Geotechnical Evaluation

Commercial Avenue Development
Anacortes, Washington

Prepared For:

Underwood & Associates
1005 4th Street
Anacortes, WA 98221
Attn: Mike Underwood

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November 15, 2019
Project No. 19-0665

Underwood & Associates
1005 4th Street
Anacortes, WA 98221

Attention: Mike Underwood

Regarding: **Geotechnical Evaluation Report**
Commercial Avenue Development
1808 Commercial Avenue
Anacortes, WA 98221

Dear Mr. Underwood:

As requested, GeoTest Services, Inc. (GeoTest) is pleased to submit the following report summarizing the results of our geotechnical evaluation for the proposed Commercial Avenue Development located at 1808 Commercial Avenue in Anacortes, Washington (see Vicinity Map, Figure 1). This report has been prepared in general accordance with the terms and conditions established in our services agreement dated September 3rd, 2019.

We appreciate the opportunity to provide geotechnical services on this project and look forward to assisting you during the construction phase. Should you have any further questions regarding the information contained within the report, or if we may be of service in other regards, please contact the undersigned.

Respectfully,
GeoTest Services, Inc.

State of Washington
Engineering Geologist
2420
Licensed Geologist

Tim Chylla 11-15-19
Tim Chylla, L.E.G.
Senior Engineering Geologist

Enclosure: Geotechnical Evaluation Report

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PURPOSE AND SCOPE OF SERVICES

The purpose of this evaluation is to establish general subsurface conditions beneath the site from which conclusions and recommendations pertaining to project design can be formulated. Our scope of services includes the following tasks:

- Exploration of soil and groundwater conditions underlying the site by advancing 10 test pits with a subcontracted tracked excavator to evaluate subsurface conditions.
- Laboratory testing on representative samples to classify and evaluate the engineering characteristics of the soils encountered.
- Chemical analysis of 5 soil samples obtained from under the Commercial Avenue sidewalk for gasoline, diesel, oil, BTEX and MTBE analytes.
- To provide a written report containing a description of subsurface conditions, exploration logs, findings and recommendations pertaining to site preparation and earthwork, fill and compaction, seismic design, foundation recommendations, concrete slab-on-grade construction, foundation and site drainage, utilities, temporary and permanent slopes, geotechnical consultation, and construction monitoring.

PROJECT DESCRIPTION

GeoTest understands there are plans to develop the vacant lot located at 1808 Commercial Avenue in Anacortes, Washington. The property is bound to the north by 18th Street, to the east by Commercial Avenue and to the west and south by alley access.

Based on preliminary design information provided by Underwood and Associates, the new development will involve the construction of a new, approximately 4,400 square foot, 2 story building, along with associated parking and access lanes to the property.

Structural loads for the new building is anticipated to be light. Construction is anticipated to utilize shallow, conventional, concrete foundations and either wood-frame or steel-frame construction, or some combination of the two. Floors are anticipated to be slab-on-grade.

The property underwent an environmental cleanup in 2008. Contaminated soils were removed within the property and chased to the edge of the sidewalk on its eastern edge along Commercial Avenue. At the time of the 2008 cleanup, petroleum contaminates were detected in areas along the sidewalk, sidewall excavation. While present, the contaminates were below the Washington State Department of Ecology's Model Toxics Control Act (MTCA) Method B cleanup levels. During this geotechnical evaluation, GeoTest sampled underneath the sidewalk to determine if contamination levels have decreased.

SITE CONDITIONS

This section includes a description of the general surface and subsurface conditions observed at the project site during the time of our field investigation. Interpretations of site conditions are based on the results and review of available information, site reconnaissance, subsurface explorations, laboratory testing, and previous experience in the project vicinity.

Surface Conditions

The rectangular site property occupies approximately 10,800 square feet, immediately southwest of the intersection of 18th Street and Commercial Avenue. The site is currently undeveloped and is primarily covered by grass. The site is relatively level, with a slight downward slope to the northeast. No surface water was observed at the time of our site visit.

Image 1: Proposed development site. Facing northeast from southwest property corner.

Subsurface Soil Conditions

Subsurface conditions were explored by advancing 10 exploratory test pits on September 30, 2019. The explorations were advanced to depths of between 2 and 8.5 feet below ground surface (BGS) using a subcontracted tracked excavator (R&J Dirtworks). Approximate locations of these explorations have been plotted on the *Site and Exploration Plan* (Figure 2).

The soil profile consisted of a thin mantle of topsoil over 1 to 5 feet of medium dense, brown to gray, gravelly sand (fill), in areas where contaminated soil had previously been excavated. In areas not involved in the 2008 cleanup, topsoil was encountered over medium stiff to stiff, blue to gray, very sandy silt with minor gravel (Glaciomarine Drift). Underlying the native silt in TP-6 and TP-8, medium dense, brown, gravelly sand was encountered (Glaciomarine Drift). With the exception of the topsoil, site soils were generally inorganic, and lacked visible human debris or deleterious materials.

General Geologic Conditions

Geologic information for the project site was obtained from the interactive Geologic Information Portal *Geologic Map of Washington State*, published by the Washington State Department of Natural Resources (DNR) as well as *Geologic map of the Bellingham 1:100,000 quadrangle, Washington* (Lapen, Thomas J., 2000). According to the referenced maps, subsurface soils mapped on the project area consist of Pleistocene aged glaciomarine drift. The drift deposits are locally known as Everson Glaciomarine Drift ($Qgdm_e$). Glaciomarine drift consists of moderately sorted to poorly hardened, moderately to unsorted diamicton with lenses and discontinuous beds of moderately to well sorted gravel, sand, silt and clay. Dropstone content is variable, and they are commonly polished, striated and/or faceted.

The native soil conditions encountered in our explorations were in general conformance with the published geologic literature.

Groundwater

Perched groundwater was encountered at depths ranging from 2 to 4 feet BGS in TP-2, TP-3, TP-7 and TP-9. The slight seepage was due to trapped rainfall and is not indicative of a regional groundwater table. The groundwater conditions reported on the exploration logs are for the specific locations and dates indicated, and therefore may not be indicative of other locations and/or times. Groundwater levels are variable and groundwater conditions will fluctuate depending on local subsurface conditions, precipitation, and changes in on-site and offsite use. Please be aware that perched groundwater may likely be encountered on the medium stiff to stiff silt deposits throughout the site during the wet season.

GEOLOGIC HAZARDS

The site is relatively level, underlain by medium dense/medium stiff to stiff soil, approximately 25 feet above sea level, and approximately 1,300 feet inland. No steep slopes exist within the near vicinity of the project site and is outside of any mapped landslide, erosion, mine, volcanic or tsunami hazard areas. As such, the site does not appear to meet the criteria outlined in the *Anacortes Municipal Code 17.70.170 Geologically Hazardous Areas*, and no evaluation or mitigation requirements apply for the above hazards.

Seismic Hazards - Liquefaction Hazard Potential

Liquefaction is defined as a significant rise in pore water pressure within a soil mass caused by earthquake-induced cyclic shaking. The shear strength of liquefiable soil is reduced during large and/or long duration earthquakes as the soil consistency approaches that of semi-solid slurry. Liquefaction can result in significant and widespread structural damage if not properly mitigated. Deposits of loose, granular soil below the groundwater table are most susceptible to liquefaction. Damage caused by foundation rotation, lateral spreading, and other ground movements can result from soil liquefaction.

A review of information obtained from the Washington State Department of Natural Resources (DNR) Geologic Information Portal indicates the subject site is classified as having a low to moderate liquefaction susceptibility. However, this map only provides an estimate of the likelihood that soil will liquefy as a result of an earthquake and is meant as a general guide to indicate areas potentially susceptible to liquefaction.

Based on the medium dense to medium stiff/stiff soils encountered in our explorations, we do not consider the site to present a liquefaction hazard. Mitigation of seismic forces can be accomplished through structural design.

CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the data collected during this investigation, it is our opinion that the subsurface conditions at the site are suitable for the proposed development, provided the recommendations contained herein are incorporated into the project design.

As mentioned previously, the site is underlain by near-surface, medium stiff to stiff, native glacial soils and medium dense, import fill. These soils are suitable for foundation bearing if covered with a minimum of 1 foot of property compacted structural fill.

A formal grading plan was not available at the time this report was written. Import and export quantities for building and hardscape subgrades will be highly dependent on what this grading plan reflects. We recommend the design team carefully review this report, subsurface logs,

geographic distribution and relative thickness of existing fill and relict topsoil units as the site civil design progresses.

Site Preparation and Earthwork

The portions of the site proposed for foundation(s), floor slabs, pavement and/or sidewalks development should be prepared by removing topsoil, deleterious material and significant accumulations of organics. Prior to placement of any foundation elements or structural fill, the exposed subgrade under all areas to be occupied by soil-supported floor slabs, spread, or continuous foundations should be recompacted to a firm and unyielding condition. Verification of compaction can be accomplished through proof rolling with a loaded dump truck, large self-propelled vibrating roller, or similar piece of equipment applicable to the size of the excavation. The purpose of this effort is to identify loose or soft soil deposits so that, if feasible, the soil distributed during site work can be recompacted.

Proof rolling should be carefully observed by qualified geotechnical personnel. Areas exhibiting significant deflection, pumping, or over-saturation that cannot be readily compacted should be overexcavated to firm soil. Overexcavated areas should be backfilled with compacted granular material placed in accordance with subsequent recommendations for structural fill. During periods of wet weather, proof rolling could damage the exposed subgrade. Under these conditions, qualified geotechnical personnel should observe subgrade conditions to determine if proof rolling is feasible.

If proof rolling is not feasible due to space, elevation or other constraints, we recommend that alternate methods such as nuclear densometer, Dynamic Cone Penetrometer (DCP), or soil probe methods be utilized to verify suitable conditions have been attained.

Fill and Compaction

Structural fill used to obtain final elevations for foundations, hardscapes and soil-supported floor slabs must be properly placed and compacted. In most cases, any non-organic, predominantly granular soil may be used for fill material provided the material is properly moisture conditioned prior to placement and compaction, and the specified degree of compaction is obtained. Material containing topsoil, wood, trash, organic content, or construction debris is not suitable for reuse as structural fill and should be properly disposed offsite or used in non-structural areas.

Soils containing more than approximately 5 percent fines are considered moisture sensitive, and are difficult to compact to a firm and unyielding condition when over the optimum moisture content by more than approximately 2 percent. The optimum moisture content is that which allows the greatest dry density to be achieved at a given level of compactive effort.

Reuse of On-Site Soil

The existing fill soils with low fines content near 5 percent are suitable for reuse as structural fill when placed at near-optimum moisture contents, as determined by ASTM D1557. Care should be taken to separate and stockpile this material from native soils with elevated fines content. Fill soils with organic content or relict topsoil are not suitable for reuse as structural fill.

The native soils with elevated fines contents will be difficult to appropriately compact during periods of wet-weather. Exposure to wet weather has potential to substantially degrade these soils, potentially leading to costly schedule delays and change orders. As such, the reuse of these soils should be limited to prolonged periods of dry weather, during which their moisture condition may be managed. These soils are suitable for reuse when placed at near-optimum moisture contents, as determined by ASTM D1557, and if allowed for in the project plans and specifications.

Structural Fill

GeoTest recommends that imported structural fill consist of clean, well-graded sandy gravel, gravelly sand, or other approved naturally occurring granular material (pit run) with at least 30 percent retained on the No. 4 sieve, or a well-graded crushed rock. Structural fill for dry weather construction may contain up to 10 percent fines (that portion passing the U.S. No. 200 sieve) based on the portion passing the U.S. No. 4 sieve. The use of an imported fill having more than 10 percent fines may be feasible, but the use of these soils should generally be reviewed by the design team prior to the start of construction.

Imported structural fill with less than 5 percent fines should be used during wet weather conditions. Due to wet site conditions, soil moisture contents could be high enough that it may be difficult to compact even clean imported select granular fill to a firm and unyielding condition. Soils with an over-optimum moisture content should be scarified and dried back to a suitable moisture content during periods of dry weather or removed and replaced with drier structural fill.

Backfill and Compaction

Structural fill should be placed in horizontal lifts. The structural fill must measure 8 to 10 inches in loose thickness and be thoroughly compacted. All structural fill placed under load bearing areas should be compacted to at least 95 percent of the maximum dry density, as determined using test method ASTM D1557. The top of the compacted structural fill should extend outside all foundations and other structural improvements a minimum distance equal to the thickness of the fill. We recommend that compaction be tested after placement of each lift in the fill pad.

Wet Weather Earthwork

Fine grained native soils are particularly susceptible to degradation during wet weather. As a result, it may be difficult to control the moisture content of site soils during the wet season. If construction takes place during wet weather, GeoTest recommends that structural fill consist of imported, clean, well-graded sandy gravel or gravelly sand as described above. If fill is to be placed or earthwork is to be performed in wet conditions, the contractor may reduce soil disturbance by:

- Limiting the size of areas that are stripped of topsoil and left exposed
- Accomplishing earthwork in small sections
- Limiting construction traffic over unprotected soil
- Sloping excavated surfaces to promote runoff
- Limiting the size and type of construction equipment used
- Providing gravel 'working mats' over areas of prepared subgrade
- Removing wet surficial soil prior to commencing fill placement each day
- Sealing the exposed ground surface by rolling with a smooth drum compactor or rubber-tired roller at the end of each working day
- Providing up-gradient perimeter ditches or low earthen berms and using temporary sumps to collect runoff and prevent water from ponding and damaging exposed subgrades

Seismic Design Considerations

The Pacific Northwest is seismically active and the site could be subject to movement from a moderate or major earthquake. Consequently, moderate levels of seismic shaking should be accounted for during the design life of the project, and the proposed structure should be designed to resist earthquake loading using appropriate design methodology.

For structures designed using the seismic design provisions of the 2018 International Building Code, the soil underlying the site within the upper 100 feet is classified as Site Class D, according to ASCE 7-16. The structural engineer should select the appropriate design response spectrum based on Site Class D soil and the geographical location of the proposed construction.

Foundation Support

Continuous or isolated spread footings founded on a minimum of 1 foot of imported structural fill over suitably prepared firm and unyielding, native soils or existing fill soils can provide foundation support for the proposed improvements. We recommend that qualified geotechnical personnel confirm that suitable bearing conditions have been reached prior to placement of structural fill or foundation formwork.

To provide proper support, GeoTest recommends that topsoil, organic matter or other deleterious material be removed from beneath the proposed foundation and slab area(s) and be replaced with properly compacted structural fill as described in the Fill and Compaction section of this report. Localized overexcavation, if necessary, can be backfilled to the design footing elevation with lean concrete, or foundations may be extended to bear on undisturbed native soil. In areas requiring overexcavation to competent native soils the limits of the overexcavation should extend laterally beyond the edge of each side of the footing a distance equal to the depth of the excavation below the base of the footing. If lean concrete is used to backfill the overexcavation, the limits of the overexcavation need only extend a nominal distance beyond the width of the footing. In addition, GeoTest recommends that foundation elements for the proposed structure(s) bear entirely on similar soil conditions to help prevent differential settlement from occurring.

Continuous and isolated spread footings should be founded 18 inches, minimum, below the lowest adjacent final grade for freeze/thaw protection. The footings should be sized in accordance with the structural engineer's prescribed design criteria and seismic considerations.

Allowable Bearing Capacity

Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings founded directly on properly compacted structural fill over native, firm and unyielding glaciomarine drift deposits or existing fill be proportioned using a net allowable soil bearing pressure of up to 2,000 pounds per square foot (psf).

The "net allowable bearing pressure" refers to the pressure that can be imposed on the soil at foundation level. This pressure includes all dead loads, live loads, the weight of the footing, and any backfill placed above the footing. The net allowable bearing pressure may be increased by one-third for transient wind or seismic loads.

Foundation Settlement

Settlement of shallow foundations depends on foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying soil. If construction is accomplished as recommended and at the maximum allowable soil bearing pressure, GeoTest estimates the total settlement of building foundations to be less than one inch. Differential settlement between two adjacent load-bearing components supported on competent soil is estimated to be less than one half the total settlement.

Floor Support

Conventional concrete slab-on-grade construction is feasible for the planned site improvements. Slabs may be supported by suitably prepared, firm and unyielding native soils or on properly

placed and compacted structural fill placed over such soils. Prior to placement of the structural fill, the subgrade conditions should be verified by a GeoTest geotechnical professional.

GeoTest recommends that interior concrete slab-on-grade floors be underlain with at least 6 inches of clean, compacted, free-draining gravel. The gravel should contain less than 3 percent passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The purpose of this gravel layer is to provide uniform support for the slab, provide a capillary break, and act as a drainage layer. To help reduce the potential for water vapor migration through floor slabs, a continuous 10 to 15-mil minimum thick polyethylene sheet with tape-sealed joints should be installed below the slab to serve as an impermeable vapor barrier. The vapor barrier should be installed and sealed in accordance with the manufacturer's instructions.

Foundation and Site Drainage

Positive surface gradients should be provided adjacent to the proposed foundation to direct surface water away from the residence and toward suitable drainage facilities. Surface water should not be allowed to pond and soak into the ground surface near buildings or paved areas during or after construction. Construction excavations should be sloped to drain to sumps where water from seepage, rainfall, and runoff can be collected and pumped to a suitable discharge facility.

To reduce the potential for groundwater and surface water to seep into interior spaces, GeoTest recommends that an exterior footing drain system be constructed around the perimeter of new foundations as shown in the Typical Footing and Wall Drain Section (Figure 3) of this report. The drain should consist of a perforated pipe measuring 4 inches in diameter at minimum, surrounded by at least 12 inches of filtering media. The pipe should be sloped to carry water to an approved collection system. The filtering media may consist of open-graded drain rock wrapped in a nonwoven geotextile fabric such as Mirafi 140N (or equivalent).

For foundations supporting retaining walls, drainage backfill should be carried up the back of the wall and be at least 12 inches wide. The drainage backfill should extend from the foundation drain to within approximately 1 foot of the finished grade and consist of open-graded drain rock containing less than 3 percent fines by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The invert of the footing drainpipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent slab grade, whichever is deeper, so that water will be contained. This process prevents water from seeping through walls or slabs. The drain system should include cleanouts to allow for periodic maintenance and inspection.

Resistance to Lateral Loads

The lateral earth pressures that develop against retaining walls will depend on the method of backfill placement, degree of compaction, slope of backfill, type of backfill material, provisions for drainage, magnitude and location of any adjacent surcharge loads, and the degree to which the wall can yield laterally during or after placement of backfill. If the wall is allowed to rotate or yield so the top of the wall moves an amount equal to or greater than about 0.001 to 0.002 times its height (a yielding wall), the soil pressure exerted comprises the active soil pressure. When a wall is restrained against lateral movement or tilting (a nonyielding wall), the soil pressure exerted comprises the at rest soil pressure. Wall restraint may develop if a rigid structural network is constructed prior to backfilling or if the wall is inherently stiff.

GeoTest recommends that yielding walls under drained conditions be designed for an equivalent fluid density of 35 pounds per cubic foot (pcf), for structural fill in active soil conditions and 40 pcf for native soils. Nonyielding walls under drained conditions should be designed for an equivalent fluid density of 55 pcf, for structural fill in at-rest conditions and 60 pcf for native soils. Design of walls should include appropriate lateral pressures caused by surcharge loads located within a horizontal distance equal to or less than the height of the wall. For uniform surcharge pressures, a uniformly distributed lateral pressure equal to 35 percent and 50 percent of the vertical surcharge pressure should be added to the lateral soil pressures for yielding and nonyielding walls, respectively.

For structures designed using the seismic design provisions of the 2018 International Building Code, GeoTest recommends that retaining walls include a seismic surcharge in addition to the equivalent fluid densities presented above. We recommend that a seismic surcharge of approximately 8H (where H is the height of the wall in feet) be used for design purposes.

Passive earth pressures developed against the sides of building foundations, in conjunction with friction developed between the base of the footings and the supporting subgrade, will resist lateral loads transmitted from the structure to its foundation. For design purposes, the passive resistance of well-compacted fill placed against the sides of foundations is equivalent to a fluid with a density of 250 pounds per cubic foot. The recommended value includes a safety factor of about 1.5 and is based on the assumption that the ground surface adjacent to the structure is level in the direction of movement for a distance equal to or greater than twice the embedment depth. The recommended value also assumes drained conditions that will prevent the buildup of hydrostatic pressure in the compacted fill. Retaining walls should include a drain system constructed in general accordance with the recommendations presented in the *Foundation and Site Drainage* section of this report. In design computations, the upper 12 inches of passive resistance should be neglected if the soil is not covered by floor slabs or pavement. If future plans call for the removal of the soil providing resistance, the passive resistance should not be considered.

An allowable coefficient of base friction of 0.35, applied to vertical dead loads only, may be used between the underlying imported granular structural fill and the base of the footing. If passive and frictional resistance are considered together, one half the recommended passive soil resistance value should be used since larger strains are required to mobilize the passive soil resistance as compared to frictional resistance. A safety factor of about 1.5 is included in the base friction design value. GeoTest does not recommend increasing the coefficient of friction to resist seismic or wind loads.

Temporary and Permanent Slopes

The contractor is responsible for construction slope configurations and maintaining safe working conditions, including temporary excavation stability. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored during and after excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring.

Temporary excavations in excess of 4 ft should be shored or sloped in accordance with Safety Standards for Construction Work Part N, WAC 296-155-66403.

Temporary unsupported excavations in the medium stiff to stiff, native silt or medium dense, existing fill encountered at the project site are classified as a Type B soil according to WAC 296-155-66401 and may be sloped as steep as 1:1 (Horizontal: Vertical). All soils encountered are classified as Type C soil in the presence of groundwater seepage. Flatter slopes or temporary shoring may be required in areas where groundwater flow is present and unstable conditions develop.

Temporary slopes and excavations should be protected as soon as possible using appropriate methods to prevent erosion from occurring during periods of wet weather.

GeoTest recommends that permanent cut or fill slopes be designed for inclinations of 2H:1V or flatter. Permanent cuts or fills used in detention ponds, retention ponds, or earth slopes intended to hold water should be 3H:1V or flatter. All permanent slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction.

Utilities

Utility trenches must be properly backfilled and compacted to reduce cracking or localized loss of foundation, slab, or pavement support. Excavations for new shallow underground utilities are expected to be placed within either existing fill or hard, native conditions.

Trench backfill in improved areas (beneath structures, pavements, sidewalks, etc.) should consist of structural fill as defined in the *Fill and Compaction* section of this report. Outside of improved

areas, trench backfill may consist of reused native material provided the backfill can be compacted to the project specifications. Trench backfill should be placed and compacted in general accordance with the recommendations presented in the *Fill and Compaction* section of this report.

Surcharge loads on trench support systems due to construction equipment, stockpiled material, and vehicle traffic should be included in the design of any anticipated shoring system. The contractor should implement measures to prevent surface water runoff from entering trenches and excavations. In addition, vibration as a result of construction activity and traffic may cause caving of the trench walls.

The contractor is responsible for trench configurations. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored by the contractor during excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring. If groundwater or groundwater seepage is present, and the trench is not properly dewatered, the soil within the trench zone may be prone to caving, channeling, and running. Trench widths may be substantially wider than under dewatered conditions.

Pavement Subgrade Preparation

Pavement section is often a choice between higher initial cost with lower maintenance fees, or lower initial cost with more frequent maintenance fees. For this reason, GeoTest recommends that the owner participate in the site pavement selection. Site grading plans should include provisions for sloping of the subgrade soils in proposed pavement areas, so that passive drainage of the pavement section(s) can proceed uninterrupted during the life of the project.

We require structural fill placed to establish subgrade elevation should be compacted to a minimum of 95 percent of its maximum dry density, as determined using test method ASTM D1557. Prior to the placement of base-course and paving materials, the exposed subgrade should be proof rolled. Proof rolling should be accomplished with a loaded dump truck, large self-propelled vibrating roller, or equivalent piece of equipment. The purpose of this effort is to identify possible loose or soft soil and recompact disturbed areas of subgrade. GeoTest is available to provide recommendations for minimum pavement sections upon request.

Stormwater Infiltration Potential

Based on the presence of near surface existing fill soils, relatively shallow, medium stiff to stiff, silt soils, and the almost certainty for shallow perched groundwater conditions in the wet season, GeoTest does not recommend that on-site infiltration be incorporated as part of stormwater design for the proposed development. It is our opinion that the on-site soils meet the criteria for a "restriction layer" per the *Stormwater Management Manual for Western Washington, 2012.*

On-site infiltration of stormwater on this site is not feasible. Rather, GeoTest recommends that stormwater be tight lined to an existing off-site municipal system or be managed by on site detention or retention systems.

Environmental Sampling Results

GeoTest collected soil samples from 5 locations under the sidewalk along Commercial Avenue. The samples were in locations where contamination was previously detected during our 2008 cleanup of the site.

Field Sampling Methodology

On September 30th, 2019, 5 discrete soil sample were obtained underneath the Commercial Avenue sidewalk for analysis using pre-cleaned stainless steel spoons and nitrile gloves. A trench was first excavated directly adjacent to the west edge of the sidewalk. GeoTest personnel excavated into the sidewall a minimum of 1 foot to sample under the sidewalk to reduce the loss of volatile contaminants. A new pre-cleaned sampling spoon was used to sample at each location, and gloves were changed between each collection point to prevent cross-contamination.

The soil sample containers consisted of one standard 4 oz. wide mouth glass jars with Teflon lined lids and 40 ml glass vials that were sampled using a disposable syringe by Method 5035. The sample containers were appropriately prepared with preservatives, as applicable, by the analytical laboratory. Each sample was labeled, immediately placed in a cooler and chilled to approximately 4 degrees Celsius. The samples were delivered to ALS Laboratory Group (ALS), located in Everett, Washington, immediately following field collection. DOE recommended sample collecting, handling, chain of custody records and protocol were maintained throughout the project. Standard laboratory analysis required 10 full business days to complete.

Our field screening consisted of visual inspection of the soils within the excavations, olfactory "sniff test", as well as the use of a hand-held photoionization detector (PID) for the presence of potential petroleum contamination. PID readings at various locations within the test pits were generally 0.0 ppm with the exception of TP-1 were a reading of 0.1 ppm was detected at 1.2 feet and 1.0 ppm at 1.6 feet.

Analytical Results

The following table provides a summary of sampling results:

TABLE 1
SUMMARY OF LABORATORY ANALYSIS.
Commercial Avenue

All soil sample results and limits are in milligrams per kilogram (MG/KG). Please refer to the individual analytical laboratory result sheets for a complete list of analysis and results.

Sample #	Method	Analyte	Reporting Limits	Results	Action Level
E-1 @ 1.6 Feet (Soil)	NWTPH-GX	TPH-Volatile Range	3.0	**7.2**	100
	EPA-8021	Methyl T-Butyl Ether	0.10	**ND**	0.1
	EPA-8021	Benzene	0.030	**ND**	0.03
	EPA-8021	Toluene	0.050	**ND**	7
	EPA-8021	Ethylbenzene	0.050	**ND**	6
	EPA-8021	Zylenes	0.20	**ND**	9
	NWTPH-GX	TPH-Diesel Range	25	**ND**	2,000
	NWTPH-GX	TPH-Oil Range	50	**ND**	2,000
E-2 @ 1.5 Feet (Soil)	NWTPH-GX	TPH-Volatile Range	3.0	**ND**	100
	EPA-8021	Methyl T-Butyl Ether	0.10	**ND**	0.1
	EPA-8021	Benzene	0.030	**ND**	0.03
	EPA-8021	Toluene	0.050	**ND**	7
	EPA-8021	Ethylbenzene	0.050	**ND**	6
	EPA-8021	Zylenes	0.20	**ND**	9
	NWTPH-GX	TPH-Diesel Range	25	**ND**	2,000
	NWTPH-GX	TPH-Oil Range	50	**ND**	2,000
E-3 @ 0.75 Feet (Soil)	NWTPH-GX	TPH-Volatile Range	3.0	**ND**	100
	EPA-8021	Methyl T-Butyl Ether	0.10	**ND**	0.1
	EPA-8021	Benzene	0.030	**ND**	0.03
	EPA-8021	Toluene	0.050	**ND**	7
	EPA-8021	Ethylbenzene	0.050	**ND**	6
	EPA-8021	Zylenes	0.20	**ND**	9
	NWTPH-GX	TPH-Diesel Range	25	**ND**	2,000
	NWTPH-GX	TPH-Oil Range	50	**ND**	2,000
E-4 @ 1.7 Feet (Soil)	NWTPH-GX	TPH-Volatile Range	3.0	**ND**	100
	EPA-8021	Methyl T-Butyl Ether	0.10	**ND**	0.1
	EPA-8021	Benzene	0.030	**ND**	0.03
	EPA-8021	Toluene	0.050	**ND**	7
	EPA-8021	Ethylbenzene	0.050	**ND**	6
	EPA-8021	Zylenes	0.20	**ND**	9
	NWTPH-GX	TPH-Diesel Range	25	**ND**	2,000
	NWTPH-GX	TPH-Oil Range	50	**ND**	2,000
E-5 @ 2.0 Feet (Soil)	NWTPH-GX	TPH-Volatile Range	3.0	**ND**	100
	EPA-8021	Methyl T-Butyl Ether	0.10	**ND**	0.1
	EPA-8021	Benzene	0.030	**ND**	0.03
	EPA-8021	Toluene	0.050	**ND**	7
	EPA-8021	Ethylbenzene	0.050	**ND**	6
	EPA-8021	Zylenes	0.20	**ND**	9
	NWTPH-GX	TPH-Diesel Range	25	**ND**	2,000
	NWTPH-GX	TPH-Oil Range	50	**ND**	2,000

Key:

ND – Indicates non detectable at a level above reporting limits.

Action Level - Indicates minimum level of contaminates within the soil or groundwater which may require cleanup action by the Washington State Department of Ecology, Model Toxics Control Act (MTCA) Cleanup Regulation Chapter 173-340 WAC, (Amended 2013), Tables 720-1 and 740-1 cleanup levels. For substances not listed in the Method A Tables, Method B values listed in the Cleanup Levels and Risk Calculations (CLARC) under the MTCA Regulation, updated 2015, were referenced.

Conclusions

Soils sampled associated with the above referenced project returned results either non-detect or below MTCA Method A Soil Clean Up Levels for Unrestricted Land Use. A petroleum odor was only detected within TP-1 and was not present within the remaining 9 test pits.

Geotechnical Consultation and Construction Monitoring

GeoTest recommends that we be involved in the project design review process. The purpose of the review is to verify that the recommendations presented in this report are understood and incorporated in the design and specifications.

We also recommend that geotechnical construction monitoring services be provided. These services should include observation by GeoTest personnel during structural fill placement, compaction activities and subgrade preparation operations to confirm that design subgrade conditions are obtained beneath the areas of improvement.

Periodic field density testing should be performed to verify that the appropriate degree of compaction is obtained. The purpose of these services is to observe compliance with the design concepts, specifications, and recommendations of this report. In the event that subsurface conditions differ from those anticipated before the start of construction, GeoTest Services would be pleased to provide revised recommendations appropriate to the conditions revealed during construction.

GeoTest is available to provide a full range of materials testing and special inspection during construction as required by the local building department and the International Building Code. This may include specific construction inspections on materials such as reinforced concrete, reinforced masonry, wood framing and structural steel. These services are supported by our fully accredited materials testing laboratory.

USE OF THIS REPORT

GeoTest Services has prepared this report for the exclusive use of Underwood and Associates and their design consultants for specific application to the design of the proposed Commercial Avenue Development Project located at 1808 Comercial Avenue in Anacortes, Washington. Use of this report by others is at the user's sole risk. This report is not applicable to other site locations. Our services are conducted in accordance with accepted practices of the geotechnical engineering profession; no other warranty, express or implied, is made as to the professional advice included in this report.

Our site explorations indicate subsurface conditions at the dates and locations indicated. It is not warranted that these conditions are representative of conditions at other locations and times.

The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth and time of our explorations, a geological reconnaissance of the area, and a review of previously published USGS geological information for the site. If variations in subsurface conditions are encountered during construction that differs from those contained within this report, GeoTest should be allowed to review the recommendations and, if necessary, make revisions. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

As a condition of our services, it is understood that, to the fullest extent permitted by law, our clients agree to defend, indemnify and hold harmless GeoTest Services, Inc., its owners, employees, subcontractors and agents, from any (past, present, or future) pollution-related claims or damages at the site, including potential claims from third parties that may name GeoTest Services, Inc., as a claimant.

The earthwork contractor is responsible to perform all work in conformance with all applicable WISHA/OSHA regulations. GeoTest Services, Inc. is not responsible for job site safety on this project, and this responsibility is specifically disclaimed.

Attachments:	Figure 1	Vicinity Map
	Figure 2	Site and Exploration Plan
	Figure 3	Typical Footing and Wall Drain Section
	Figure 4	Typical Utility Trench Section
	Figure 5	Soil Classification Sheet
	Figures 6-10	Test Pit Logs
	Figures 11-12	Grain Size Analysis
	Attachment	Analytical Results (9 pages)
	Attachment	Geotechnical Report Limitations and Guidelines (4 pages)

REFERENCES

Anacortes Municipal Code, Title 17, Section 70.170 Geologically Hazardous Areas, retrieved November 2019 from https://www.codepublishing.com/AMC/html/.

Bakeman, S., Dan, G., Howie, D., Killelea, J., Labib, F., & Ed, O. (n.d.). 2012 Stormwater Management Manual for Western Washington, as Amended in December 2014 (The 2014 SWMMWW) (pp. 1-1042) (United States, Washington State Department of Ecology).

Lapen, Thomas J., 2000, Geologic map of the Bellingham 1:100,000 quadrangle, Washington: Washington Division of Geology and Earth Resources, Open File Report 2000-5, scale 1:100,000.

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