Geotechnical Engineering Services

R Avenue Long-Term Improvements
Anacortes, Washington

for
H. W. Lochner, Inc.

November 23, 2021
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GeoEngineers

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Anacortes, Washington

File No. 0382-042-00

November 23, 2021

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Table of Contents

1.0 INTRODUCTION AND PROJECT UNDERSTANDING..............................................1

2.0 SITE CONDITIONS.........................................................................................1

2.1. Surface Conditions.........................................................................................1

2.2. Geology..........................................................................................................2

2.3. Subsurface Explorations..................................................................................2

2.4. Subsurface Conditions ..................................................................................2

2.4.1. Existing Asphalt Pavement ........................................................................2

2.4.2. Soil Conditions............................................................................................3

2.4.3. Groundwater Conditions............................................................................3

3.0 GEOLOGICALLY HAZARDOUS AREAS...............................................................4

3.1. Erosion Hazard...............................................................................................4

3.2. Landslide Hazard.............................................................................................4

3.3. Seismic Hazard ..................................................................................................4

3.4. Coal Mine Hazard.............................................................................................4

4.0 CONCLUSIONS AND RECOMMENDATIONS..................................................5

4.1. Pavement Recommendations...........................................................................5

4.1.1. New Pavement Sections.............................................................................6

4.1.2. Cement Concrete Apron Pavement Section.................................................7

4.1.3. Pavement Recycling....................................................................................7

4.2. Luminary Foundations.....................................................................................7

4.2.1. Allowable Lateral Bearing Capacity...........................................................7

4.2.1. Settlement ..................................................................................................8

4.2.1. Construction Considerations......................................................................8

4.3. Stormwater Management ..............................................................................8

4.4. Trench Backfill..................................................................................................9

4.5. Earthwork.........................................................................................................9

4.5.1. Excavation Considerations.........................................................................9

4.5.2. Temporary Erosion Control ........................................................................9

4.5.3. Subgrade Preparation..................................................................................9

4.5.4. Temporary Cut Slopes................................................................................10

4.5.5. Permanent Slopes......................................................................................10

4.5.6. Structural Fill..............................................................................................11

4.5.7. Wet Weather Earthwork............................................................................12

5.0 LIMITATIONS..................................................................................................12

6.0 REFERENCES.....................................................................................................12
LIST OF FIGURES
Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan

APPENDICES
Appendix A. Field Exploration and Laboratory Testing
   Figure A-1 – Key to Exploration Logs
   Figures A-2 through A-12 – Log of Borings
   Figures A-13 – Sieve Analysis Results
   Figure A-14 – Atterberg Limits Test Results
Appendix B. Report Limitations and Guidelines for Use
1.0 INTRODUCTION AND PROJECT UNDERSTANDING

This report presents the results of our geotechnical engineering services for the proposed R Avenue Long-Term Improvements project located along the R and Q Avenue roadway corridors between the intersections of 22nd and 34th Streets in Anacortes, Washington. The general location of the project corridor is shown in the Vicinity Map, Figure 1.

As currently envisioned, proposed roadway improvements along the R Avenue corridor between 22nd and 34th Streets will consist of median modification, new sidewalk and street lighting, and a new roundabout at the intersection of 30th Street and R Avenue with improvements that will extend west along 30th Street to Q Avenue. It is our understanding that proposed improvements along the Q Avenue corridor will occur between 29th and 32nd Streets, and on 29th Street between Q Avenue and Commercial Avenue and will generally be limited to roadway improvements, sidewalk construction, and street lighting installation.

The purpose of our geotechnical engineering services was to explore subsurface soil and groundwater conditions at the site as a basis for developing geotechnical conclusions and recommendations for the proposed corridor improvements. Our scope of services included: drilling 11 borings; characterizing pavement and subgrade conditions during drilling; completing laboratory testing on soil samples obtained from the explorations; performing engineering analyses; and preparing this geotechnical engineering report. Our geotechnical services were provided under the Subconsultant Agreement with H.W. Lochner, Inc. (HWL) executed on February 26, 2021.

2.0 SITE CONDITIONS

2.1. Surface Conditions

The existing R Avenue roadway within the project corridor consists of a north-south oriented divided four-lane street identified as a minor arterial by the City of Anacortes (COA) Street Classification Map (2018) with posted speed limits of 35 miles per hour. North and south bound lanes are separated by a central median containing intermittent turning lanes providing access to/from cross streets. The road serves as a truck route for hauling materials to and from the shipyard and other Port of Anacortes facilities located at the north end of town. An existing roundabout was previously constructed north of the project site at the 22nd Street and R Avenue intersection. The R Avenue roadway is approximately 65 feet wide, which includes an approximately 15-foot-wide grass median and two 25-foot-wide asphalt concrete pavement (ACP) sections. The paved sections are marked with a white dashed centerline and lined with curb, gutter, and stormwater inlets. Offset sidewalks and street lighting are located to the east and west of the two paved sections. Aside from existing light poles, no overhead utilities are present within this portion of the project corridor, however, significant underground utilities (water, sanitary sewer, stormdrain, electrical, gas, telephone) are present along both sides of and within the roadway median and travel lanes. Generally, small businesses, multi- and single-family residences, and associated landscaping are located west of this portion of the project corridor with industrial buildings and fields associated with the marina located to the east.

The existing Q Avenue, 30th Street, and 29th Street roadways within the project corridor generally consist of north-south or east-west oriented two-lane local low volume ACP streets that support light commercial and residential traffic loading with posted speed limits of 25 miles per hour. Lane widths along this
portion of the corridor generally range from 20 to 25 feet with the exception of 29th Street which is approximately 35 feet wide. Numerous utility lines including overhead telephone, overhead power, and underground water, sanitary sewer, and storm drain are present along both shoulders of the roadways within this area. Small businesses, multi- and single-family residences, and associated landscaping are located along this portion of the project corridor.

2.2. Geology

Based on our review of “Geologic Map of Bellingham 1:100,000 Quadrangle, Washington,” by Thomas J. Lapen (2000) for the project area, we understand the project corridor is mapped as glaciomarine drift. This soil unit typically consists of unsorted, unstratified silt and clay with varying amounts of sand, gravel, cobbles, and occasional boulders. Glaciomarine drift is derived from sediment melted out of floating glacial ice that was deposited on the sea floor during periods of glacial retreat, while the land surface was depressed 500 to 600 feet from previous glaciations. This material locally contains shells and wood, and large erratics (boulders) can be present sporadically or even in a cluster.

A contact with Vashon glacial till of the Fraser Glaciation is mapped just to the west of the western most edge of the project corridor. Glacial till is generally a non-stratified mixture of very dense sand, gravel and silt that has been overridden and consolidated by glacial ice. As such, this material has very high shear strength and deformation characteristics. Although not mapped within the project area, it has been our experience that glaciomarine drift in the Anacortes area may be underlain by both glacial and non-glacial sedimentary deposits of pre-Fraser Glaciation age or the Whidbey Formation. These formations generally consist of till-like deposits of sand and gravel in a matrix of silt and clay, or fine-grained interbedded sand, silt and clay with minor lenses of coarse sand and gravel. These sediments were consolidated from the pressures experienced by overlying glacial ice as it was glacially overridden. For the purposes of this report, very dense/hard soils underlying the glaciomarine drift will be referred to as “glacially consolidated soils.”

2.3. Subsurface Explorations

Subsurface soil conditions at the site were explored to depths ranging between 10½ to 21½ feet below ground surface (bgs) by drilling 11 borings (B-1 through B-11) on April 26, 2021 with a track-mounted drill rig subcontracted to GeoEngineers. The approximate locations of the borings are shown in the Site and Exploration Plan, Figure 2. Details of the field exploration program and the exploration logs are presented in Appendix A. Details regarding the laboratory testing program and results are also presented in Appendix A.

2.4. Subsurface Conditions

2.4.1. Existing Asphalt Pavement

All borings were completed in the paved portions of R Avenue, Q Avenue, 29th Street, and 30th Street with the exception Boring B-3 which was drilled in the unpaved shoulder of the roadway on the north side of 30th Street. Boring B-1 was completed in the westbound lane of 29th Street, borings B-2 through B-4 were completed in Q Avenue, B-5 was completed in the eastbound lane of 30th Street, borings B-6, B-7, and B-9 were completed in the southbound (west) lane of R Avenue, and borings B-8, B-10, and B-11 were completed in the northbound lane (east) of R Avenue. The typical roadway section included ACP overlying silty sand and gravel road base (fill) overlying native soil with the exception of borings B-8 and B-11 which encountered portland cement concrete (PCC) underlying the ACP overlying fill. ACP and PCC thickness were observed as follows:
<table>
<thead>
<tr>
<th>Location</th>
<th>Boring Number</th>
<th>ACP/PCC Thickness (inches)</th>
<th>Depth to Native Soil (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29th Street</td>
<td>B-1</td>
<td>1/0</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>B-2</td>
<td>2/0</td>
<td>30</td>
</tr>
<tr>
<td>Q Avenue</td>
<td>B-3</td>
<td>N/A</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>B-4</td>
<td>1/0</td>
<td>0</td>
</tr>
<tr>
<td>30th Street</td>
<td>B-5</td>
<td>3/0</td>
<td>66</td>
</tr>
<tr>
<td>R Avenue</td>
<td>B-6</td>
<td>3/0</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>B-7</td>
<td>2/0</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>B-8</td>
<td>3/9</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>B-9</td>
<td>4/0</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>B-10</td>
<td>3/0</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>B-11</td>
<td>5/6</td>
<td>42</td>
</tr>
</tbody>
</table>

**2.4.2. Soil Conditions**

The subsurface soils encountered at the site generally consisted of asphalt pavement surfacing overlying fill underlain by native glacial deposits. A summary of each soil unit encountered is provided below:

**Fill:** Fill soils were encountered in all of our explorations except boring B-4 to depths of about 1½ to 5 feet bgs. The fill generally consisted of brown fine to medium sand with gravel to gravel with sand and variable silt and clay content, with a few areas of fill consisting of clay with sand and gravel that are considered to be reworked/disturbed native deposits.

**Glaciomarine Drift:** Glaciomarine drift was encountered in all of our borings and generally consisted of stiff to very stiff clay with variable sand and gravel content. In the project area, this unit generally has high shear strength, low compressibility, and low permeability characteristics. Glacial erratics (boulders) are present randomly within this unit.

**Glacially Consolidated Deposits:** Glacially consolidated soils were generally encountered below the glaciomarine drift unit in borings B-5 through B-7, B-9, and B-11. The glacially consolidated deposits encountered in our borings generally consisted of very stiff to hard sandy silt with variable sand and gravel content and dense to very dense fine to medium silty sand. The unit was predominantly homogenous with limited layering or stratification.

**2.4.3. Groundwater Conditions**

We expect the regional groundwater table to be below the maximum excavation elevation for this project. A perched groundwater condition is commonly encountered where groundwater flow is limited by a more impermeable layer and was encountered in the glacial drift soils at the site in boring B-3 at 7½ feet bgs, B-5 at 2½ feet bgs, and B-7 at 12½ feet bgs. Saturated sand pods with free water can also be encountered within glaciomarine drift or glacially consolidated soils. The groundwater conditions should be expected to vary as a function of season, precipitation, and other factors.
3.0 GEOLOGICALLY HAZARDOUS AREAS

The methods of designating geologic hazard areas are presented in the Anacortes Municipal Code (AMC) Chapter 17.70.180. Our evaluation included document review and site reconnaissance during our field exploration program.

3.1. Erosion Hazard

The AMC defines an erosion hazard as an area mapped as having moderate to severe, severe or very severe erosion hazard in the U.S. Department of Agriculture’s (USDA’s) Soil Conservation Service Soil Survey of the Skagit County Area (1989). According to the USDA Soil Survey and the Skagit County Potential Landslide and Erosion Areas (2016) map, soils along the project corridor present no erosion hazard.

In our opinion, the erosion hazard along the project corridor is low provided that temporary erosion control measures are used during construction as necessary depending on the weather, location, soil type, and other factors. Temporary erosion protection (e.g., straw, plastic, or other measures) may be necessary over stockpiles and/or backfilled surfaces to reduce sediment transport until permanent surfacing applied. Appropriate best management practices (BMPs) should be incorporated into the temporary erosion and sediment control plan developed by the civil engineer. We are available to provide additional input if desirable.

3.2. Landslide Hazard

To identify areas of steep slopes and landslide hazard we conducted site reconnaissance, reviewed the site topographic survey, and reviewed the Skagit County Potential Landslide and Erosion Areas (2016 map dated September 14, 2016). The corridor largely consists of 0 to 5 percent slopes and does not have any clearly identified slopes steeper than 20 percent as presented in the Skagit County Potential Landslide and Erosion Areas (2016) map. Based on our site evaluation, the proposed corridor does not fall within a landslide hazard area and the potential for landslides to impact the proposed corridor is very low.

3.3. Seismic Hazard

The AMC defines a seismic hazard area as those areas that are subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, or surface faulting. The dense to very dense and hard soils encountered at the site are not considered liquefiable. The nearest mapped fault is the Devil’s Mountain Fault located approximately 9 miles to the south.

Based on our review of available information and on-site soils, it is our opinion that the potential seismic hazards at the site are very low.

3.4. Coal Mine Hazard

The AMC identifies a coal mine hazard area as those project areas that are underlain or affected by historic mine operations, or areas identified on maps produced by the DNR as a coal hazard. We reviewed the DNR document titled “Inventory of Abandoned Coal Mines in the State of Washington,” (LaSalata et al. 1985) to assess the impact from coal mining. We found no evidence to indicate that coal mine activity occurred anywhere along the project corridor. The mapped glacial deposits encountered during our exploration program are not associated with coal deposits. We conclude that there is no known coal mine hazard along the proposed alignment.
4.0 CONCLUSIONS AND RECOMMENDATIONS

We conclude that the proposed improvements can be constructed using conventional methods. We recommend that the construction conform to the 2021 version of the Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction (herein after referred to as WSDOT Standard Specifications).

4.1. Pavement Recommendations

Project specific traffic data for R Avenue improvement project was not available at the time of this report. We reviewed a traffic impact analysis (TIA) for a nearby proposed local development. The TIA provided projected peak hour trip estimates along the northern portion of the R Avenue alignment for the year 2025 in baseline and developed conditions. We also reviewed the WSDOT Traffic GeoPortal which provided Annual Average Daily Traffic (AADT) and truck percentages on SR 20 east and west of the R Avenue intersection. Our assumptions should be reviewed by the project civil or traffic engineer.

No traffic volume estimates were provided for the local streets in the project corridor (Q Avenue, 29th Street, and 30th Street). Therefore, we assumed that the COA road standards will be applicable for these areas.

We utilized American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures, observations of existing pavement and subgrade conditions to complete preliminary structural pavement thickness designs. The preliminary pavement designs are based on the following information and assumptions:

R Avenue is classified by the COA as a Minor Arterial for which we assumed a desired reliability level of 90 percent. Traffic data and pavement design and assumptions are provided below:

- AADT at R Avenue and SR-20 is 11,000 total for both directions. With an assumed directionality factor of 70 percent, we used 8,000 as the Average Daily Traffic (ADT) with an assumed growth rate of approximately 2 percent;
- Assumed 6 percent trucks with an assumed truck factor of 0.91;
- Assumed 40-year design life;
- Change in serviceability index: 2.2;
- No groundwater at the subgrade elevation and installation of suitable sub-drainage to carry water away from the pavement section; and
- The anticipated prepared pavement subgrade, based on our site explorations, has an estimated California Bearing Ratio (CBR) value of about 4.5 and a corresponding resilient modulus (Mr) value of 6,750 pounds per square inch (psi). The CBR and Mr values are based on correlations with soil type and field density/consistency from field standard penetration test (SPT) blow count data. Improper subgrade preparation, inadequate protection from wet weather, or disturbance will result in a reduced Mr value and substandard pavement performance.
The shoulder areas are not subjected to the same traffic loading but will be required to meet the minimum structural requirements in accordance with the COA Standards. These areas may have a reduced pavement section and were not considered during our analysis.

Material structural coefficients for analysis of:

- 0.42 for new hot-mix asphalt;
- 0.14 for crushed base course; and
- 0.11 for sand and gravel sub-base course.

The results of our preliminary pavement analysis using the above data and assumptions results in a pavement structural number of 4.77 required to support the traffic over the 40-year design life.

4.1.1. New Pavement Sections

4.1.1.1. R Avenue Alignment

Based on the anticipated traffic loading, the recommend minimum pavement section along R Avenue alignment according to AASHTO design approach would be less than the minimum structural requirements required by the COA Standards. As a result, we recommend the following minimum pavement design section in accordance with the minimum requirements for the COA Standards:

- Five (5) inches of ACP per WSDOT Standard Specifications;
- Six (6) inches of Crushed Surfacing Base Course (CSBC) per WSDOT Standard Specifications 9-03.9(3);
- Eighteen (18) inches of sub-base course consisting of gravel base in accordance with WSDOT Standard Specifications, 9-03.10. (The subgrade should be compacted to a dense condition prior to placement of gravel base.); and
- If fine-grained or soft soils are exposed at the subgrade, placement of a woven geotextile over the subgrade with a minimum grab tensile strength (ASTM International [ASTM] D 4632) of 200 pounds, such as Mirafi HP270 or equivalent.

The structural number of this new pavement section a is about 4.92.

If a thicker ACP surface thickness is desired, we recommend the following options that provide similar design structural number:

**TABLE 2. ALTERNATIVE PAVEMENT SECTION THICKNESSES**

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1 Layer Thickness (inches)</th>
<th>Alternative 2 Layer Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACP</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>CSBC</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Sub-base</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Structural Number</td>
<td>4.9</td>
<td>5.1</td>
</tr>
</tbody>
</table>
**4.1.1.2. Local Street Alignments**

For project areas outside of the primary R Avenue corridor, consisting of roadways classified by the COA as local streets, we recommend the minimum pavement section required by the COA Engineering Standards for non-arterials and adjacent shoulders:

- Three (3) inches of ACP per WSDOT Standard Specifications;
- Three (3) inches of CSBC per WSDOT Standard Specifications 9-03.9(3);
- Six (6) inches of sub-base course consisting of gravel base in accordance with WSDOT Standard Specifications, 9-03.10. (The subgrade should be compacted to a dense condition prior to placement of gravel base.); and
- If fine-grained or soft subgrade soils are exposed at the subgrade, placement of a woven geotextile over the subgrade with a minimum grab tensile strength (ASTM D 4632) of 200 pounds, such as Mirafi HP270 or equivalent.

**4.1.1.3. Separated Non-motorized Bike/Pedestrian Paths**

For proposed separated bike and pedestrian paths along the roadways, we recommend the minimum standard section required by the COA Engineering Standards:

- Two (2) inches of ACP per WSDOT Standard Specifications or 4 inches of concrete;
- Three (3) inches of CSBC per WSDOT Standard Specifications 9-03.9(3);
- Six (6) inches of sub-base course consisting of gravel base in accordance with WSDOT Standard Specifications, 9-03.10. (The subgrade should be compacted to a dense condition prior to placement of gravel base.); and
- If fine-grained or soft subgrade soils are exposed at the subgrade, placement of a woven geotextile over the subgrade with a minimum grab tensile strength (ASTM D 4632) of 200 pounds, such as Mirafi 500X or equivalent.

**4.1.2. Cement Concrete Apron Pavement Section**

If the roundabout will include a truck apron consisting of PCC, we can provide additional specific recommendations if requested.

**4.1.3. Pavement Recycling**

Removal of the existing pavement will generate quantities of ACP, PCC, and crushed rock. These materials may be recycled and used in the proposed pavement section, provided they meet the specifications provided in the WSDOT Standard Specifications, sections 9-03.8(3)C, 9-03.21(1), 9-03.21(2), and 5-04.2.

**4.2. Luminary Foundations**

**4.2.1. Allowable Lateral Bearing Capacity**

We understand new luminaries are planned in the area of the proposed roundabout, although luminary design and specific locations have not been selected at the time of this report. For foundation design, we recommend the following allowable lateral bearing capacities based on the conditions encountered and
the guidelines provided in Table 17-2, Design Parameter Correlations for the Design of Signal, Signs, Sign Bridge, and Luminaire Foundations, of the WSDOT Geotechnical Design Manual (GDM):

- An allowable lateral bearing capacity of 1,500 pounds per square foot (psf) for fill soils to a depth of 5 feet bgs;
- An allowable lateral bearing capacity of 2,100 psf for glaciomarine drift or glacially consolidated soils below a depth of 5 feet bgs.

Based on local experience, a reasonable unit weight for the glaciomarine drift clay is 115 pounds per cubic foot (pcf). Typical standard drilled foundations for level ground would be 3- or 4-foot round at depths between 8 and 13 feet bgs.

4.2.1. Settlement

We estimate that settlement of the drilled signal pole foundations, designed and installed as recommended in Section 4.2.1, will be less than 1 inch. Most of this settlement will occur rapidly as loads are applied. Post-construction settlement should be minor at the anticipated foundation loads.

4.2.1. Construction Considerations

Drilled cast-in-place concrete piers should be installed to the depth determined by the designer. The base of the hole should be cleaned of all loose material and significant accumulations of water prior to the placement of concrete and reinforcing steel. Wet, sandy seepage zones may be encountered at the contact line between fill and glaciomarine drift and within sandier zones of the glaciomarine drift.

The granular fill at the site may be prone to caving during excavation. The contractor should be prepared to use casing in the fill layer. We anticipate that significant caving of the drilled pier is unlikely in the native glaciomarine drift layer. If seepage zones are encountered, minor caving within the granular seepage zone is likely to occur, but can likely be addressed with cleanout of the hole prior to concrete placement. We recommend that the drilling and concrete placement be scheduled to minimize the time the drilled pier needs to stay open and recommend the drilled piers do not remain open overnight unless casing is used. The bottom of the drilled piers should be stable, clean and free of loose debris prior to concrete placement.

It is assumed that the pier foundations can be drilled to the required depth with a soil or bucket auger. Glaciomarine drift may locally contain cobbles and boulders. We recommend that the contract documents contain provisions that address the potential presence, handling, and disposal of oversize material/obstructions. If obstructions are encountered, it may be necessary to locally excavate and remove the obstruction prior to continuing with pier installation or relocate the luminary. Any oversizing of the hole should be filled with concrete to maintain the lateral bearing pressure.

4.3. Stormwater Management

We evaluated the suitability of the soils for onsite infiltration for stormwater management within project corridor. The conditions encountered along the project corridor included highly variable fill containing sand, silt, and clay overlying stiff to very stiff clay layer within 5 feet of the ground surface. It is our opinion that on-site soils will have very low permeabilities and soil infiltration facilities within the project corridor would not meet Department of Ecology (Ecology) stormwater guidelines for separation from a restrictive layer. We understand that bioretention with underdrains is the planned strategy for stormwater treatment and management.
4.4. Trench Backfill

If utilities will be installed along the project corridor within or immediately adjacent to the proposed roadway prism, we recommend that the entire utility trench be backfilled with imported gravel meeting the requirements of WSDOT Standard Specifications for Bank Run Gravel 9-3.19, Gravel Backfill for Pipe Zone Bedding 9-03.12(3) or Gravel Borrow 9-03.14(1), or other material approved by the Engineer. The backfill should be compacted to 95 percent of the maximum dry density (MDD) per ASTM D 1557. Trench backfill placed outside a 1H:1V (horizontal to vertical) prism extending down from the outside edge of the road base, and areas outside of sidewalks or other hardscape, may be compacted to a minimum of 90 percent of the MDD.

4.5. Earthwork

4.5.1. Excavation Considerations

The corridor improvements will be constructed within the footprint of the existing paved roads and shoulders of R Avenue, Q Avenue, 29th Street, and 30th Street. Fill, glaciomarine drift, and glacially consolidated soil deposits were observed in the explorations. We anticipate that these soils may be excavated with conventional excavation equipment, such as large excavators and/or dozers. The very dense glacially consolidated soils may be very difficult to excavate, depending upon the depth of cuts planned, and large excavators and/or dozers equipped with rippers may be needed. Although cobbles and boulders were not encountered in our explorations, it is our experience that they are commonly encountered in these soil deposits and the contractor should be prepared to deal with them. We recommend that procedures be identified in the project specifications for measurement and payment of work associated with removal of cobbles and boulders.

4.5.2. Temporary Erosion Control

Temporary erosion control measures should be used during construction depending on the weather, location, soil type, and other factors. Temporary erosion protection (e.g., straw, plastic, or rolled erosion control products [RECPs]) may be necessary to reduce sediment transport until vegetation is established or permanent surfacing applied. Appropriate best management practices (BMPs) should be incorporated into the temporary erosion and sediment control plan developed by the civil engineer. We are available to provide input if desirable.

4.5.3. Subgrade Preparation

The majority of the proposed improvements are located over an area that is currently covered with ACP surfacing or concrete sidewalk. We anticipate that stripping of any organic material will be limited to small areas along the edges of the roadway. Our explorations were not completed in areas that will require stripping therefore we cannot provide an estimated stripping depth. The existing asphalt pavement within the project corridor should be removed based on grading plans and may be recycled as mentioned previously.

We anticipate that the exposed subgrade soils will consist of silty sand or mixed clayey soil that was placed as fill material or native glaciomarine drift clay soils. We recommend that the subgrade soils be compacted with a large vibratory roller to a uniformly firm condition and at least 95 percent of the MDD based on ASTM D 1557 test procedure. It is imperative that the subgrade be compacted to a firm and unyielding condition to support the layer of gravel base.
After the gravel, sidewalk, and/or strippings have been removed and the pavement subgrade is exposed and compacted, we recommend that the subgrade be thoroughly proofrolled with heavily loaded rubber-tired construction equipment. The proofrolling should be observed by one of our geotechnical engineers, who will evaluate the subgrade. If soft or otherwise unsuitable areas observed during proofrolling cannot be compacted to a stable and uniformly dense condition, excavation to firm soil or to 2 feet below the original ground surface, or as otherwise recommended by the soils engineer, should be accomplished. The overexcavated material should be replaced with structural fill in accordance with recommendations provided in subsequent sections of this report.

4.5.4. Temporary Cut Slopes

We anticipate that temporary excavations will be required for roadway widening and installation of the new utilities. Regardless of the soil types encountered in the excavation, either shoring and/or sloped sidewalls will be required for excavations deeper than 4 feet under Washington State Administrative Code (WAC) 296-155, Part N. The stability of open-cut slopes is a function of soil type, slope inclination and nearby surface loads. The use of inadequately designed open cuts could impact the stability of adjacent structures and existing utilities and endanger personnel.

In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to the soil and groundwater conditions. Construction site safety is generally the sole responsibility of the contractor, who also is solely responsible for the means, methods, and sequencing of the construction operations and choices regarding temporary excavations and shoring. We are providing this information only as a service to our client. Under no circumstances should the information provided below be interpreted to mean that GeoEngineers, Inc. is assuming responsibility for construction site safety or the contractor’s activities; such responsibility is not being implied and should not be inferred.

The regulations allow temporary slopes from 0.75H:1V to 1.5H:1V, depending upon soil type. The regulations assume that surface loads, such as construction equipment and storage loads, will be kept a sufficient distance away from the top of the cut so that the stability of the excavation is not affected. Based on our explorations, the fill soils encountered at the site are defined as Type C soil, which has an allowable temporary maximum slope angle of 1.5H:1V; the glaciomarine drift and glacially consolidated soils encountered are defined as Type A soil and allow for steeper temporary slopes of 0.75H:1V. Flatter slopes may be necessary if seepage is present on the cut face. If temporary slopes are near the edge of the paved shoulder, we recommend that a protective barrier (such as a jersey barrier) be placed at the edge of the roadway to provide a buffer/protection for vehicle traffic. We recommend that the proximity of the barriers and temporary slope to the edge of pavement consider potential sloughing and undermining of the road and surcharge effects.

It should be expected that unsupported cut slopes would experience some sloughing and raveling if exposed to surface water. Hay bales, plastic sheeting, fencing laid over the slope, or other provisions could be installed along the top and sides of the excavation to reduce the potential for sloughing and erosion of cut slopes during wet weather.

4.5.5. Permanent Slopes

Based on the results of the field exploration, any new cuts will occur within the shallow very loose to medium dense silty sand and gravel fill or native stiff to very stiff clay. We recommend permanent cut and
fill slopes be constructed at a maximum 2H:1V. This slope inclination is statically and seismically stable in the native materials and structural fill. Fill slopes should be overbuilt and cut back to achieve compaction of the outer edge of the slope. The site soils have a high erosion potential if exposed. Therefore, we recommend temporary erosion protection measures as described in the “Temporary Erosion Control” section. Some limited sloughing and erosion would be expected until vegetation is established on permanent slopes.

4.5.6. Structural Fill

We recommend that structural fill consist of non-plastic soil meeting the WSDOT Standard Specifications for Common Borrow, Section 9-03.14(3). Structural fill should be placed in 8- to 12-inch loose lifts, or that thickness necessary to achieve the required compaction using the mechanical equipment chosen by the contractor. We recommend that the MDD be determined based on ASTM D 1557.

- Structural fill should be compacted to at least 95 percent of the MDD in existing/future pavement areas.
- Gravel base and crushed surfacing materials should be compacted to at least 95 percent of the MDD.

Sufficient earthwork monitoring and/or a sufficient number of in-place density tests should be performed to evaluate fill placement and compaction operations and to confirm that the required compaction is being achieved for structural fill.

4.5.6.1. Suitability of On-site Materials

Soils within the proposed corridor generally consist of existing fill, clay (CL), silt (ML), and silty sand (SM). The existing silt/clay glaciomarine drift encountered during our explorations typically had moisture content above the optimum moisture content for compaction. Since these soils are highly moisture sensitive and have a high natural water content, it will be very difficult to compact these soils to dry densities greater than 90 percent of the MDD as specified. Therefore, we recommend that the existing glaciomarine drift be considered unsuitable for use as structural fill.

The existing fill is variable. Some of the fill consists of granular material with limited fines such that if it is properly segregated it may be suitable for reuse as general structural fill during periods of dry weather and where a specific gradation (e.g., gravel base) is not required. Fill soils with high percentage of fines should be considered unsuitable for reuse.

4.5.6.2. Select Import Soils

During periods of wet weather, we recommend that select import be used for backfill in the roadway. The select import fill should consist of sand and gravel with a fines content less than 5 percent based on that portion passing the ¾-inch sieve. Suitable WSDOT Standard Specifications include Gravel Borrow 9-03.14(1), with the fines content limited as noted. The on-site soils generally will not meet this criterion.

4.5.6.3. Recycled Materials

Removal of the existing pavement will generate quantities of asphalt and cement concrete. These materials may be recycled and used in the proposed pavement section and as structural fill, provided they meet the specifications provided in the WSDOT Standard Specifications, Sections 9-03.21 Recycled Material and 9-03.8(3)B Gradation for Recycled Asphalt Pavement and Mineral Aggregate.
4.5.7. Wet Weather Earthwork

General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean fill. The size and type of construction equipment used may need to be limited to prevent soil disturbance.
- The ground surface within the construction area should be sealed by a smooth-drum vibratory roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture that can erode off the jobsite.
- Excavation and placement of structural fill and trench backfill material should be performed under sufficient observation and testing to confirm that the work is completed in accordance with the project specifications and the recommendations contained herein.
- Soil stockpiles should be covered with plastic sheeting if wet weather conditions are anticipated.
- Silt fences should be installed between the work area and sensitive areas to prevent transport of sediment beyond the work area.

5.0 LIMITATIONS

We have prepared this report for use by the COA, H.W. Lochner, and other members of the design team for use in design of the R Avenue Long-Term Improvements project in Anacortes, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted geotechnical practices in this area at the time the report was prepared. No warranty or other conditions, express or implied, should be understood.

Please refer to Appendix B, titled Report Limitations and Guidelines for Use, for additional information pertaining to use of this report.

6.0 REFERENCES


Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI
Projection: NAD 1983 UTM Zone 10N

Vicinity Map
R Avenue Long-Term Improvements
Anacortes, Washington

Figure 1
Figure 2

R Avenue Long-Term Improvements
Anacortes, Washington

Site and Exploration Plan

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Background from LDES, Inc. dated 06/02/2021.
Projection: Washington State Plane, North Zone, NAD83, US Foot
APPENDIX A

Field Exploration and Laboratory Testing
APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Field Explorations

Subsurface soil and groundwater conditions were evaluated by drilling 11 borings (B-1 through B-11) along the project alignment on April 26, 2021. The borings were completed using a track-mounted hollow-stem auger drill rig subcontracted to GeoEngineers, Inc. The borings were completed to depths ranging from about 16½ to 21½ feet below the existing ground surface (bgs). The approximate locations of the explorations are shown in the Site and Exploration Plan, Figure 2. The locations of the explorations were determined using recreational grade global positioning system (GPS) units; therefore, the locations shown in Figure 2 should be considered approximate.

Soil samples from the borings were obtained using the standard penetration test (SPT) method. This method involves driving a split spoon sampler a total of 18 inches using a 140-pound rope and cat-head hammer free falling 30 inches. The number of blows required to drive the sampler the last 12 inches are recorded on the boring logs. The samples collected were placed in plastic bags to maintain the moisture content and transported back to our laboratory for analysis and testing as described below.

The site explorations were continuously monitored by a representative from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration. Soils encountered were classified visually in general accordance with ASTM International (ASTM) D-2488-90, which is described in Figure A-1. The logs of the borings are presented in Figures A-2 through A-12. The exploration logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. They also indicate the depths at which these soils or their characteristics change, although the change might actually be gradual. If the change occurred between samples, the depth was interpreted.

Laboratory Testing

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of moisture content determination, percent fines, and grain size distribution. The tests were performed in general accordance with ASTM test methods or other applicable procedures.

Moisture Content Testing

The natural moisture contents of selected soil samples obtained from the explorations were determined in general accordance with ASTM D 2216 test procedures. The results from the moisture content determinations are displayed in the column labeled “Moisture Content (%)” adjacent to the corresponding samples on the summary logs.

Percent Passing U.S. No. 200 Sieve

Selected samples were “washed” through the U.S. No. 200 mesh sieve to determine the relative percentage of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted in general accordance with ASTM D 1140. The results from the percent fines determinations are displayed in the column labeled “Fines Content (%))” adjacent to the corresponding samples on the summary exploration logs.
Grain Size Analyses

Grain size analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the grain size analyses were plotted, classified in general accordance with the Unified Soil Classification System (USCS), and are presented in Figure A-13.

Atterberg Limits

Atterberg limits tests were performed on selected fine-grained soil samples. The tests were used to classify the soils as well as to evaluate index properties. The liquid limit and the plastic limit were estimated through a procedure performed in general accordance with ASTM D 4318. The results of the Atterberg limits tests are summarized in Figure A-14.
### Soil Classification Chart

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Symbols</th>
<th>Typical Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gravel and Gravelly Soils</strong></td>
<td><strong>GW</strong></td>
<td>Well-graded gravel, gravel - sand mixtures</td>
</tr>
<tr>
<td><strong>Sand and Sandy Soils</strong></td>
<td><strong>SP</strong></td>
<td>Poorly-graded sands, gravelly sands</td>
</tr>
<tr>
<td><strong>Silty Sands, Sand - Silt Mixtures</strong></td>
<td><strong>SM</strong></td>
<td>Silty sands, sand - silt mixtures</td>
</tr>
<tr>
<td><strong>Organic Soils</strong></td>
<td><strong>PT</strong></td>
<td>Peat, humus, swamp soils with high organic contents</td>
</tr>
</tbody>
</table>

### Additional Material Symbols

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Typical Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC</strong></td>
<td>Asphalt Concrete</td>
</tr>
<tr>
<td><strong>CC</strong></td>
<td>Cement Concrete</td>
</tr>
<tr>
<td><strong>CR</strong></td>
<td>Crushed Rock/Quarry Spalls</td>
</tr>
<tr>
<td><strong>SOD</strong></td>
<td>Sod/Forest Duff</td>
</tr>
<tr>
<td><strong>TS</strong></td>
<td>Topsoil</td>
</tr>
</tbody>
</table>

### Groundwater Contact
- Measured groundwater level in exploration, well, or piezometer
- Measured free product in well or piezometer

### Graphic Log Contact
- Distinct contact between soil strata
- Approximate contact between soil strata

### Material Description Contact
- Contact between geologic units
- Contact between soil of the same geologic unit

### Laboratory / Field Tests
- **%F** Percent fines
- **%G** Percent gravel
- **AL** Atterberg limits
- **CA** Chemical analysis
- **CP** Laboratory compaction test
- **CS** Consolidation test
- **DD** Dry density
- **DS** Direct shear
- **HA** Hydrometer analysis
- **MC** Moisture content
- **MD** Moisture content and dry density
- **Mohs** Mohs hardness scale
- **OC** Organic content
- **PM** Permeability or hydraulic conductivity
- **PI** Plasticity index
- **PL** Point load test
- **PP** Pocket penetrometer
- **SA** Sieve analysis
- **TX** Triaxial compression
- **UC** Unconfined compression
- **VS** Vane shear

### Sheen Classification
- **NS** No Visible Sheen
- **SS** Slight Sheen
- **MS** Moderate Sheen
- **HS** Heavy Sheen

---

**Sampler Symbol Descriptions**

- 2.4-inch I.D. split barrel
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab
- Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

---

**Note:** The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

---

**Key to Exploration Logs**

---

**Figure A-1**
### Field Data

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Interval</th>
<th>Recovered (in)</th>
<th>Brown/foot</th>
<th>Collected Sample Testing</th>
<th>Group Classification</th>
<th>Descriptive Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>4</td>
<td>16</td>
<td></td>
<td>1</td>
<td>AC</td>
<td>1 inch of asphalt concrete pavement</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>18</td>
<td>16</td>
<td></td>
<td>2</td>
<td>SM</td>
<td>Brown silty fine to medium sand with crushed rock (medium dense, moist) (fill)</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>18</td>
<td>16</td>
<td></td>
<td>3</td>
<td>CL</td>
<td>Gray to brown clay with occasional gravel, trace sand (stiff, moist) (glaciomarine drift)</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>18</td>
<td>16</td>
<td></td>
<td>4</td>
<td></td>
<td>Becomes medium stiff</td>
</tr>
</tbody>
</table>

### Material Description

- **CL**: Gray to brown clay with occasional gravel, trace sand (stiff, moist) (glaciomarine drift)

### Remarks

- LL=41; PI=19

---

**Note:** See Figure A-1 for explanation of symbols.

**Coordinates Data Source:** Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

---

**Log of Boring B-1**

- **Project:** R Avenue Long-Term Improvements
- **Project Location:** Anacortes, Washington
- **Project Number:** 0382-042-00

---

**Figure A-2**

**Sheet 1 of 1**

Surface Elevation (ft) Vertical Datum: 64 NAVD88

Easting (X) Northing (Y): 1209410 551720

Logged By JES  Checked By AJH
Hammer Data: Rope & Cathead 140 (lbs) / 30 (in) Drop

Driller: Boretec 1, Inc. Drilling Method: EC 55 Track Mounted

System Datum: WA State Plane North NAD83 (feet)

Notes: Groundwater not observed at time of exploration

FIELD DATA

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Recovered (in)</th>
<th>Blow/foot</th>
<th>Sample Name Testing</th>
<th>Graphic Log</th>
<th>Group Classification</th>
<th>Material Description</th>
<th>Geotech Moisture Content (%)</th>
<th>Geotech Percent</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>AC</td>
<td>SM</td>
<td>2 inches of asphalt concrete pavement</td>
<td>9</td>
<td>No recovery</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>10</td>
<td>22</td>
<td>3</td>
<td>CL</td>
<td></td>
<td>Brown silty fine to medium sand with gravel (loose, moist) (fill)</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>18</td>
<td>24</td>
<td>4</td>
<td></td>
<td></td>
<td>Gray to brown clay with occasional gravel, trace sand (very stiff, moist) (glaciomarine drift)</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>18</td>
<td>10</td>
<td>19</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: See Figure A-1 for explanation of symbols.

Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

Log of Boring B-2

Project: R Avenue Long-Term Improvements
Project Location: Anacortes, Washington
Project Number: 0382-042-00

Figure A-3  Sheet 1 of 1
### Field Data

<table>
<thead>
<tr>
<th>Interval (feet)</th>
<th>Depth (feet)</th>
<th>Recovered (in)</th>
<th>Sample Name</th>
<th>Group Classification</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>4</td>
<td></td>
<td>SM</td>
<td>Brown silty fine to medium sand with gravel (loose, moist) (fill)</td>
</tr>
<tr>
<td>6</td>
<td>1.0</td>
<td>6</td>
<td></td>
<td>CL</td>
<td>Brown clay with crushed rock and inorganic debris (medium stiff, moist)</td>
</tr>
<tr>
<td>12</td>
<td>0.0</td>
<td>12</td>
<td></td>
<td>CL</td>
<td>Gray to brown clay with occasional gravel, trace sand (stiff, moist) (glaciomarine drift)</td>
</tr>
<tr>
<td>14</td>
<td>0.0</td>
<td>14</td>
<td></td>
<td></td>
<td>Becomes wet and lacks gravel</td>
</tr>
<tr>
<td>16</td>
<td>0.0</td>
<td>16</td>
<td></td>
<td></td>
<td>Perched groundwater observed at 7½ feet during drilling</td>
</tr>
</tbody>
</table>

### Remarks

- Perched groundwater observed at 7½ feet during drilling

---

Note: See Figure A-1 for explanation of symbols. Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Interval</th>
<th>Recovered (in)</th>
<th>Blown (foot)</th>
<th>Collected Sample</th>
<th>Sample Name</th>
<th>Testing</th>
<th>Group</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
<td>15</td>
<td>1</td>
<td>AC</td>
<td></td>
<td></td>
<td>CL</td>
<td>1 inch of asphalt concrete pavement</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>21</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gray to brown sandy clay with occasional gravel (very stiff, moist) (glaciomarine drift)</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>23</td>
<td>3</td>
<td>MEC</td>
<td></td>
<td></td>
<td></td>
<td>Contains trace gravel and sand and becomes very stiff</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td>15</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Becomes stiff</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td>15</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Becomes gray with high plasticity</td>
</tr>
</tbody>
</table>

**MATERIAL DESCRIPTION**

- **1 inch of asphalt concrete pavement**
- **Gray to brown sandy clay with occasional gravel (very stiff, moist) (glaciomarine drift)**
- **Contains trace gravel and sand and becomes very stiff**
- **Becomes stiff**
- **Becomes gray with high plasticity**

**REMARKS**

- Measure water content (%) and plasticity

Note: See Figure A-1 for explanation of symbols. Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.
### Field Data

<table>
<thead>
<tr>
<th>Interval</th>
<th>Depth (feet)</th>
<th>Sample Name</th>
<th>Sample Number</th>
<th>Group Classification</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12</td>
<td>0-17</td>
<td>1</td>
<td></td>
<td>AC SPSM</td>
<td>3 inches of asphalt concrete pavement</td>
</tr>
<tr>
<td>13-18</td>
<td>13-32</td>
<td>2</td>
<td></td>
<td>CL</td>
<td>Gray clay with occasional gravel and sand (stiff, moist)</td>
</tr>
<tr>
<td>19-20</td>
<td>19-42</td>
<td>3</td>
<td></td>
<td>ML</td>
<td>Gray silt with sand and trace gravel (very stiff to hard, moist)</td>
</tr>
<tr>
<td>21-20</td>
<td>21-32</td>
<td>4</td>
<td></td>
<td>SM</td>
<td>Gray silt fine sand (dense, moist)</td>
</tr>
</tbody>
</table>

### Remarks

- Perched groundwater observed at 2½ feet during drilling
- Hard drilling at 12 feet

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

---

### Log of Boring B-5

**Project:** R Avenue Long-Term Improvements  
**Project Location:** Anacortes, Washington  
**Project Number:** 0382-042-00
### Log of Boring B-6

**Project:** R Avenue Long-Term Improvements  
**Project Location:** Anacortes, Washington  
**Project Number:** 0382-042-00

#### Field Data

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Interval</th>
<th>Recovered (in)</th>
<th>Borehole/Foot</th>
<th>Collected Sample</th>
<th>Sample Name</th>
<th>Testing</th>
<th>Graphic Log</th>
<th>Group Classification</th>
<th>Material Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AC</td>
<td>3 inches of asphalt concrete pavement</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CL</td>
<td>Gray clay with sand and trace gravel (medium stiff, moist) (fill)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GM</td>
<td>Gray sandy gravel with silt (very loose, moist)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CL</td>
<td>Gray to brown clay with occasional gravel (very stiff, moist) (glaciomarine drift)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Becomes gray</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ML</td>
<td>Gray silt with sand and trace gravel (hard, moist) (glaciomically consolidated soils)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ML</td>
<td>Gray silt with trace sand (hard, moist)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** See Figure A-1 for explanation of symbols.  
Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.
**Log of Boring B-7**

**Project: R Avenue Long-Term Improvements**

**Project Location: Anacortes, Washington**

**Project Number: 0382-042-00**

---

**FIELD DATA**

<table>
<thead>
<tr>
<th>Interval (feet)</th>
<th>Depth (feet)</th>
<th>Recovered (in)</th>
<th>Blows/foot</th>
<th>Sample Name</th>
<th>Testing</th>
<th>Graphic Log</th>
<th>Group Classification</th>
<th>Material Description</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>Ac</td>
<td>2 inches of asphalt concrete pavement</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>2</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td>Cl</td>
<td>Gray clay with sand and gravel (medium stiff, moist) (fill)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cl</td>
<td>Gray clay with occasional gravel (stiff, moist) (glaciomarine drift)</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>10</td>
<td>4</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lacks gravel</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>18</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Becomes very stiff with trace sand</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>18</td>
<td>6</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td>Sm</td>
<td>Gray silty fine to coarse sand with gravel (dense to very dense, wet) (glacially consolidated soils)</td>
<td>Perched groundwater observed at 12½ feet during drilling</td>
</tr>
<tr>
<td>70</td>
<td>20</td>
<td>7</td>
<td>50/5*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very hard drilling at 17 feet, gravel</td>
<td>No recovery</td>
</tr>
</tbody>
</table>

---

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.
FIELD DATA

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Blows/foot</th>
<th>Collected Sample</th>
<th>Graphic Log</th>
<th>Classification</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>18</td>
<td>19</td>
<td>CL</td>
<td>Brown to gray with slight iron staining clay with sand and occasional gravel (very stiff, moist)</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>18</td>
<td>27</td>
<td>CL</td>
<td>Brown-gray with iron staining clay with silt and sand (very stiff, moist) (glaciomarine drift)</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>18</td>
<td>19</td>
<td>GP-GM</td>
<td>Gray-brown silty sand with gravel (medium dense, moist)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>2</td>
<td></td>
<td>SM</td>
<td>Approximately 9 inches of concrete</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>AC</td>
<td>Approximately 3 inches of asphalt</td>
</tr>
</tbody>
</table>

MATERIAL DESCRIPTION

- Blow count overstated, on gravel

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

Log of Boring B-8

Project: R Avenue Long-Term Improvements
Project Location: Anacortes, Washington
Project Number: 0382-042-00

Figure A-9
Sheet 1 of 1
Surface Elevation (ft) | 49 ft | Vertical Datum | NAVD88
--- | --- | --- | ---
Easting (X) | 1209800 ft | Northing (Y) | 552070 ft
Notes: Groundwater not observed at time of exploration

**FIELD DATA**

<table>
<thead>
<tr>
<th>Interval</th>
<th>Depth (feet)</th>
<th>Recovered (in)</th>
<th>Boring Foot</th>
<th>Sample Name</th>
<th>Testing</th>
<th>Graphic Log</th>
<th>Group</th>
<th>Classification</th>
</tr>
</thead>
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</tr>
</tbody>
</table>

**MATERIAL DESCRIPTION**

Approximately 4 inches of asphalt
Brown fine to coarse sand with trace silt and gravel (medium dense, moist to wet) (fill)
Gray to black clay with sand, silt and occasional gravel (medium stiff, moist)
Gray silty fine to medium sand with occasional gravel (medium dense, moist to wet)
Brown-gray with iron staining clay with sand and occasional gravel (very stiff, moist) (glaciomarine drift)
Gray sandy silt (hard, moist) (glaciafilms consolidated soils)
Gray silty sand (very dense, moist)

**REMARKS**

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

**Log of Boring B-9**

Project: R Avenue Long-Term Improvements
Project Location: Anacortes, Washington
Project Number: 0382-042-00

Figure A-10
Sheet 1 of 1
**Log of Boring B-10**

**Project:** R Avenue Long-Term Improvements  
**Project Location:** Anacortes, Washington  
**Project Number:** 0382-042-00

---

**Notes:**

- Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

---

**Drilled**  
**End**  
**Total Depth (ft)**  
**Logged By**  
**AF**  
**Driller**  
**Drilling Method**  
**Surface Elevation (ft)**  
**Vertical Datum**  
**Hammer Checked By**  
**Rope & Cathead**  
**System**  
**Drilling Equipment**  
**Eastings (X)**  
**Northings (Y)**  
**Datum**  
**Equipment**  
**Groundwater not observed at time of exploration**  
---

**FIELD DATA**

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<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Interval</th>
<th>Recovered (in)</th>
<th>Sample Name</th>
<th>Testing</th>
<th>Group</th>
<th>Classification</th>
<th>Measure Content (%)</th>
<th>Content (%)</th>
<th>REMARKS</th>
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<td>0</td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>19</td>
<td>2 MC</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
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<td>14</td>
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</tbody>
</table>

- Approximately 3 inches of asphalt
- Light brown-gray fine to coarse gravel with sand and silt and concrete fragments (medium dense, moist) fill
- Brown silty fine to coarse sand with gravel and clay (medium dense, moist)
- Brown with slight iron staining silty clay with sand and occasional gravel (very stiff, moist) (glaciomarine drift)
- Gray with slight iron staining silt with trace sand (very stiff, moist)
- Iron staining grades out

---

**GeoEngineers**

---

**Figure A-11**  
**Sheet 1 of 1**
### Log of Boring B-11

**Project:** R Avenue Long-Term Improvements  
**Project Location:** Anacortes, Washington  
**Project Number:** 0382-042-00

---

**Notes:**
- See Figure A-1 for explanation of symbols.  
- Coordinates Data Source: Horizontal approximated based on Google Earth. Vertical approximated based on Topographic Survey.

---

**FIELD DATA**

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Interval</th>
<th>Recovered (in)</th>
<th>Below/Not</th>
<th>Collected Sample</th>
<th>Graphic Log</th>
<th>Group Classification</th>
</tr>
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<tbody>
<tr>
<td>0</td>
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<td>14</td>
<td>AC</td>
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<td></td>
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</tr>
<tr>
<td>5</td>
<td>5</td>
<td>18</td>
<td>17</td>
<td>SP,SM</td>
<td></td>
<td></td>
<td>Approximately 6 inches of concrete</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>18</td>
<td>21</td>
<td>CL</td>
<td></td>
<td></td>
<td>Brown fine to coarse sand with silt and gravel (medium dense, moist) (fil)</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>18</td>
<td>74</td>
<td>ML</td>
<td></td>
<td></td>
<td>Gray to brown clay with iron staining with sand and occasional gravel (very stiff, moist) (glaciomarine drift)</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>18</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td>Gray sandy silt with occasional gravel (hard, moist) (glacially consolidated soils)</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Grades to very stiff</td>
</tr>
</tbody>
</table>

**MATERIAL DESCRIPTION**

- Approximately 5 inches of asphalt
- Approximately 6 inches of concrete
- Brown fine to coarse sand with silt and gravel (medium dense, moist) (fil)
- Gray to brown clay with iron staining with sand and occasional gravel (very stiff, moist) (glaciomarine drift)
- Gray sandy silt with occasional gravel (hard, moist) (glacially consolidated soils)
- Grades to very stiff

**REMARKS**

- **pp=3.75 tfs**

---

**Drilled**  
4/27/2021  
**End**  
4/27/2021  
**Total Depth (ft)**  
21.5

**Logged By**  
AJH  
**Hammer**  
Rope & Cathead  
140 (lbs) / 30 (in) Drop  
**System**  
WA State Plane North  
**Datum**  
NAD83 (feet)

**Driller**  
Boretec 1, Inc.  
**Equipment**  
EC 55 Track Mounted  
**Drilling**  
Method: Hollow-stem Auger

**Notes:**
- Groundwater not observed at time of exploration
U.S. STANDARD SIEVE SIZE

PERCENT PASSING BY WEIGHT

GRAIN SIZE IN MILLIMETERS

COBBLES | GRAVEL | SAND | SILT OR CLAY
---|---|---|---
COARSE | FINE | COARSE | MEDIUM | FINE

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Boring Number</th>
<th>Depth (feet)</th>
<th>Moisture (%)</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑️</td>
<td>B-2</td>
<td>0.5</td>
<td>9</td>
<td>Silty sand with gravel (SM)</td>
</tr>
<tr>
<td>☑️</td>
<td>B-8</td>
<td>2.5</td>
<td>12</td>
<td>Silty sand with gravel (SM)</td>
</tr>
</tbody>
</table>

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The grain size analysis results were obtained in general accordance with ASTM D 6913.
Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The liquid limit and plasticity index were obtained in general accordance with ASTM D 4318.
APPENDIX B

Report Limitations and Guidelines for Use
APPENDIX B
REPORT LIMITATIONS AND GUIDELINES FOR USE

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services are performed for Specific Purposes, Persons and Projects

This report has been prepared for use by the City of Anacortes, H.W. Lochner, Inc. and other members of the design team. This report may be made available to the project design team for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for the R Avenue Improvements project in Anacortes, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it 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.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

1 Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org
If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

**Subsurface Conditions Can Change**

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability, or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

**Most Geotechnical and Geologic Findings are Professional Opinions**

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

**Geotechnical Engineering Report Recommendations are Not Final**

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers’ professional judgment and opinion. GeoEngineers’ recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

**A Geotechnical Engineering or Geologic Report Could be Subject to Misinterpretation**

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.
Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists 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 or geologic 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 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 or geologic 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 GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor’s procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these “Report Limitations and Guidelines for Use” apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.
**Biological Pollutants**

GeoEngineers’ Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.