AMERICAN GEOSERVICES

Geotechnical Evaluation Report

7523 92nd Ave SE, Mercer Island, WA

Date: October 22, 2018
Project No: 0354-WA18

AMERICAN GEOSERVICES

GEOTECHNICAL & MATERIALS
ENVIRONMENTAL
STRUCTURAL
CIVIL
ENGINEERING AND SCIENCE

888-276-4027

October 22, 2018

PROJECT NO: 0354-WA18

CLIENT: Mr. Mark O'Shea
Mercer Island, WA

Reference: Lot-Specific Geologic hazard evaluation, 7523 92nd Ave SE, Mercer Island, WA

Dear Mr. O'Shea,

At your request, we have completed the above referenced services for the referenced project in accordance with the American GeoServices, LLC (AGS) proposal and your authorization-to-proceed. Results of our evaluation and design recommendations are described below.

PROJECT INFORMATION

The site is located as shown in Figure 1 and Figure 2. The site is roughly a rectangular-shaped parcel of undeveloped lot and gently to moderately sloping land in a residential neighborhood. Site topography is relatively flat for the most part until it slopes upwards to the west as illustrated in Figure 1.

The proposed development will consist of placing back the soil that was excavated from the future retaining walls, and potentially build a short retaining wall, less than 4 feet tall. We do not anticipate significant site grading, such as fill placement on top of slope or deep excavation at the bottom of the slope, for this project. If these proposed conditions change, we should be contacted to modify our report.

SCOPE OF WORK

In September 2018, one soil exploration was performed by us at location B1 as shown in Figure 2. This exploration included soil auguring, soil sampling, and Standard Penetration Testing (SPT) equivalent testing. Explorations extended to a maximum depth of 10 feet below the existing ground surface where high (50+) SPT equivalent blow counts were encountered. In addition, we also reviewed available water well logs which contained a subsurface profile extending to several tens of feet. Additional subsurface exploration was not deemed necessary at this time.

All soil samples were identified in the field and were placed in sealed containers and transported to the laboratory for further testing and classification. Logs of all soil explorations showing details of subsurface soil conditions encountered at the site are included in an appendix. The SPT tests, when properly evaluated, provide an index to the soil strength and density of the material tested. The penetration test results are shown on the individual Exploration Log included in an Appendix. The Legend and Notes necessary to interpret our Exploration Logs are also included in an appendix.

Data obtained from site observations, subsurface exploration, laboratory evaluation, and previous experience in the area was used to perform engineering analyses. Results of engineering analyses were then used to reach conclusions and recommendations presented in this report.

The subsurface exploration results are shown on the individual Boring Logs included in an Appendix. The Legend and Notes necessary to interpret our Boring Logs are also included in an appendix.

SUBSURFACE CONDITIONS

Soil classification and identification is based on commonly accepted methods employed in the practice of geotechnical engineering. In some cases, the stratigraphic boundaries shown on Boring Logs represents transitions between soil types rather than distinct lithological boundaries. It should be recognized that subsurface conditions often vary both with depth and laterally between individual boring locations. The summary of the subsurface conditions encountered at the site is illustrated in the attached borehole log.

Groundwater was encountered during exploration at borehole B1 at 3 feet. This observation may not be indicative of other times or at locations other than the site. Some variations in the groundwater level may be experienced in the future. The magnitude of the variation will largely depend upon the duration and intensity of precipitation, temperature and the surface and subsurface drainage characteristics of the surrounding area.

GEOLOGIC HAZARDS EVALUATION

Based upon the results of our site exploration, engineering analysis, and literature review of following documents, we evaluated geologic hazards at the site.

- Washington Division of Geology and Earth Resources
- U.S. Geological Survey, The Geologic Maps
- City of Mercer Island GIS

- Environmental Critical Areas Maps.
- King County GIS
- Soil Survey Maps

Landslides: Our review of available geologic maps and landslide hazard maps did not indicate that landslides or debris blow had occurred at the site or in the immediate building area. During our site reconnaissance, we did not notice scarps, crevices, depressions, tension cracks in the ground surface, irregular slope toes, exposed surfaces of ruptures without vegetation, presence of distinct fast-growing vegetation, undrained depressions, etc., that are generally indicative of local active and/or inactive landslides or slope instability that would adversely impact the on-site structure at this time. During our reconnaissance, there was no visual evidence of global slope instability or global landslides that would adversely impact site stability, however, a detailed global landslide evaluation of any kind or global stability evaluation under seismic conditions was beyond our scope of services.

Notwithstanding, site and the neighborhood is located close to the mapped moderate to high slope instability and landslide hazard areas surrounding the site (Figure 5). There are potentially mapped landslides and/or ancient landslide deposits very close to the site boundaries. There is also moderate potential for the presence of historic landslides, deep-seated ancient landslides, or recently developed landslides in the site vicinity.

The site itself is not mapped as being situated within the existing active or ancient landslide mass or an ancient global landslide. However, the site vicinity area is mapped as having moderate to high landslide hazard. Considering these findings and the site topography, it is our opinion that the immediate site and the vicinity area have the 'site-specific landslide hazards' and has some 'inherent' risk associated with slope instability and impact from the movement of any global/ancient landslide and local slope movements. Moreover, historically, with construction in such areas, there is always an inherent risk associated with ground movement and/or settlements and related structural damage. The owner should understand these inherent risks. The owner is completely responsible for taking all risks associated with any future potential for instability at the site or in the site vicinity. Since this report and preliminary recommendations contained herein have been prepared to maintain a low degree of risk for future structural damage, all our recommendations should be strictly followed. If the owner wants to better understand the risks and to lower the risks, a detailed geotechnical evaluation and a detailed geologic hazards assessment (including global landslide hazards evaluation) should be performed to quantify the abovementioned risks and to provide detailed recommendations for mitigation.

Initial Slope Stability Evaluation: Based on the results of our initial analyses (as discussed in following paragraphs), in our opinion, at present there are no site-specific slope instability hazards

at the site impacting the stability of the existing slope, provided site drainage is properly maintained at the site including all the uphill and downhill areas, during the design life of the structure.

Using the results of geologic and soils literature review (as attached in the appendix) and site reconnaissance data, we analyzed on-site slopes by performing preliminary slope stability analysis. We used the software SLOPE/W to model on-site slopes, subsurface soil conditions, and the impact of existing construction on the stability of the site.

We used several methods (Bishop, Janbu, Spencer, etc.) in order to obtain the lowest factor of safety against slope failures. The SLOPE/W computer software calculates the most likely failure plane based on topography, subsurface conditions (including soil parameters), and groundwater conditions. The stability of this most likely failure plane is calculated as the factor of safety (FOS), which is a ratio of the resisting forces or shear strength to the driving forces or shear stress required for equilibrium of the slope. A FOS of 1.0 indicates the resistive forces and driving forces are equal. A FOS below 1.0 indicates the driving forces are greater and the landslide is active. A FOS above 1.0 indicates the resisting forces are greater and the slope is stable. Based on the engineering community and our experience, a factor of safety in the range of 1.3-2.0 is generally acceptable to assure slope stability in residential applications.

Preliminary slope stability analysis was performed using various input soil parameters derived from the results of our preliminary geotechnical evaluation, in order to evaluate the stability of a slope. Of particular importance were surface and subsurface profiles (slope geometry), soil strength parameters, and groundwater conditions. Based on our experience with past slope stability evaluations in similar geologic conditions, soil strength parameters can vary considerably. Notwithstanding, we used soil strength values typical of on-site soils and native soils/bedrock based on our experience with soil strength testing, as well as back-calculation of soil strength parameters for failed slopes in similar geologic conditions.

Based on the results of our initial analyses, in our opinion, at present there are no slope instability hazards at the site that would directly impact the stability of the existing on-site slopes for the proposed placement of the excavated soils and for the proposed construction of a short retaining wall in future. There is always a possibility of localized shallow slides at the site slopes or localized soil creep resulting from topography and drainage conditions during wet season of the year, which is typical of many such properties in the Mercer Island area, however, the proposed fill placement and future retaining wall construction will only improve the site stability conditions due to its placement at the toe of the site and not on top of the slope.

Earthquake Related Hazards: The following paragraphs describe potential earthquake related hazards that are known to exist within most of the northwestern United States.

Earthquakes in the Pacific Northwest occur due to tectonic activity associated with the subduction of the Juan de Fuca Oceanic plate beneath the North American Continental plate. The Juan de Fuca plate is converging on and thrusting beneath the North American Continental plate along the Cascadia Subduction Zone (CSZ), which is situated offshore along Washington. This convergence along the CSZ is the source of three types of earthquakes in western Washington. These are (1) deep intraplate earthquakes originating in the Juan de Fuca plate, (2) large subduction zone-interplate earthquakes that may occur along the interface between the Juan de Fuca and the North American Plates, and (3) shallow crustal earthquakes generated along faults.

Most of the intraplate earthquakes have occurred within the Puget Sound region. The estimated maximum magnitudes of CSZ intraplate earthquakes are in the range of M7.0 to M7.5.

Available research indicates that there is a potential for a large subduction zone earthquake near the Washington coast. To interpret earthquake potential of the CSZ plate interface, geologic lines of evidence such as coastal subsidence, stratigraphic evidence for flooding associated with earthquakes and turbidity in the ocean have been used. Based on the available geologic evidence, there is a sufficient scientific consensus to consider the CSZ plate interface as a potential earthquake source. The estimated maximum magnitudes of CSZ interplate earthquakes are in the range of M8.0 to M9.0+. The estimated recurrence interval is 350 to 500 years.

Crustal earthquakes are generally concentrated above a depth of approximately 10 to 20 km. Based on our literature review, the estimated maximum magnitudes of these crustal earthquakes are in the range of M6.0 to M6.5.

Based on site geology, topography, and our preliminary evaluation, in our opinion, the site may be susceptible to severe ground shaking and landsliding during a major earthquake. Ground acceleration more than 0.35g may occur at the site. As mentioned above, it should be noted that most of the northwestern United States is susceptible to similar earthquake-related hazards. A detailed site-specific seismic evaluation of any kind was beyond the scope of this report.

Based on the results of our subsurface explorations and review of available literature (2009 International Building Code), in our opinion, a site classification “E” and a design PGA of 0.35 may be used for this project. However, this site classification may be revised by performing a site-specific shear wave velocity study. The 1 Hz spectral acceleration with 2% probability of exceedance in 50 years is 120-140% g.

Subsurface soil conditions at the site are not susceptible to significant liquefaction. Seismically induced slope instability most likely will occur on a localized or global scale; however, such an evaluation was beyond our scope of services. A detailed seismic hazards evaluation of the site was beyond our scope of services.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our limited geotechnical and geologic hazards evaluation, in our opinion, the site is suitable for the proposed the proposed fill placement near the toe of the on-site slopes and future retaining wall construction, because it will only improve the site stability conditions due to its placement at the toe of the site and not on top of the slope, provided following recommendations are strictly followed. It should be noted that our conclusions and recommendations are intended as design guidance. They are based on our interpretation of the geotechnical data obtained during our evaluation and following assumptions:

- On-site excavated soils may be used as fill provided they are placed at or close to the optimum moisture content. Fill material should be placed in uniform horizontal layers (lifts) not exceeding 12 inches before compacting to the required density and before successive layers are placed. If the contractor's equipment is not capable of properly moisture conditioning and compacting 8-inch lifts, then the lift thickness shall be reduced until satisfactory results are achieved. Import soils should be approved by AGS prior to placement. Fill placement observations and fill compaction tests should be performed by AGS Engineering to minimize the potential for future problems. Fill material should not be placed on frozen ground. Vegetation, roots, topsoil, the existing fill materials, and other deleterious material to depth of approximately 6 inches should be removed before new fill material is placed.

- On-site fill to be placed should be moisture treated to within 2 percent of optimum moisture content (OMC) for sandy/silty fill. Fill to be placed in wall backfill areas all other structural areas should be compacted to 95% of Modified Proctor (ASTM D1557) maximum dry density or greater. Compaction in landscape areas should be 85% or greater.

- Imported structural fill should consist of sand or gravel material with a maximum particle size of 3 inches or less. In addition, this material shall have a liquid limit less than 30 and a plasticity index of 15 or less. Structural fill should also have a percent fine between 15 to 30 percent passing the No. 200 sieve. Structural fill should be moisture conditioned to within 2 percent of OMC and compacted to at least 95 percent of Modified Proctor (ASTM D1557) maximum dry density.

- Future retaining walls are designed and construction in accordance with following recommendations:

WALL DESIGN AND CONSTRUCTION RECOMMENDATIONS

Based on our evaluation, we estimated following design parameters for the proposed wall design.

- Granular backfill friction angle (if used) = 30 degrees.
- Granular backfill cohesion (if used) = 0 psf.
- Granular backfill unit weight (if used) = 120 pcf.
- Retained soil friction angle, SC/GC = 30 degrees.
- Retained soil cohesion, SC/GC = 0 psf.
- Retained soil unit weight, SC/GC = 110 pcf.
- Retained soil friction angle, SC = 30 degrees.
- Foundation soil friction angle = 28 degrees.
- Foundation soil cohesion = 0 psf.
- Foundation soil unit weight = 105 pcf.
- All foundation subgrades must be inspected and approved by AGS or geotechnical engineer.
- No hydrostatic pressure on the wall. To achieve this condition, proper surface and subsurface drainage should be provided at and around all wall locations. Additional drainage pipes should be installed as shown on the attached wall construction plans.
- Net maximum allowable bearing capacity with 18 inches minimum embedment depth = 1,500 psf

We provide following general recommendations for the wall construction.

- Construction should be preferably performed during summer or dry season of the year. If not, then specific fill materials per geotechnical engineer's recommendations may be used. We recommend continuous and periodic inspections by American GeoServices, LLC representative during construction.

- All foundation subgrades and any exposed cuts at wall locations must be evaluated and approved by a registered geotechnical engineer from our office for estimated soil design parameters.

- Normal vehicular surcharge load during and after construction must not exceed 250 psf.

- Proper installation of drainage pipe behind the wall and drainage control after the completion of wall construction is important. Under no conditions should this wall drainpipe be connected to house drainage system. As a minimum, all new building downspouts should be drained away from wall areas or discharged into suitable receptacle to avoid ponding near the wall base. All pavement or toe areas should be drained away so that drainage towards wall areas is minimized.

GENERAL DRAINAGE RECOMMENDATIONS

All drainage systems must be maintained leak-free. Proper surface and subsurface drainage are critical for long-term performance of the retaining structures. In general, proper surface drainage should be maintained at this site. Irrigation should be minimal and limited to maintain plants. Roof downspouts should discharge on splash-blocks or other impervious surfaces and directed away from the proposed retaining wall and steep slopes. Ponding of water should not be allowed immediately adjacent to the proposed retaining wall area.

It is important to follow these recommendations to minimize settling or movement of the retaining wall elements throughout the life of the facility. Construction means, and methods should also be utilized which minimizes saturation of soils during construction. Again, positive drainage away from the new structures is essential to the successful performance of retaining walls and should be provided during the life of the structure. Downspouts from all roof drains, if any, should cross all backfilled areas such that they discharge all water away from the backfill zones and structures.

Drainage pipes installed behind the proposed retaining wall should be discharged into suitable receptacles without adversely impacting the on-site and off-site stability.

GENERAL CONSTRUCTION RECOMMENDATIONS

Subgrade Preparation: In general, we recommend that any surface water within construction areas be drained away by cutting drainage ditches or by pumping from a sump hole, if necessary. Surface vegetation including topsoil, any saturated/inundated and disturbed soil, and any non-soil or incompetent materials encountered at the time of construction should be removed. If any deep root systems or tree trunks are removed, then the excavated areas should be filled with densely compacted on-site silt soil or imported crushed rock.

In wet season, to protect moisture sensitive soils during construction activities, a 3-inch to 6-inch thick crushed rock layer should be placed immediately on any exposed subgrades after site grading and topsoil removal. For construction truck traffic areas, at least 12-inch thick granular

working base is generally recommended with thicker sections and/or geotextile fabrics for heavily traveled areas.

Fill Placement: Granular backfill materials for the proposed retaining wall should be placed in layers that, when compacted, do not exceed 12 inches. At your request, depending upon weather conditions during construction, we may provide specific fill recommendations, especially for wet weather conditions.

Excavation/Cuts and Dewatering: No additional excavations should be performed without geotechnical oversight. In general, excavations should be performed in accordance with Department of Labor Occupational Safety and Health Administration (OSHA) guidelines for Type C soils, unless temporary shoring is installed, or geotechnical monitoring/oversight is implemented, or specific recommendations or approvals are obtained from AGS for excavations and site stability during construction. Deeper excavations may be excavated at grade steeper than the recommended OSHA grades provided the excavations are monitored and certified by a qualified geotechnical engineer. Please note that site safety is the sole responsibility of the project contractor and/or the owners.

The use of a standard excavator may be adequate for this site. Groundwater seepage in excavations should be anticipated during wet season of the year. For most of the excavations on this project, pumping from sumps outside the limits of the excavation should control groundwater seepage and surface water ponding.

Soils exposed in excavated areas should be protected from rain, freezing, and excessive loading along edges. Surface water run-off should be intercepted and drained away from excavated areas. Ideally, in structural areas, concrete should be poured within 24 hours of the completion of excavation.

Wet Weather Construction: In our opinion, the site is not suitable for wet weather construction, unless additional geotechnical evaluation and further slope stability analyses are performed. Earthwork done during summer months will be most likely more economical. In any case, during construction in wet or cold weather, grade the site such that surface water can drain readily away from the building areas. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces and allow these areas to dry before resuming construction. Berms, ditches and similar means may be used to prevent storm water from entering the work area and to convey any water off-site efficiently. Wet weather construction will require the implementation of best management erosion and sedimentation control practices to reduce the chances of off-site sediment transport, including but not limited to covering the

excavated slopes with plastic sheets, using silt fences, bales of straws, and prompt subgrade preparation and concrete pour.

All excavations during wet weather should be covered with plastic sheeting and adequate drainage should be provided to avoid cut/excavation instability due to soil saturation. It is important to understand that, if proper precautions are not taken, sudden cut or excavation failures can occur without warning during wet weather, which can be fatal.

LIMITATIONS

Historically, with construction in seismic and landslide hazard areas such as the site vicinity, there is an inherent risk associated with ground movement and/or settlements and related structural damage due to an earthquake and/or slope movement. Although there was no active local or global landsliding observed within the proposed construction area at this time, the owner is completely responsible for taking all risks associated with any future potential for instability at the site or in the site vicinity. Although there was no global slope instability observed in the immediate vicinity of the proposed construction area, the potential for future slope failure associated with movement of the global/ancient landslide and related local slope movement is low and the owner is responsible for any risks associated with any future potential for instability at the site or in the site vicinity. It should be noted that the detailed evaluation of the impact of any ancient or global landslides in the site vicinity area was beyond our scope of services. Since this report and recommendations contained herein have been prepared to maintain a low degree of risk for future structural damage, all our recommendations should be strictly followed.

Recommendations contained in this report are based on our field observations and subsurface explorations, limited laboratory evaluation, and our present knowledge of the proposed construction. It is possible that soil conditions could vary between or beyond the points explored. If soil conditions are encountered during construction that differ from those described herein, we should be notified so that we can review and make any supplemental recommendations necessary. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, our recommendations should also be reviewed and revised by AGS.

Our Scope of Work for this project did not include research, testing, or assessment relative to past or present contamination of the site by any source. If such contamination were present, it is very likely that the exploration and testing conducted for this report would not reveal its existence. If the Owner is concerned about the potential for such contamination, additional studies should be undertaken. We are available to discuss the scope of such studies with you. No tests were

performed to detect the existence of mold or other environmental hazards as it was beyond Scope of Work.

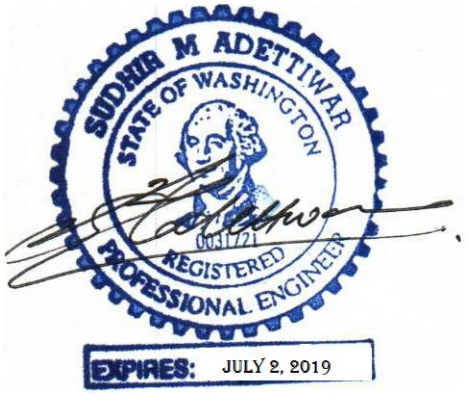
Local regulations regarding land or facility use, on and off-site conditions, or other factors may change over time, and additional work may be required with the passage of time. Based on the intended use of the report within one year from the date of report preparation, AGS may recommend additional work and report updates. Non-compliance with any of these requirements by the client or anyone else will release AGS from any liability resulting from the use of this report by any unauthorized party. Client agrees to defend, indemnify, and hold harmless AGS from any claim or liability associated with such unauthorized use or non-compliance.

In this report, we have presented judgments based partly on our understanding of the proposed construction and partly on the data we have obtained. This report meets professional standards expected for reports of this type in this area. Our company is not responsible for the conclusions, opinions or recommendations made by others based on the data we have presented. Refer to American Society of Foundation Engineers (ASFE) general conditions included in an appendix.

This report has been prepared exclusively for the client, its' engineers and subcontractors for design and construction of the proposed structure. No other engineer, consultant, or contractor shall be entitled to rely on information, conclusions or recommendations presented in this document without the prior written approval of AGS.

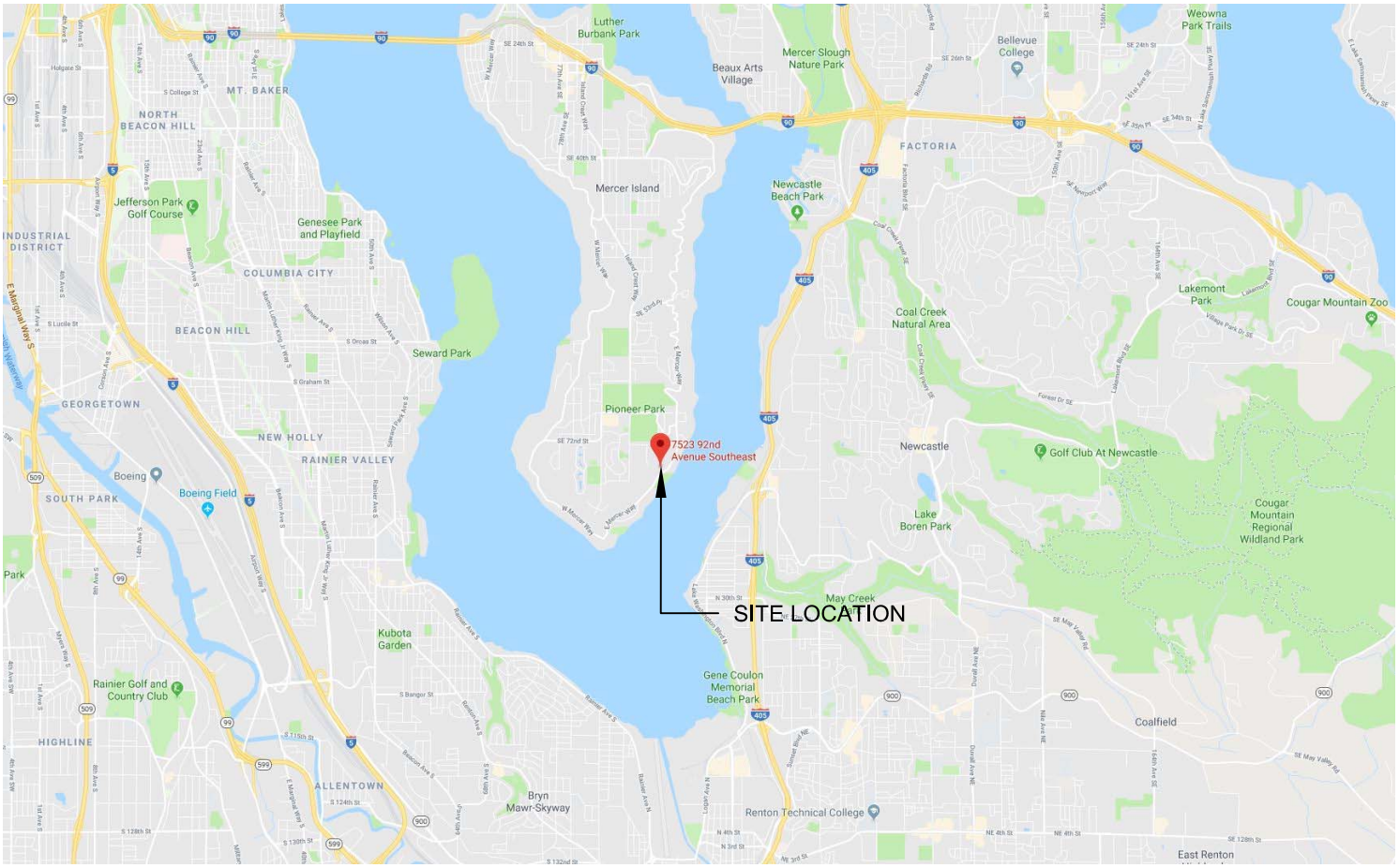
We appreciate the opportunity to be of service to you on this project. If we can provide additional assistance or observation and testing services during design and construction phases, please call us at 1 888 276 4027.

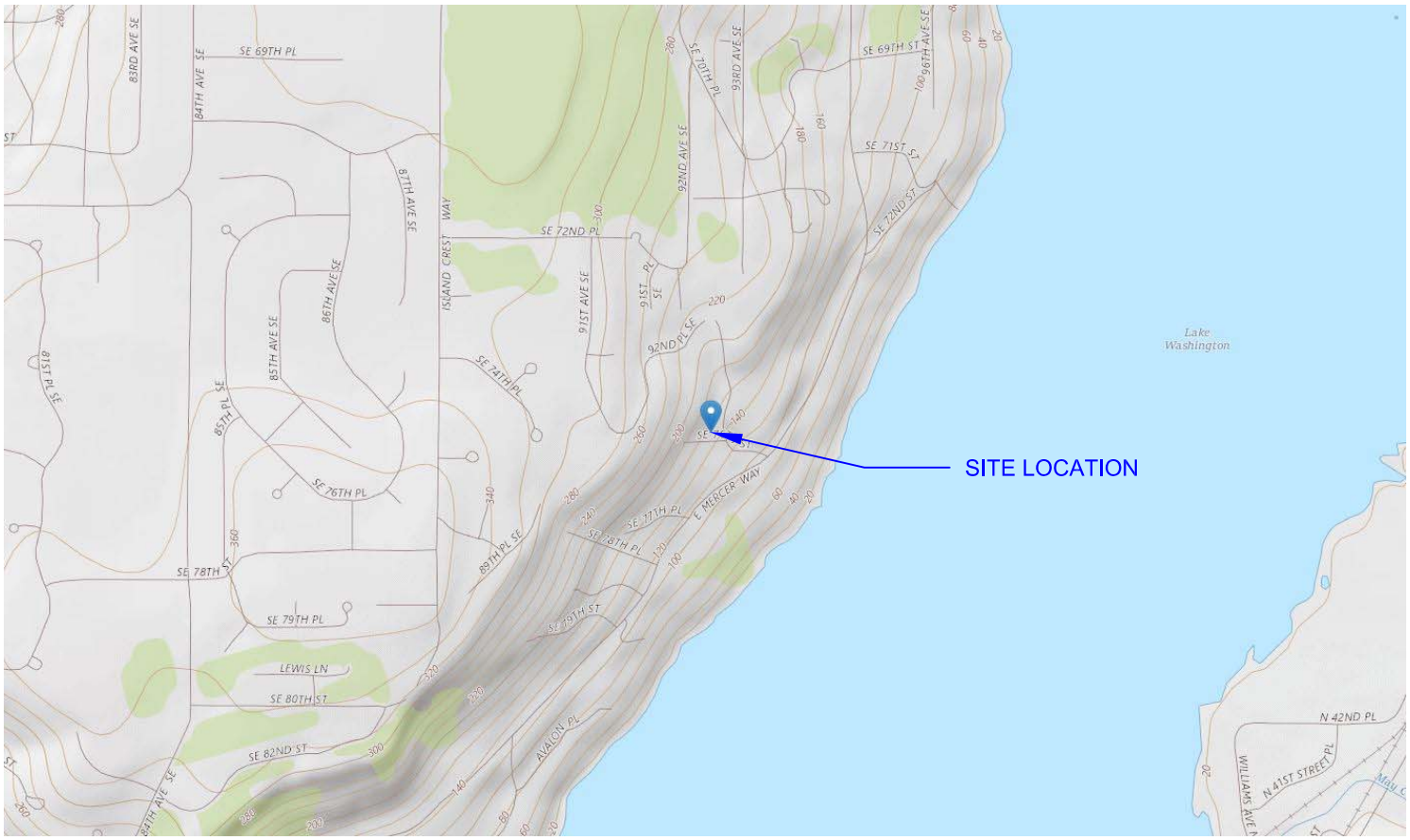
Sincerely,



Sam Adettiwar, MS, PE, GE, P. Eng, M. ASCE
Senior Engineer
Attachments

FIGURES





REFERENCE:
GOOGLE MAPS
KING COUNTY TOPO MAP

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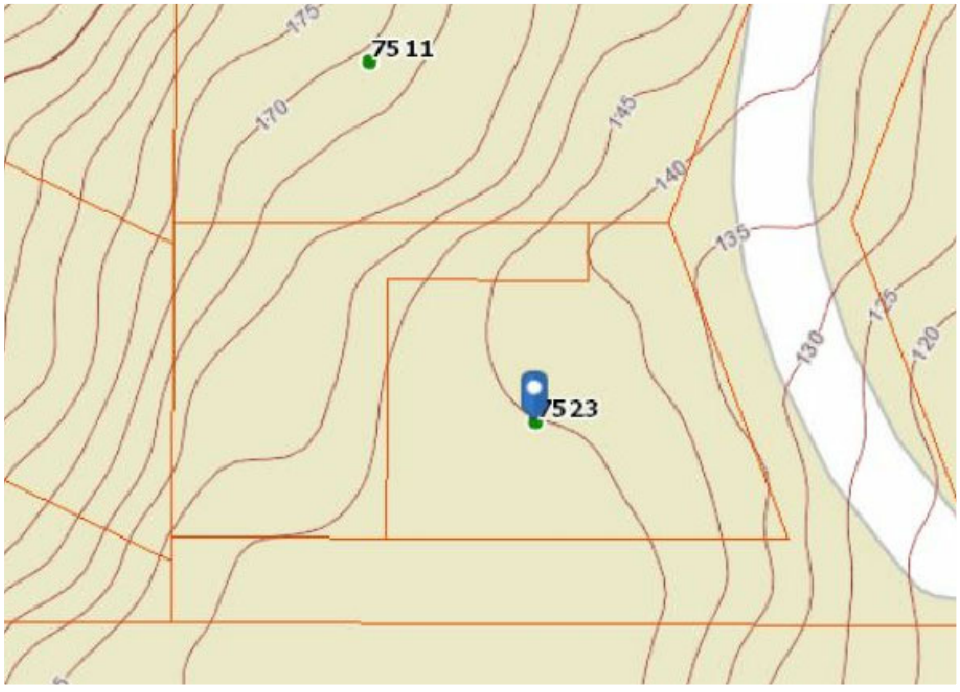
FIGURE 1: SITE LOCATION MAP



NOTE:
SCHEMATIC PLAN TO SHOW APPROXIMATE SUBSURFACE EXPLORATION LOCATION ONLY; NOT SURVEYED.

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LEGEND:

DESIGNATES SUBSURFACE EXPLORATION LOCATION, BY AMERICAN GEOSERVICES, LLC. , SEPTEMBER 2018 SEE EXPLORATION LOG IN APPENDIX FOR FURTHER DETAILS.

REFERENCE:
KING COUNTY GIS

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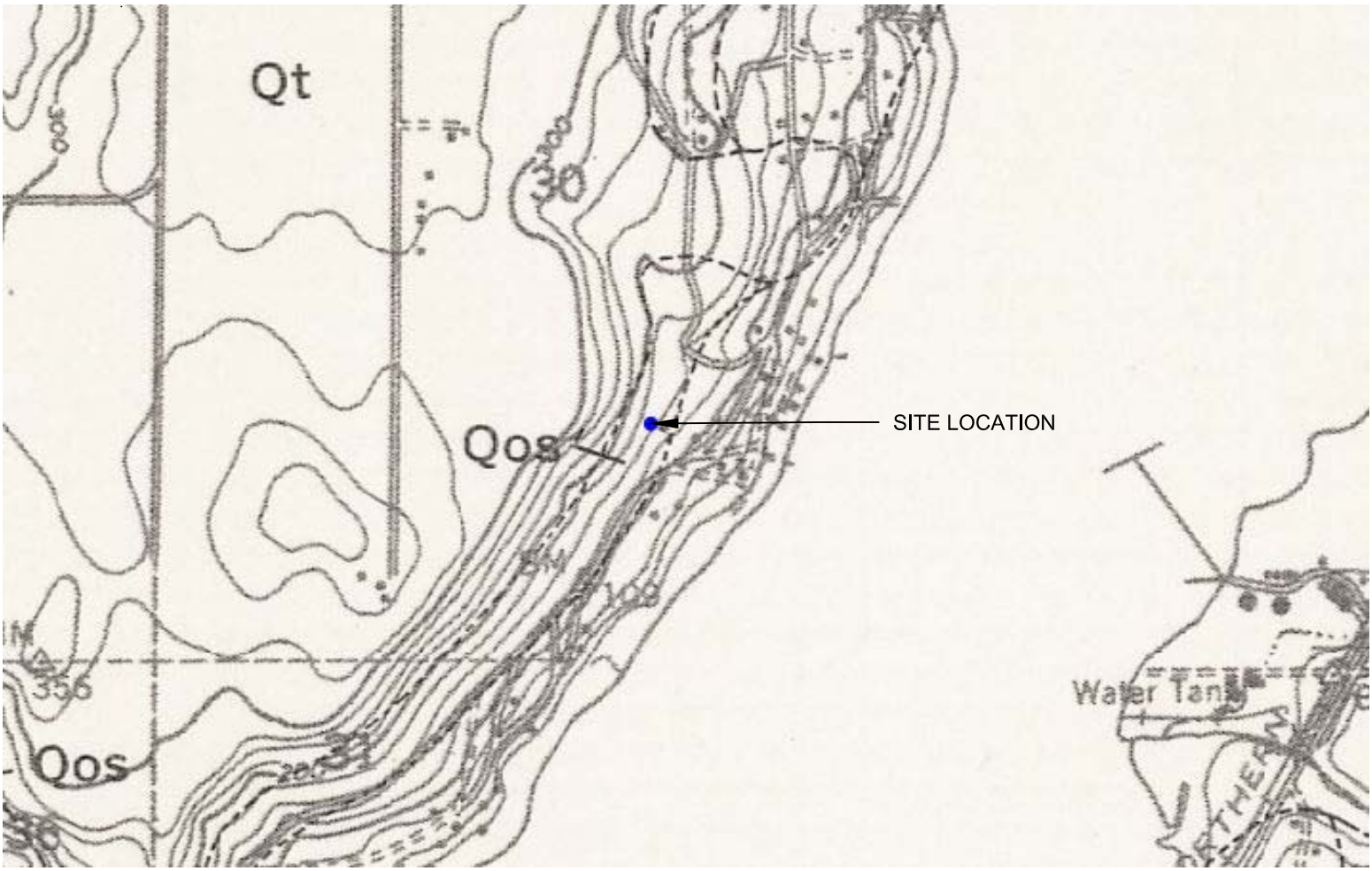
FIGURE 2: SCHEMATIC SITE PLAN



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MAP UNIT	SPECIAL FEATURES	DRAINAGE	GROUND WATER	EASE OF EXCAVATION	FOUNDATION STABILITY	SLOPE STABILITY	SEISMIC STABILITY	REPORTED OR POSSIBLE USE	SOIL TYPES
Older sand Qos	Generally uncemented. Physical characteristics consistent vertically and laterally over broad areas. Where unit overlies impermeable material, springs near base cause erosion.	Same as older gravel	Generally contains unconfined water. May be perched. Permeability high.	Same as older gravel	Same as older gravel	Same as older gravel. Scattered silty beds stand in steep cuts. Subject to gullying.	Good	Fill	
Older clay till and gravel Qc	Much vertical and lateral variation of physical properties is characteristic. Interbedding of materials with very different size range and engineering properties also characteristic.	Runoff variable. Infiltration slow. Seeps common.	Generally contains water, much of which is under high hydrostatic head. Permeability generally low to medium, but variable, depending on texture.	Highly variable. Generally difficult to excavate with hand or light power equipment. Compact and cohesive. Till lacks bedding or fractures.	Fair to excellent. Dependent on local conditions of slope and ground water conditions.	Highly variable. Till, silt, and clay may stand in steep cuts. Abundant silt and clay together with contained water under high hydrostatic head results in low natural slopes. Shear strength of silt and clay indicated by laboratory tests may not be strictly applicable to field conditions owing to fracturing. Especially subject to landsliding. Rebound reported in silt and clay.	Good	Fill, clay products. Some interbedded sand contains material probably reactive in high-alkali concrete.	
Vashon till Qt	Intimately graded mixture of clay to gravel sizes. May contain local lenses of sand and gravel. "Hardpan" of common usage. In some areas till is thin and consists of loose silty sand and gravel. Elsewhere till is thick; characteristics in table refer to till where it is more than 5 feet thick.	Runoff variable. Undrained and poorly drained depressions common. Runoff good on steeper slopes. Infiltration very slow.	Height of water table depends on topographic position. Permeability very low except in contained lenses of sand and gravel.	Very difficult to excavate with hand or light power equipment. Dense, tough and cohesive. Generally lacks bedding or extensive fracturing.	Excellent. No settlement expectable.	Stands in steep natural and cut slopes for long periods. May ravel and spall by wetting and drying, and freezing and thawing.	Good	Fill	GW-GM, GW-GC.

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REFERENCE

U.S. GEOLOGIC SURVEY

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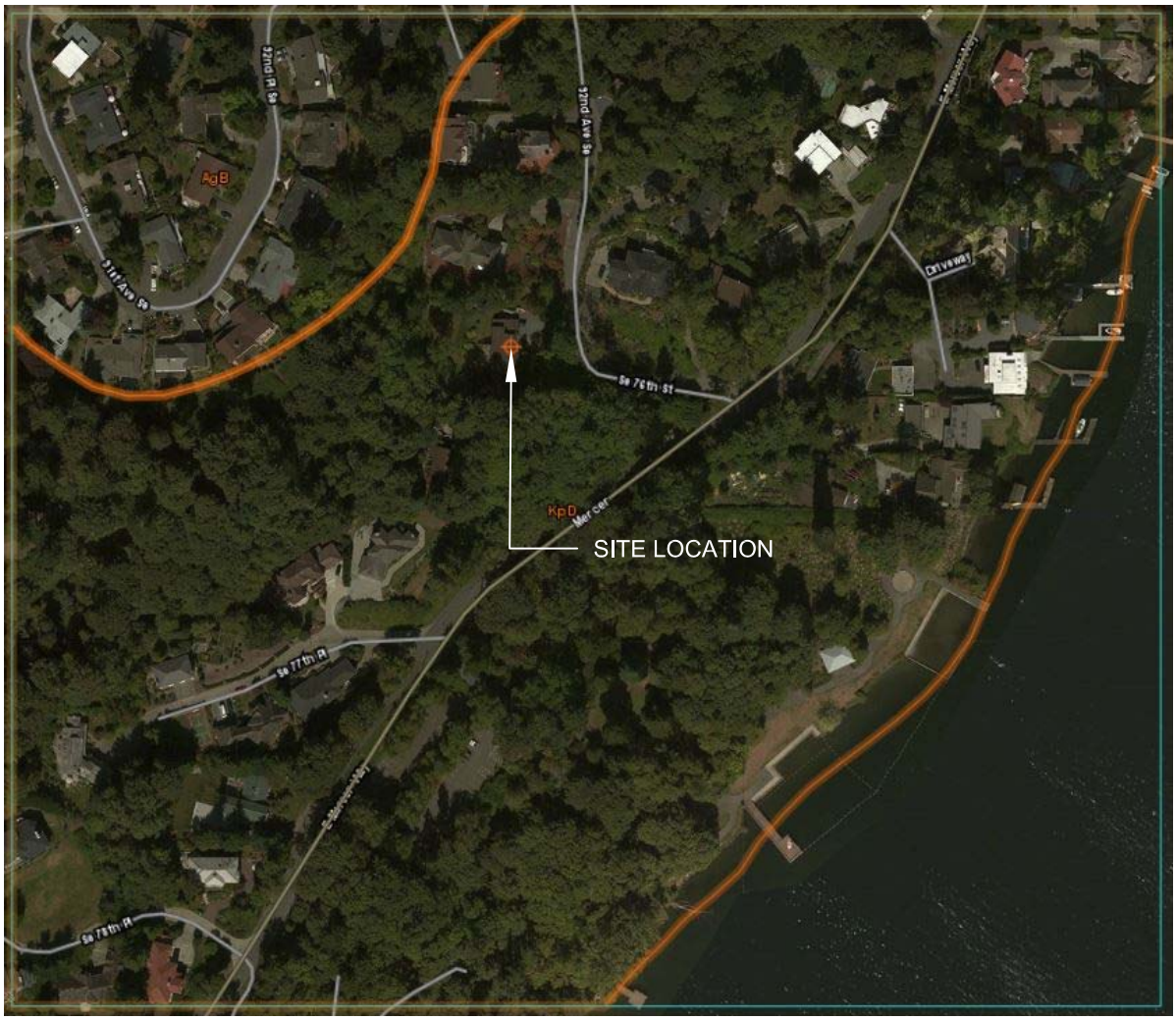
FIGURE 3: GEOLOGIC MAP



LEGEND

King County Area, Washington (WA633)

King County Area, Washington (WA633)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AgB	Alderwood gravelly sandy loam, 0 to 8 percent slopes	5.9	12.5%
KpD	Kitsap silt loam, 15 to 30 percent slopes	33.7	71.8%
Totals for Area of Interest		**47.0**	**100.0%**

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REFERENCE:

WEB SOIL SURVEY

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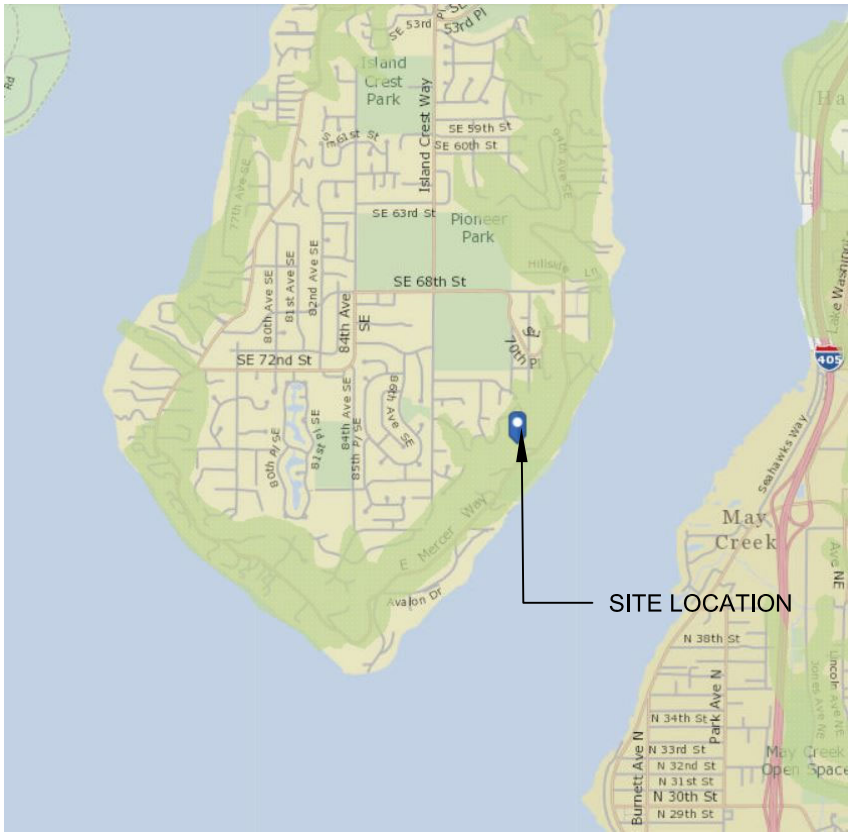
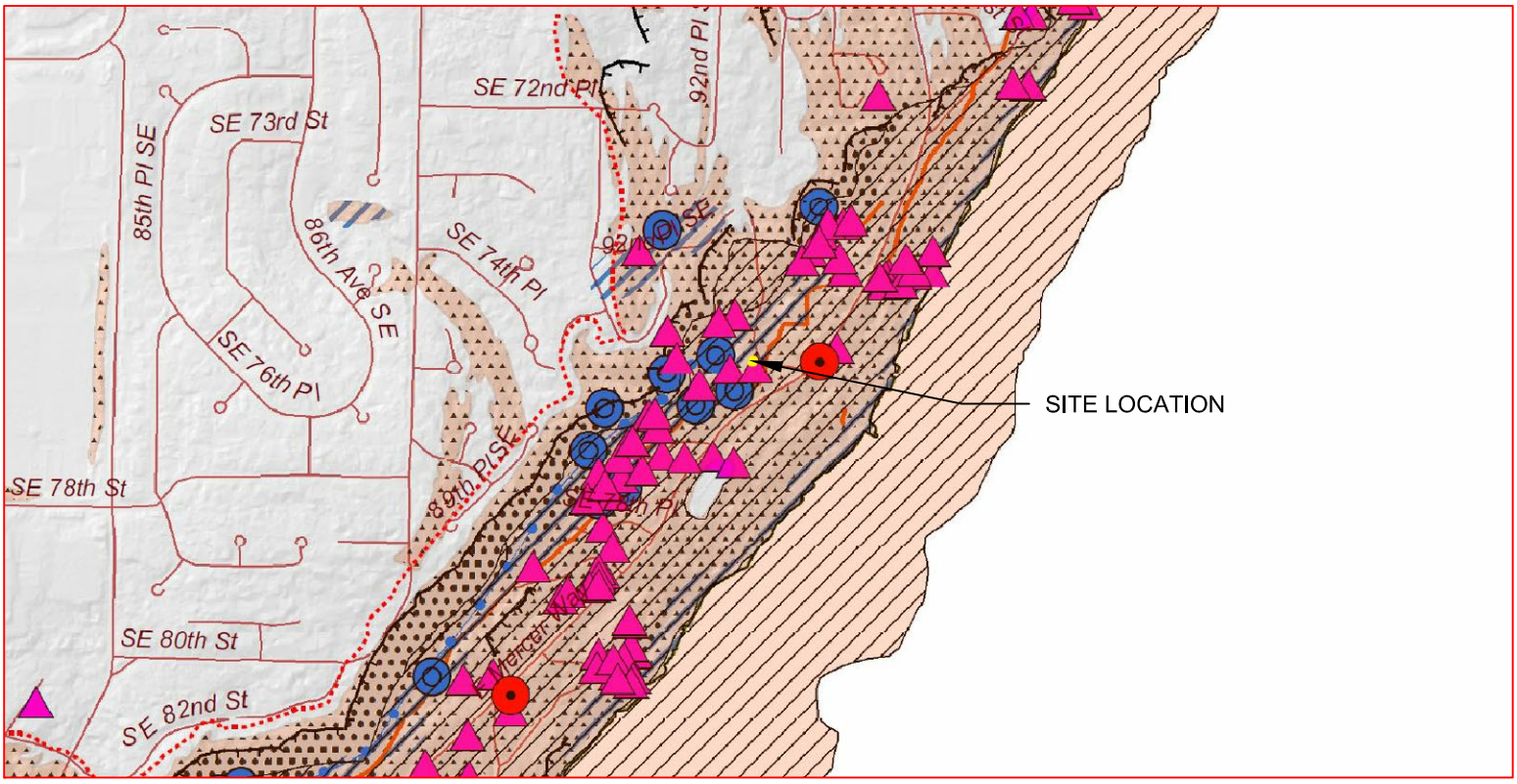
FIGURE 4: SOIL SURVEY MAP



Environmentally Sensitive Areas

Erosion hazard (1990 SAO)



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REFERENCE:
CITY OF MERCER ISLAND
GIS

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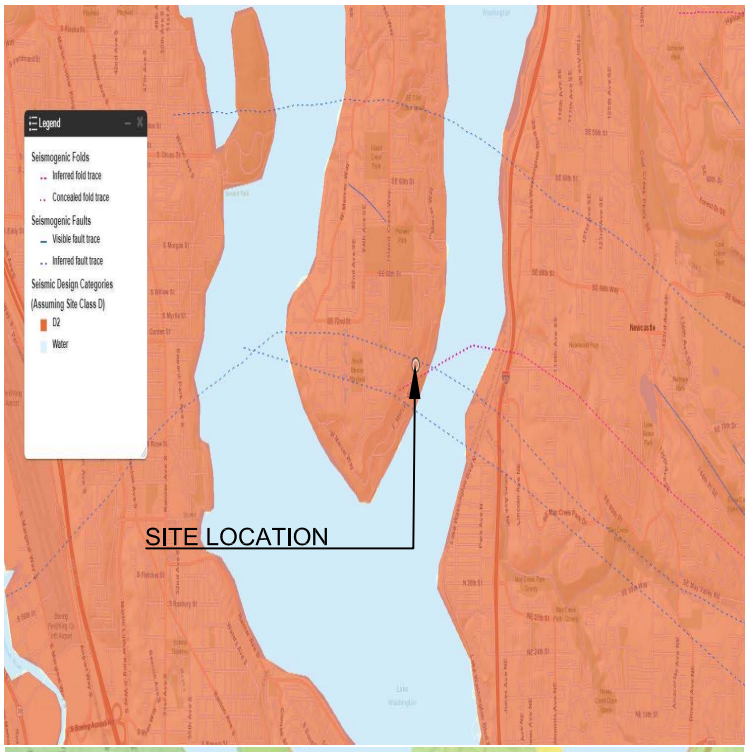
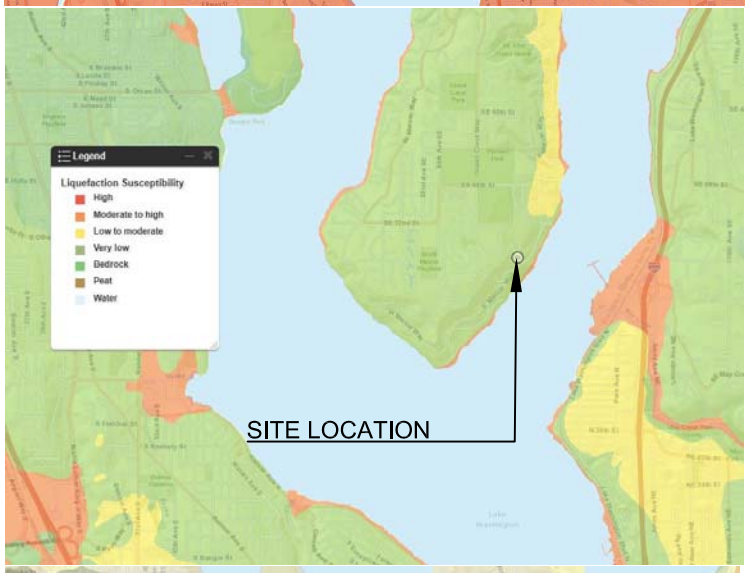
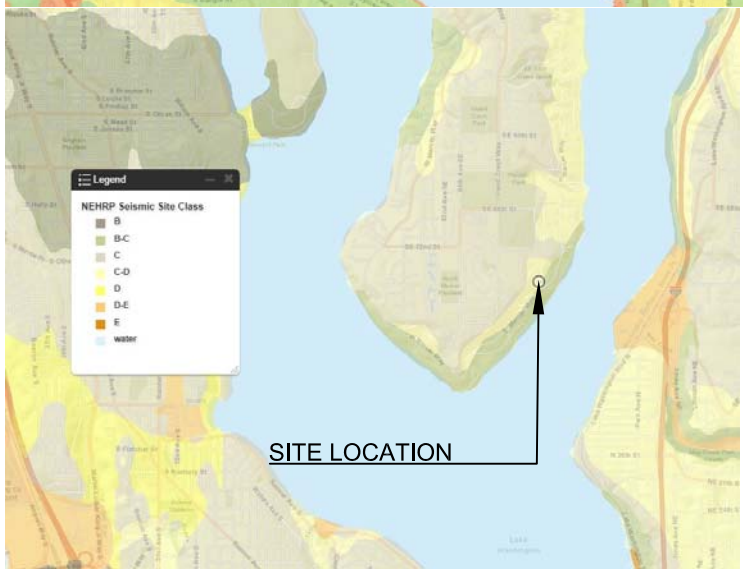
FIGURE 5: LANDSLIDE HAZARD MAP







REFERENCE:

WASHINGTON GEOLOGIC INFORMATION PORTAL

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FIGURE 6:EARTHQUAKE HAZARD MAP

APPENDIX

B1

7523 92nd Ave SE, Mercer Island, WA

Project Number	0354-WA18	Drill Rig: CME55 Solid Stem Auger, 4" Diameter	
Geologist/Engineer	SMA	Ground Elevation	See Figures
Date Drilled	09-10-2018	Total Depth of Borehole	12.5 Feet
Borehole Diameter	4 OD Inches	Depth to Water	3 Feet

Graphic Log		Description / Lithology	Depth (feet)	Sample	SPT Blow Count	Recovery (%)	Moisture (%)	DD (pcf)	LL (%), PL (%)	Swell (%)	Completion
		Surface 6.0" topsoil									
	SC/ GC	CLAYEY SAND with COBBLES, dark gray, loose to medium dense, moist to wet									
		Significant COBBLES in upper 3 feet (Possible fill)	2.5 ▽								
	SC/ GC	CLAYEY SAND with COBBLES, dark gray, medium dense, wet (Possible Colluvium)			13-14-24						
			5.0								
					8-10-11						
			7.5								
			10								
	ML	CLAYEY SANDY SILT, grey, low plasticity, stiff, wet, possible volcanic ash traces in silty soil matrix			6-6-7	20					
		End of Borehole at 12.5 feet due to difficult drilling in wet ground. Groundwater seepage was encountered during or at the completion of drilling at 3 feet. At completion, borehole was backfilled with soil cuttings.	12.5								

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DESCRIPTIVE TERMINOLOGY & SOIL CLASSIFICATION
UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)			
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines
		SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)			
SILTS AND CLAYS Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils

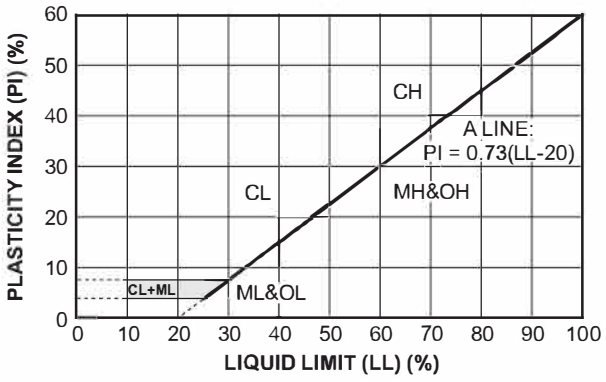
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



DESCRIPTIVE TERMINOLOGY & SOIL CLASSIFICATION

LABORATORY/FIELD TESTING DEFINITIONS FOR EXPLORATION LOGS

DD = DRY DENSITY (PCF)

WD = WET DENSITY (PCF)

MC = MOISTURE CONTENT (%)

PL = PLASTIC LIMIT (%)

LL = LIQUID LIMIT (%)

PI = PLASTICITY INDEX

OC = ORGANIC CONTENT (%)

S = SATURATION PERCENT (%)

SG = SPECIFIC GRAVITY

C = COHESION

Φ = ANGLE OF INTERNAL FRICTION

QU = UNCONFINED COMPRESSION STRENGTH

#200 = PERCENT PASSING THE #200 SIEVE

CBR = CALIFORNIA BEARING RATIO

VS = VANE SHEAR

PP = POCKET PENETROMETER

DP = DRIVE PROBE

SPT = STANDARD PENETRATION TEST

BPF = BLOWS PER FOOT (N VALUE)

SH = SHELBY TUBE SAMPLE

GW = GROUND WATER

RQD = ROCK QUALITY DESIDNATION

TP = TEST PIT

B = BORING

HA = HAND AUGER

GROUNDWATER LEVEL/SEEPAGE ENCOUNTERED DURING EXPLORATION

STATIC GROUNDWATER LEVEL WITH DATE MEASURED

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STP (BPF)	PP (TSF)
VERY SOFT	0-1	LESS THAN 0.25
SOFT	2 - 4	0.25 - 0.5
MEDIUM STIFF	5 - 8	0.5 - 1.0
STIFF	9 - 15	1.0 - 2.0
VERY STIFF	16 - 30	2.0 - 4.0
HARD	30+	OVER 4.0

RELATIVE DENSITY OF COHESIONLESS SOILS

DENSITY	SPT (BPF)
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	50+

PARTICLE SIZE IDENTIFICATION

NAME	DIAMETER (INCHES)	SIEVE NO.
ROCK BLOCK	>120	
BOULDER	12-120	
COBBLE	3-12	
GRAVEL		
COURSE	3/4 - 3	
FINE	1/4 – 3/4	NO. 4
SAND		
COARSE	4.75 MM	NO. 10
MEDIUM	2.0MM	NO. 40
FINE	.425 MM	NO. 200
SILT	.075 MM	
CLAY	<0.005 MM	

GRAIN SIZE

FINE GRAINED	<0.04 INCH	FEW GRAINS ARE DISTINGUISHABLE IN THE FIELD OR WITH HAND LENS.
MEDIUM GRAINED	0.04-0.2 INCH	GRAINS ARE DISTINGUISHABLE WITH THE AID OF A HAND LENS.
COARSE GRAINED	0.04-0.2 INCH	MOST GRAINS ARE DISTINGUISHABLE WITH THE NAKED EYE.

DESCRIPTIVE TERMINOLOGY & SOIL CLASSIFICATION

SPT EXPLORATIONS:

STANDARD PENETRATION TESTING IS PERFORMED BY DRIVING A 2 – INCH O.D. SPLIT-SPOON INTO THE UNDISTURBED FORMATION AT THE BOTTOM OF THE BORING WITH REPEATED BLOWS OF A 140 – POUND PIN GUIDED HAMMER FALLING 30 INCHES. NUMBER OF BLOWS (N VALUE) REQUIRED TO DRIVE THE SAMPLER A GIVEN DISTANCE WAS CONSIDERED A MEASURE OF SOIL CONSISTENCY.

SH SAMPLING:

SHELBY TUBE SAMPLING IS PERFORMED WITH A THIN WALLED SAMPLER PUSHED INTO THE UNDISTURBED SOIL TO SAMPLE 2.0 FEET OF SOIL.

AIR TRACK EXPLORATION:

TESTING IS PERFORMED BY MEASURING RATE OF ADVANCEMENT AND SAMPLES ARE RETRIEVED FROM CUTTINGS.

HAND AUGUR EXPLORATION:

TESTING IS PREFORMED USING A 3.25" DIAMETER AUGUR TO ADVANCE INTO THE EARTH AND RETRIEVE SAMPLES.

DRIVE PROBE EXPLORATIONS:

THIS "RELATIVE DENSITY" EXPLORATION DEVICE IS USED TO DETERMINE THE DISTRIBUTION AND ESTIMATE STRENGTH OF THE SUBSURFACE SOIL AND DECOMPRESSED ROCK UNITS. THE RESISTANCE TO PENETRATION IS MEASURED IN BLOWS-PER-1/2 FOOT OF AN 11-POUND HAMMER WHICH FREE FALLS ROUGHLY 3.5 FEET DRIVING THE 0.5 INCH DIAMETER PIPE INTO THE GROUND. FOR A MORE DETAILED DESCRIPTION OF THIS GEOTECHNICAL EXPLORATION METHOD, THE SLOPE STABILITY REFERENCE GUIDE FOR NATIONAL FORESTS IN THE UNITED STATES, VOLUME I, UNITED STATES DEPARTMENT OF AGRICULTURE, EM-7170-13, AUGUST 1994, P. 317-321.

CPT EXPLORATION:

CONE PENETROMETER EXPLORATIONS CONSIST OF PUSHING A PROBE CONE INTO THE EARTH USING THE REACTION OF A 20-TON TRUCK. THE CONE RESISTANCE (QC) AND SLEEVE FRICTION (FS) ARE MEASURED AS THE PROBE WAS PUSHED INTO THE EARTH. THE VALUES OF QC AND FS (IN TSF) ARE NOTED AS THE LOCALIZED INDEX OF SOIL STRENGTH.

ANGULARITY OF GRAVEL & COBBLES

ANGULAR	COARSE PARTICLES HAVE SHARP EDGES AND RELATIVELY PLANE SIDES WITH UNPOLISHED SURFACES.
SUBANGULAR	COARSE GRAINED PARTICLES ARE SIMILAR TO ANGULAR BUT HAVE ROUNDED EDGES.
SUBROUNDED	COARSE GRAINED PARTICLES HAVE NEARLY PLANE SIDES BUT HAVE WELL ROUNDED CORNERS AND EDGES.
ROUNDED	COARSE GRAINED PARTICLES HAVE SMOOTHLY CURVED SIDES AND NO EDGES.

SOIL MOISTURE MODIFIER

DRY	ABSENCE OF MOISTURE; DUSTY, DRY TO TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER

WEATHERED STATE

FRESH	NO VISIBLE SIGN OF ROCK MATERIAL WEATHERING; PERHAPS SLIGHT DISCOLORATION IN MAJOR DISCONTINUITY SURFACES.
SLIGHTLY WEATHERED	DISCOLORATION INDICATES WEATHERING OF ROCK MATERIAL AND DISCONTINUITY SURFACES. ALL THE ROCK MATERIAL MAY BE DISCOLORED BY WEATHERING AND MAY BE SOMEWHAT WEAKER EXTERNALLY THAN ITS FRESH CONDITION.
MODERATELY WEATHERED	LESS THAN HALF OF THE ROCK MATERIAL IS DECOMPOSED AND/OR DISINTEGRATED TO SOIL. FRESH OR DISCOLORED ROCK IS PRESENT EITHER AS A CONTINUOUS FRAMEWORK OR AS CORE STONES.
HIGHLY WEATHERED	MORE THAN HALF OF THE ROCK MATERIAL IS DECOMPOSED AND/OR DISINTEGRATED TO SOIL. FRESH OR DISCOLORED ROCK IS PRESENT EITHER AS DISCONTINUOUS FRAMEWORK OR AS CORE STONE.
COMPLETELY WEATHERED	ALL ROCK MATERIAL IS DECOMPOSED AND/OR DISINTEGRATED TO SOIL. THE ORIGINAL MASS STRUCTURE IS STILL LARGELY INTACT.
RESIDUAL SOIL	ALL ROCK MATERIAL IS CONVERTED TO SOIL. THE MASS STRUCTURE AND MATERIAL FABRIC IS DESTROYED. THERE IS A LARGE CHANGE IN VOLUME, BUT THE SOIL HAS NOT BEEN SIGNIFICANTLY TRANSPORTED.

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/the Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENG.NEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report:

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS
Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates, Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations. you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

- when the nature of the proposed structure is changed. for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation. or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership; or .for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY
The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site.

Because actual subsurface conditions can be discerned only during earthwork, you should retain your geo- technical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

SUBSURFACE CONDITIONS CAN CHANGE A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consult- ant to learn if additional tests are advisable before construction starts. Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS
Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE
Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

about the potential for hazardous materials existing at the site. The equipment, techniques, and personnel used to perform a geoenvironmental exploration differ substantially from those applied in geotechnical engineering. Contamination can create major risks. If you have no information about the potential for your site being contaminated. you are advised to speak with your geotechnical consultant for information relating to geoenvironmental issues.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION Costly problems can occur when other design profes- sionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid misinterpretations, retain your geotechnical engineer to work with other project design professionals who are affected by the geotechnical report. Have your geotechnical engineer explain report implications to design professionals affected by them. and then review those design professionals' plans and specifications to see how they have incorporated geotechnical factors. Although certain other design professionals may be fam- iliar with geotechnical concerns, none knows 'as much about them as a competent geotechnical engineer.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE REPORT Geotechnical engineers develop final boring logs based upon their interpretation of the field logs (assembled by site personnel) and laboratory evaluation of field samples. Geotechnical engineers customarily include only final boring logs in their reports. Final boring logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs. delays. disputes. and unanticipated costs ara the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use. (If access is provided only to the report prepared for you, you should advise contractors of the report's limitations. assuming that a contractor was not one of the specific persons for whom the report was prepared and that developing construction cost estimates was not one of the specific purposes for which it was prepared. In other words. while a contractor may gain important knowledge from a report prepared for another party, the contractor would be well-advised to discuss the report with your geotechnical engineer and to perform the additional or alternative work that the contractor believes may be needed to obtain the data specifically appropriate for construction cost estimating purposes.) Some clients believe that it is unwise or unnecessary to give contractors access to their geo- technical engineering reports because they hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems. It also helps reduce the adversarial attitudes that can aggravate problems to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical engineers. To help prevent this problem, geotechnical engineers have developed a number of clauses for use in their contracts, reports, and other documents. Responsibility clauses are not exculpatory clauses designed to transfer geotechnical engineers' liabilities to other parties. Instead, they are definitive clauses that identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report. Read them closely. Your geotechnical engineer will be pleased to give full and frank answers to any questions.

RELY ON THE GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE Most ASFE-member consulting geotechnical engineering firms are familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a construction project, from design through construction. Speak with your geotechnical engineer not only about geotechnical issues, but others as well, to learn about approaches that may be of genuine benefit. You may also wish to obtain certain ASFE publications. Contact a member of ASFE of ASFE for a complimentary directory of ASFE publications.

ASFE

8811 Colesville Road/Suite G106/Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017

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