP

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GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Mukilteo Beverly Park	SAMPLE ID/TYPE	TP2-2
PROJECT NO.	2018-113	SAMPLE DEPTH	2'
TECH/TEST DATE	CM 3/20/2018	DATE RECEIVED	3/20/2018

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	313.7
Wt Dry Soil & Tare (gm)	(w2)	269.6
Weight of Tare (gm)	(w3)	15.6
Weight of Water (gm)	(w4=w1-w2)	44.1
Weight of Dry Soil (gm)	(w5=w2-w3)	254.0
Moisture Content (%)	(w4/w5)*100	17

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

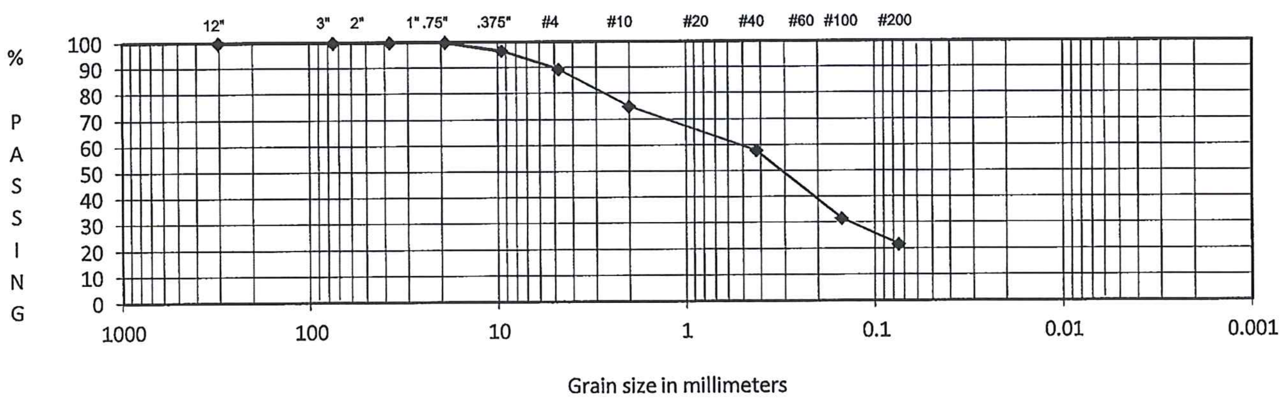
Weight Of Sample (gm)	269.6
Tare Weight (gm)	15.6
(W6) Total Dry Weight (gm)	254.0

% COBBLES	0.0
% C GRAVEL	0.0
% F GRAVEL	10.7
% C SAND	14.3
% M SAND	17.2
% F SAND	36.1
% FINES	21.7
% TOTAL	100.0

D10 (mm)	
D30 (mm)	
D60 (mm)	
Cu	
Cc	

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	15.6	0.00	0.00	100.00	cobbles
3.0"	15.6	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	15.6	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	15.6	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	24.4	8.80	3.46	96.54	fine gravel
#4	42.8	27.20	10.71	89.29	coarse sand
#10	79.1	63.50	25.00	75.00	medium sand
#20					medium sand
#40	122.7	107.10	42.17	57.83	fine sand
#60					fine sand
#100	189.3	173.70	68.39	31.61	fine sand
#200	214.4	198.80	78.27	21.73	fines
PAN					silt/clay



DESCRIPTION	Silty SAND with trace gravel
USCS	SM

Prepared For:
Brian Cole

Reviewed By:
KMW

RILEYGROUP