Geohazard and Infiltration Feasibility Report

Ashley Street Residence
119 Ashley Street
Bellingham, WA 98225

Prepared For:
Slusher Luxury Homes
512 40th Street
Bellingham, WA 98229

Attn: Mr. Trent Slusher

GEOTEST
An RMA Company

Bellingham | Arlington | Oak Harbor | Tacoma
www.geotest-inc.com
1.888.251.5276

GEOTEST
An RMA Company

1.888.251.5276
Bellingham | Arlington | Oak Harbor | Tacoma
www.geotest-inc.com

August 29, 2024 (Revised September 6, 2024)
Project No. 24-2327

Slusher Luxury Homes
512 40th Street
Bellingham, WA 98229

Attn: **Trent Slusher**

Regarding: **Geohazard and Infiltration Feasibility Report – Revision 1**
Ashley Street Residence
119 Ashley Street
Bellingham, WA 98225
(Parcel No. 3803320250950000)

Dear Mr. Slusher,

As requested, GeoTest Services, Inc. (GeoTest) is pleased to submit the following report summarizing the results of our Geohazard and Infiltration Feasibility Report for the property located at 119 Ashley Street in Bellingham, Washington (see *Vicinity Map*, Figure 1). This report has been prepared in general accordance with the terms and conditions established in our services agreement (Proposal No. 00-242327-P) dated July 17th, 2024 .

GeoTest appreciates the opportunity to provide these services on this project and look forward to assisting you in further phases of the development and on any future projects. Should you have any 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
19110664
Licensed Geologist
9.6.2024.
HARRISON G. SIMONS

Harrison Simons, L.E.G.
Geotechnical Project Manager

State of Washington
23013805
Licensed Geologist
9.6.2024.
Daniel F. Keogh

Daniel Keogh, L.G.
Staff Geologist

Enclosure: Geohazard and Infiltration Feasibility Report – Revision 1

TABLE OF CONTENTS

PURPOSE AND SCOPE OF SERVICES

The purpose of this investigation is to establish general surface and subsurface conditions beneath the site from which conclusions and recommendations pertaining to project design can be formulated. Our study includes a review of the potential geologic hazards that are present on, or adjacent to the property. In addition, we have evaluated the feasibility of stormwater infiltration at the project site. Our scope of services includes the following tasks:

- Perform surface reconnaissance of the parcel and sloping terrain within its vicinity.
- Explore soil and groundwater conditions underlying the subject area by advancing two test pit explorations (TP-1 and TP-2) with a subcontracted tracked excavator and one hand auger exploration (HA-1).
- Perform laboratory testing on representative samples to classify and determine the engineering characteristics of the soils encountered.
- Provide a written report containing a description of surface and subsurface conditions, exploration logs, with findings and recommendations pertaining to the feasibility of on-site stormwater infiltration based on the 2019 Stormwater Management Manual for Western Washington.
- Discussion of geologic hazards and recommended mitigations, as needed, in compliance with Bellingham Municipal Code (BMC).

PROJECT DESCRIPTION

The subject area consists of a rectangularly-shaped, 0.18-acre parcel located adjacent to Lincoln Creek to the west of Ashley Street in Bellingham, Washington. Based on a preliminary plan set provided by our client, site improvement is expected to include the construction of a new, roughly 2,120 square foot single-family residence and associated utilities. Based on the provided plans we anticipate that the structures will utilize conventional concrete foundations, wood framing and slab on grade style floor construction. Thus, structural loading conditions are expected to be light in scale.

Following a review of *City of Bellingham CityIQ* mapping, the site appears to contain slopes along the alignment of Lincoln Creek which exceed 30 to 40 percent slope inclinations. Therefore, these areas may be considered potential geologic hazard areas per Bellingham Municipal Code.

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 investigations. 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. A GeoTest Licensed Geologist performed field work on July 29th, 2024.

Surface Conditions

The subject property is located within a mid-slope setting on the east side of Ashley Street in the Samish neighborhood of Bellingham, Washington. The site is bordered by predominantly single-family residences with an apartment complex situated across Ashley Street to the west. The site is densely vegetated with mature maple, cedar, and fir trees and dense underbrush. Mature trees existing on site slopes display generally vertical trunk geometry with some inconsistently present examples of pistol butting or downslope leaning growth patterns. Lincoln Creek crosses the eastern side of the property as it flows from the southeast to the northwest. The creek bed contained flowing water at the time of our visit in late July 2024 and was comprised of coarse gravel and cobbles over exposed glacial soils. The banks of the creek are well vegetated on both sides, up and down stream as well as on the subject parcel. Minor undercutting of the bank (about 1.5 feet) of the creek was observed near the southeast property corner of the parcel. GeoTest did not observe evidence of insipient slope instability, or other significant ongoing erosion at the time of our site visit.

Image 1*:* Site conditions viewed from Lincoln Creek where it enters the property's eastern edge. View is facing approximately northwest. The proposed house site is to picture left. Photo taken July 29th, 2024

Overall, the parcel contains gentle topography in the form of a bench in the southwest where it borders Ashley Street. The bench gradually slopes to the northwest and more steeply (in excess of 40 percent) along the marginal slopes of Lincoln Creek. From the high point of the site at 238 feet above sea level (ASL) on the southern property line, a total vertical elevation change of approximately 20 feet takes place over a horizontal distance of 75 feet. Based on the existing conditions map provided by our client, the existing slope that extends down to Lincoln Creek from the bench within the central portion of the site falls 10 to 13 feet at steep inclinations (in excess of 40 percent) to the toe of the slope.

Subsurface Soil Conditions

Subsurface conditions were investigated by advancing two test pit explorations (TP-1 and TP-2) with a subcontracted excavator and operator under the direction of a GeoTest Staff Geologist on July 29th, 2024. One hand auger exploration (HA-1) was also advanced during this visit. The explorations were advanced to depths ranging from 3 to 8 feet below ground surface (BGS). Soil classification followed the guidelines of the American Society for Testing and Materials (ASTM) D2487 and D2488. Approximate locations of the test pit explorations have been plotted on the *Site and Exploration Plan* (Figure 2B). A *Soil Classification System and Key* is presented as Figure 4. Detailed test pit logs of the subsurface conditions encountered at exploration locations are attached as Figures 5 and 6. Laboratory testing data is attached as Figure 7.

Image 2: Subsurface conditions as observed in TP-2. Note dense, undifferentiated glacial deposits materials extending to depth from near surface elevations. Photo taken July 29th, 2024

Our subsurface explorations revealed relatively consistent subsurface conditions throughout the subject site. The general soil profile consisted of a thin layer of forest duff over topsoil with undifferentiated glacial deposits beneath. Topsoil and forest duff extended to depths of up to 1-

foot BGS in our explorations. Forest duff consisted of soft, dark brown, moist, predominantly organic decomposed forest matter while topsoil consisted of soft, brown, dry, gravelly, sandy silt with frequent organics and woody debris. Undifferentiated glacial deposits displayed a weathered horizon where it was encountered below forest duff and topsoil. Weathered undifferentiated glacial deposits consisted of dense, tan, dry, gravelly, very silty sand with frequent large roots. The weathered portion of the undifferentiated glacial deposits extended to between 1.5 and 2.5 feet BGS. Below this depth, the undifferentiated glacial deposits did not show signs of weathering as noted by a shift in color. Undisturbed undifferentiated glacial deposits at the site consisted of dense or hard, gray, damp, gravelly, very silty sand and very sandy silt. Undifferentiated glacial deposits extended to the termination depth of our explorations at 3 to 8 feet BGS. At the time of our field investigation in late July 2024 no groundwater seepage was observed in any explorations.

General Geologic Conditions

According to the *Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington* (Lapen, 2000) general geologic conditions at the project site are mapped as undifferentiated glacial deposits (unit Qgd). According to Lapen, this unit may include any and all glacial deposits mapped within the project vicinity, such as glacial outwash, marine deltaic outwash, glacial till, marine outwash, glaciomarine drift and/or emergence (beach) deposits.

According to the same map, the Chuckanut Formation is located approximately 0.45 miles to the west of the project site. Lapen describes this unit (Ec_{cp}) as the Padden Member of the Chuckanut Formation. The Chuckanut Formation contains six members which consist of arkosic sandstone, siltstone, conglomerate, and coal which were deposited during the Eocene and possibly Late Paleocene to Early Oligocene. Specifically, Lapen describes the Padden Member as moderately to well sorted sandstone and conglomerate alternating with mud stone and minor coal. The sandstone ranges from fine to coarse grained, with pebbly to conglomeratic sandstone layers common. Planar cross-bedding, flat-bedding, trough cross-bedding and ripple lamination are common bedding features. Color is light olive-gray to pale yellowish brown. Thickness is possibly more than 3,000 meters.

Our field observations appear to support the mapped undifferentiated glacial deposits. It should be noted that the published soil types are representative of regional conditions and some variation between on-site soils and mapped geologic units should generally be anticipated.

Based on our review of the Washington State Department of Natural Resources (DNR) *Geologic Information Portal,* there are no active tectonic faults or landslides mapped within the vicinity of the project site.

Groundwater

Groundwater was not encountered during our explorations in late July 2024. However, due to the relatively dense and fine-grained nature of site soils it is expected that perched groundwater may develop at the subject site.

Perched groundwater conditions occur above the regional groundwater table in the unsaturated zone and typically occur when loose, more permeable soil is underlain by denser, less permeable soil or bedrock. The vertical movement of water through loose soil is restricted once a dense or less permeable soil or bedrock is encountered. Perched groundwater conditions typically develop in the wet season (October through April) or after extended periods of rainfall. The occurrence of perched water within the subsurface is often discontinuous.

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 off-site use.

Web Soil Survey

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) *Web Soil Survey* website, soils within the subject area are classified as Squalicum gravelly loam, 5 to 15 percent slopes. Table 1, below, summarizes the soil properties that were obtained from the USDA *Web Soil Survey* website.

Table 1
USDA Web Soil Survey Soil Classifications

Map Unit Symbol	156
Map Unit Name	Squalicum gravelly loam, 5 to 15 percent slopes
Soil Description	Gravelly ashy loam
Landform	Hillslopes
Parent Material	Volcanic ash, loess, and slope alluvium over glacial drift
Land Capability Classification	3e
Erosion K Factor, Whole Soil	0.24

The Squalicum gravelly loam soils consist of gravelly, ashy loam derived from a parent material of volcanic ash, loess, and slope alluvium over glacial drift. These soils are generally moderately well drained and are rated as having a **moderate** erosion susceptibility with an erosion K factor

of 0.24. Values of K range from 0.02 to 0.69, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Native soils at the project site appeared to be generally consistent with the *Web Soil Survey* description. Further discussion is provided in the *Erosion Hazard Areas* section of this report.

Bare Earth Imagery Review

GeoTest reviewed bare earth imagery acquired in 2013 of the subject property, and the associated landforms. Based on our review, the site itself contains slopes in excess of 40 percent along the margins of Lincoln Creek. However, based on the 2013 images and our site observations and measurements (of bank relief), the creek channel alignment appears to have remained consistent in terms of location and morphology since these images were taken.

No evidence of instability, such as tension cracks, head scarps, or significant downslope accumulations of materials were noted on or adjacent to the project site. (*Bare Earth Site Plan*, Figure 3). Outside of the general topographic profile of the site slopes, no signs of large scale "global" instability on subject property were observed in our bare earth imagery review.

Please note that not all signs of slope instability can be observed in the bare earth imagery review due to imagery resolution and scale. In addition, any signs of instability on the site slopes that have occurred within the last 11 years, if present, have occurred after original imagery acquisition. Bare earth imagery was obtained through the DNR *LIDAR Portal* website.

GEOLOGICALLY HAZARDOUS AREAS

According to BMC section 16.55.410, *geologically hazardous areas include areas susceptible to erosion, landslide, rock fall, subsidence, earthquake, or other geological events that pose a threat to the health and safety of citizens when incompatible development is sited in areas of significant hazard*. In this section we present a review of the site and proposed development in accordance with the City of Bellingham Critical Areas Ordinance 16.55.410-16.55.460, specifically as relating to geologic hazards.

Erosion Hazard Areas - BMC 16.55.420A

Bellingham Municipal Code (BMC) 16.55.420A defines Erosion Hazard Areas as, *areas prone to soil erosion. Specifically, these areas include any area where the soil type is predominantly (greater that 50 percent) comprised of sand, clay, silt, and/or organic matter and the slope is greater than 30 percent.*

The soils underlying the project site are composed of greater than 50 percent sand and silt. Additionally, areas of the site exceed 30 percent grades along the margins of Lincoln Creek (See

Figure 3 – *Bare Earth Imagery*). **Therefore, this portion of the project site is considered to contain Erosion Hazard Areas per Bellingham Municipal Code.** Residential construction is required to meet the standards outlined in 16.55.440A. Thus, the development will require an erosion and sediment control, drainage, and mitigation plan prepared in compliance with BMC 15.42. In our opinion, the erosion potential at the project site can be managed with appropriate construction practices.

Long term slope erosion must be mitigated through proper drainage and civil design. Stormwater volumes generated from proposed impermeable surfaces should be collected and directed to a municipally acceptable location. The following recommendations are intended to prevent excessive erosion from occurring at the site during and following construction:

- All clearing and grading activities for future residence construction will need to incorporate Best Management Practices (BMP's) for erosion control in compliance with current Bellingham Municipal Codes and standards.

- We recommend that appropriate silt fencing be incorporated into the construction plan for erosion control.

- We recommend that on-site BMP's be implemented during construction. Areas of native vegetation should be left in place or may be enhanced by adding additional native plant species and/or other vegetation enhancements.

- Removal of vegetation and trees without proper mitigation may increase the risk of failure for the surficial soils during periods of wet weather. Planting additional native vegetation within the sloped portion of the subject site and in areas disturbed by excavation activities will help maintain near surface slope stability by providing a stable root base within the near surface soils.

- Proper drainage controls have a significant effect on erosion. All surface water and any collected drainage water should not be allowed to be concentrated and discharged down the face of the sloped portions of the subject area. All collected stormwater should be directed to an engineered collection system.

- All areas disturbed by the construction practices should be vegetated or otherwise protected to limit the potential for erosion as soon as practical during and after construction. Areas requiring immediate protection from the effects of erosion should be covered with either plastic, mulch, or erosion control netting/blankets. Areas requiring permanent stabilization should be seeded with an approved grass seed mixture, hydroseeded with an approved seed-mulch-fertilizer mixture or landscaped with a suitable planting design.

It should also be noted that the proposed development will be subject to the City of Bellingham Stormwater Mitigation Minimum Requirements that are set forth in BMC section 15.42.060F. Depending on the final surface area that will be disturbed as a result of site development, various requirements (#1 through #9) may be required by the City of Bellingham, prior to project permitting.

Landslide Hazard Areas - BMC 16.55.420B

BMC 16.55.420B broadly defines Landslide Hazard Areas as, *[areas] prone to landslides and/or subsidence that could include slow to rapid movement of soil, fill materials, rock and other geologic strata resulting in risk of injury or damage to the public and environment. Landslides could result from any combination of soil, slope, topography, underlying geologic structure, hydrology, freeze-thaw, earthquake, and other geologic influences. Specific geologic hazards include slopes with an incline that is equal or greater than 40 percent grade (22 degrees) with a vertical elevation change of at least 10 feet. Slope shall be calculated by identifying slopes that have at least 10 feet of vertical elevation change within a horizontal distance of 25 feet or less.*

Based on our review of digital elevation models, topographic drawings, and our on-site observations, **the project site does contain Landslide Hazard Areas as defined by Bellingham Municipal Code along the marginal slopes of Lincoln Creek** (See Figure 3 – *Bare Earth Imagery*).

Based on our observations and research, the subject property does not currently exhibit any geomorphic or vegetative evidence of insipient slope instability. Further, the site is underlain by dense, glacially consolidated soil, therefore the potential landslide hazards are not considered to be an active landslide hazard.

When the recommendations presented in this report are incorporated into the project, it is our opinion that there is a **low risk** associated with relatively shallow, “skin-slides” occurring and impacting the proposed residence location over the life of the structure. Similarly, it is also our professional opinion that there is a generally **low risk** of large-scale rotational, or translational landslides occurring and impacting the planned development site under static conditions over the life the proposed improvements.

Large scale global instability, consisting of deep-seated rotational failures, can extend down into the subsurface to substantial depths. These failures typically leave geomorphic evidence of their existence on the slope. Typical indicators can consist of recessional and sometimes nested head scarps, tension cracks, sag pongs, seepage zones, hummocky ground surface and slump blocks. Visual indications of large-scale global slope instability, such as those referenced above, were not observed at the subject property. In addition, Chuckanut Formation bedrock is known to exist in the shallow subsurface in the vicinity of the proposed development which would reduce the potential for deep-seated failures.

Please keep in mind that the Pacific Northwest is seismically active, and it is difficult to predict how the slopes at the property may behave during a large earthquake.

Seismic Hazard Areas - BMC 16.55.420C

Bellingham Municipal Code defines Seismic Hazard Areas as, *areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface faulting. Specific areas of very high response to seismic shaking include areas depicted as "fill" and "alluvial deposits" within Whatcom County's Map Folio of Geologic Hazards, 1995.*

The subject site is mapped as a "very low to low" liquefaction susceptibility area (Palmer et al., 2004). 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. The shallow presence of dense, fine grained soils and lack of regional near surface groundwater table at the subject property support the mapped susceptibility rating. Therefore, the subject **site is not considered a seismic hazard area per BMC**.

The proposed development is located within the Seismic Design Category D_1, which states that site slopes may be unstable during a seismic event. As such, we recommend that the design team utilize seismic design standards per the International Building Code (IBC) such that the planned structure, including nonstructural components that are permanently attached to building's supports, be designed to resist the effects of earthquake motions. However, GeoTest does not expect that further mitigations will be required to address this potential hazard.

Please keep in mind that the Pacific Northwest is seismically active. Large Cascadia subduction zone earthquakes with possible magnitudes of 8 or 9 could produce ground shaking events with the potential to significantly impact the subject property regardless of the subsurface. Cascadia subduction zone earthquakes have occurred 6 times in the last 3,500 years with the most recent taking place in 1700, approximately 320 years ago. They have been determined to have an average reoccurrence interval of approximately 300 to 700 years. (Atwater and Haley, 1997).

Mine Hazard Areas - BMC 16.55.420D

The BMC defines Mine Hazard Areas as *those areas underlain by or affected by mine workings such as adits, gangways, tunnels, drifts, or airshafts, and those areas of probable sink holes, gas releases, or subsidence due to mine workings.*

Based on Bellingham Geologic Hazards Map (1991), the project site is **not** located within the near vicinity of any mine areas, and therefore does not meet the criteria of a Mine Hazard Area as defined by BMC 16.55.420D. As such, no mitigations for this specific hazard are required.

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. Dense native soils are present at shallow depths in the vicinity of the development area and can provide adequate support for the proposed residence.

The project site is known to contain potential erosion and landslide hazards as described by Bellingham Municipal Code. Because of these hazards, we recommend that the proposed residence be sited as far towards the southeast corner of the parcel as possible. Based on our analysis of the information obtained over the course of this investigation, we recommend that the Landslide and Erosion hazard area buffer be reduced to an effective setback of 10 feet from the top of site slopes to the northeast of the planned structure (Figure 2, *Site Development Plan*). To further utilize the limited buildable space within the subject area, foundations elevations along the eastern, northeastern and northern margin of the structure may be extended to depths of up to 5 feet into the subsurface at a 1(Vertical):1(Horizontal) ratio in order to allow foundations to be placed 5 feet closer to the top of the existing slopes while maintaining the recommended "effective setback" distance of 10 feet from the top of these slopes.

A portion of this report constitutes a stormwater infiltration feasibility evaluation. Based on the conditions encountered within our subsurface explorations, the project site does not appear to be suitable for the conventional infiltration of stormwater. We anticipate that stormwater generated from the planned improvements will be captured and tightened to the municipal system in Ashley Street. When this stormwater management strategy is implemented into the planned development, GeoTest does not anticipate that the proposed improvements will negatively impact the subject property or adjacent parcels.

Assuming that the recommendations presented in this report are implemented into the plan for development, it is our opinion that the existing hazards will be adequately mitigated in conformance with BMC 16.55.450(A). Further, it is our opinion that the residence is planned within the only possible location at the project site from a mitigation sequencing standpoint.

Mitigation of Geologic Hazards

Based upon an evaluation of the data collected during this investigation, it is our opinion that the construction of the proposed single-family residence on the subject property, as discussed, is feasible and can be adequately mitigated with respect to the following requirements per BMC 16.55.450(A).

As a result of the limited size of the Lincoln Creek drainage basin upgradient from the subject property, the well vegetated conditions of the marginal creek channel slopes (and documented

lack of erosion more than a couple of feet above the channel), the density of the native soil deposits, and the vertical separation from the proposed residence finished floor elevation and the Ordinary High Water Mark elevation (shown on the client provided survey), it is our opinion that these hazards can be adequately mitigated in conformance with BMC 16.55.450(A). Based on our analysis of the information obtained over the course of this investigation, we recommend that the Landslide and Erosion hazard area buffer be reduced to an effective setback from the top of site slopes of 10 feet. To further utilize the limited buildable space within the subject area, foundations elevations along the eastern, northeastern and northern margin of the structure may be extended to depths of up to 5 feet into the subsurface at a 1(Vertical):1(Horizontal) ratio in order to allow foundations to be placed 5 feet closer to the top of the existing slopes to maintain the recommended "effective setback" distance of 10 feet from the top of the site slopes.

We understand that site generated stormwater will be addressed via engineered design which will collect site generated stormwater direct it to the municipal stormwater system in Ashley Street.

As such, it is our opinion that the proposed development:

- Will not increase the threat of the geological hazard to adjacent properties beyond predevelopment conditions.
- Will not adversely impact other critical areas.
- Is designed so that the hazard to the project is eliminated or mitigated to a level equal to or less than predevelopment conditions; and
- We anticipate the site to be safe as designed under static conditions and normal use.

Furthermore, per BMC 16.55.460(A.2) it is our opinion that the proposed development:

- Will not increase surface water discharge or sedimentation to adjacent properties beyond predevelopment conditions.
- Will not decrease slope stability on adjacent properties; and
- Such alterations will not adversely impact other geologically hazardous areas.

In consideration of 16.55.460 (4 and 5), GeoTest does not anticipate that removal of the vegetation or the placement of the planned building footings will have a negative impact on the slopes. We recommend that development plans retain as much native vegetation as possible and revegetate site slopes as feasible.

We recommend that the design team utilize seismic design standards per the IBC such that the planned structure, including nonstructural components that are permanently attached to the building's supports, be designed to resist the effects of earthquake motions.

Due to the proximity of the site to Lincoln Creek project ownership should generally be aware that, over time, erosion will continue to cause downcutting of the creek channel. This process will cause erosion of the steep site slopes and contribute to the migration of the top of the slope toward the foundations of the home. However, as discussed above, we consider the likelyhood of this process impacting the home over its intended lifespan to be generally low.

It should be noted that no amount of engineering can completely mitigate or prevent slope instability. Mitigation is intended to make the risk posed by the slope that is present on site less and it should not be interpreted that mitigation is representative of eliminating any and all risk that might be present on the site. It is assumed that the property owner is aware of the slope and risk of erosion that is present on the site and that she/he has been adequately informed and is accepting of the risks associated with sloped property development.

Stormwater Infiltration Potential

The presence of dense/hard fine-grained native materials supports the presence of a "restrictive layer" as defined by the 2019 Stormwater Management Manual for Western Washington. Maintaining a minimum separation from the base of traditional stormwater infiltration systems to these restrictive layers does not appear feasible. Thus, it is our opinion that the site is not suitable for conventional stormwater infiltration. We anticipate that stormwater will be captured and directed to the municipal stormwater system.

Stormwater Considerations

With adequate engineering and/or proper stormwater design based on the current Stormwater Manual, GeoTest does not anticipate that the proposed improvements will negatively impact the steep slopes any more than the existing site conditions do.

The stormwater collection system should be considered a routine maintenance item and should be regularly checked for proper working order. Typically, the stormwater system is checked at least twice a year and after any major storm event.

Plan Review

GeoTest was provided with an architectural plan set dated September 5, 2024 by Slusher Luxury Homes detailing the planned construction of a new single-family residence at the subject property in Bellingham, Washington. Based on our review of the plan set, the previously presented geotechnical recommendations pertaining to geologically hazardous areas mitigation (buffer distance and foundation embedment) as well as stormwater management have been appropriately implemented into the plan for site development.

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 proposed building. Periodic field density testing should be performed to verify that the appropriate degree of compaction is obtained.
GeoTest is available to provide a full range of materials testing and special inspection during building 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.

This report is intended to support project permitting and present conclusions pertaining to existing geologically hazardous areas, appropriate mitigation of those hazards, and the preliminary feasibility of stormwater infiltration at the project site. Our scope of services did not include other significant geotechnical engineering recommendations. GeoTest would be pleased to provide these recommendations under a separate scope of services, if requested.

USE OF THIS REPORT

GeoTest Services, Inc. has prepared this report for the exclusive use of Slusher Luxury Homes and their design consultants for specific application to the design of the proposed residence at 119 Ashley Street in Bellingham, 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 and conclusions 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 geological information for the site. If variations in subsurface conditions are encountered during future construction that differ from those contained within this report, GeoTest should be allowed to review our report 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 contained herein.

The future prospective earthwork contractor is responsible for performing 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 Development Plan
Figure 2B	Site and Exploration Plan
Figure 3	Bare Earth Imagery
Figure 4	Soil Classification System and Key
Figures 5 - 6	Test Pit Logs
Figure 7	Laboratory Test Results
	Report Limitations and Guidelines for Its Use (4 Pages)

REFERENCES

American Society for Testing and Materials (ASTM). *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).* ASTM D2487 – 17e1.

American Society for Testing and Materials (ASTM). *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).* ASTM D2488 – 17e1.

Atwater, B. F.; Hemphill-Haley, Eileen, 1997*, Recurrence intervals for great earthquakes of the past 3,500 years at northeastern Willapa Bay, Washington*: U.S. Geological Survey Professional Paper 1576, 108 p.

Bellingham *CityIQ.* (n.d.). Retrieved August 2024 https://www.cob.org/services/maps/online-mapping.

Bellingham Municipal Code - Critical Areas, §§ 16-16.55.410-16.55.460.

Gariepy, D., Graul, C. Heye, A., Howie, D., Labib, F. & Song, K. (n.d.) 2019. *Stormwater Management Manual for Western Washington* (2019 SMMWW) (pp. 1-1108) (United States, Washington Department of Ecology).

Kelsey, H.M., Sherrod, B.L., Blakely, R.J., Pratt, T.L., Haugerud, R.A., 2010. *Active Faulting in the Bellingham Forearc Basin: North-South Shortening at the Northern End of the Cascadia Subduction Zone*, NEHRP Final Technical Report, USGS Award Number: G09AP00043.

Lapen, Thomas, J. (2000). *Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington.* Washington Division of the Geology and Earth Resources. Open File Report 2000-5, scale 1:100,000.

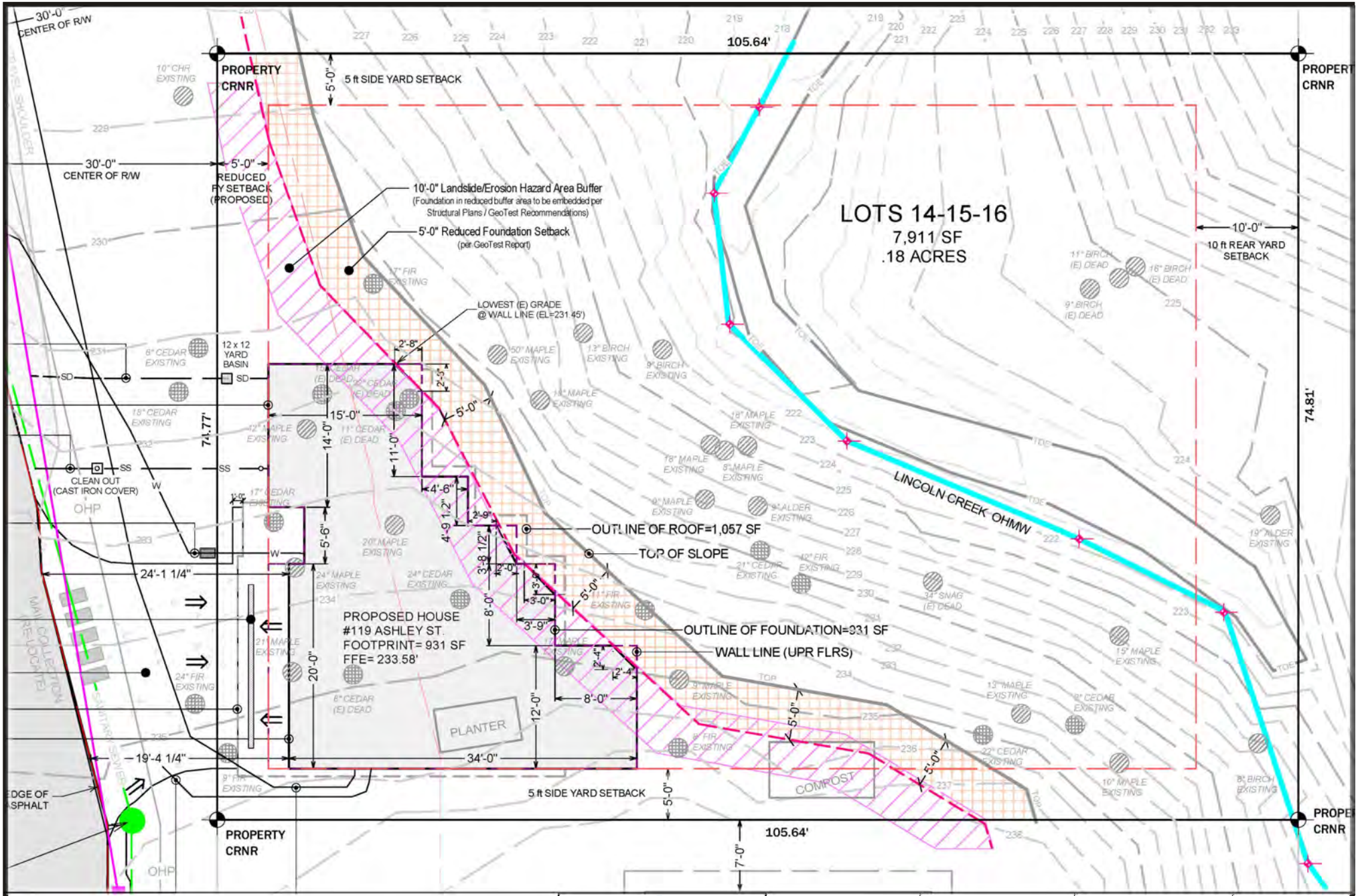
Palmer et al., 2004. *Liquefaction Susceptibility and Site Class Maps of Washington State by County.* 1:24,000. Washington Division of Geology and Earth Resources, Open File Report 2004-20.

USDA *Web Soil Survey*. Retrieved August 2024 from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

Washington Geologic Information Portal, Washington State Department of Natural Resources – Online Web Services, Retrieved August 2024 from https://geologyportal.dnr.wa.gov.

Washington Lidar Portal. (n.d.). Retrieved August 2024 from http://lidarportal.dnr.wa.gov/ .

GEOTEST An RMA Company	Date: 7-29-24	By: DK	Scale: As Shown
	VICINITY MAP **ASHLEY STREET RESIDENCE** **119 ASHLEY STREET** **BELLINGHAM, WASHINGTON**		Project **24-2327** Figure 1



Site Plan Provided by Client

N
W E
S

GEOTEST
An RMA Company

Date: 9-6-24	By: HS	Scale: As Shown	Project 24-2327

Site Development Plan

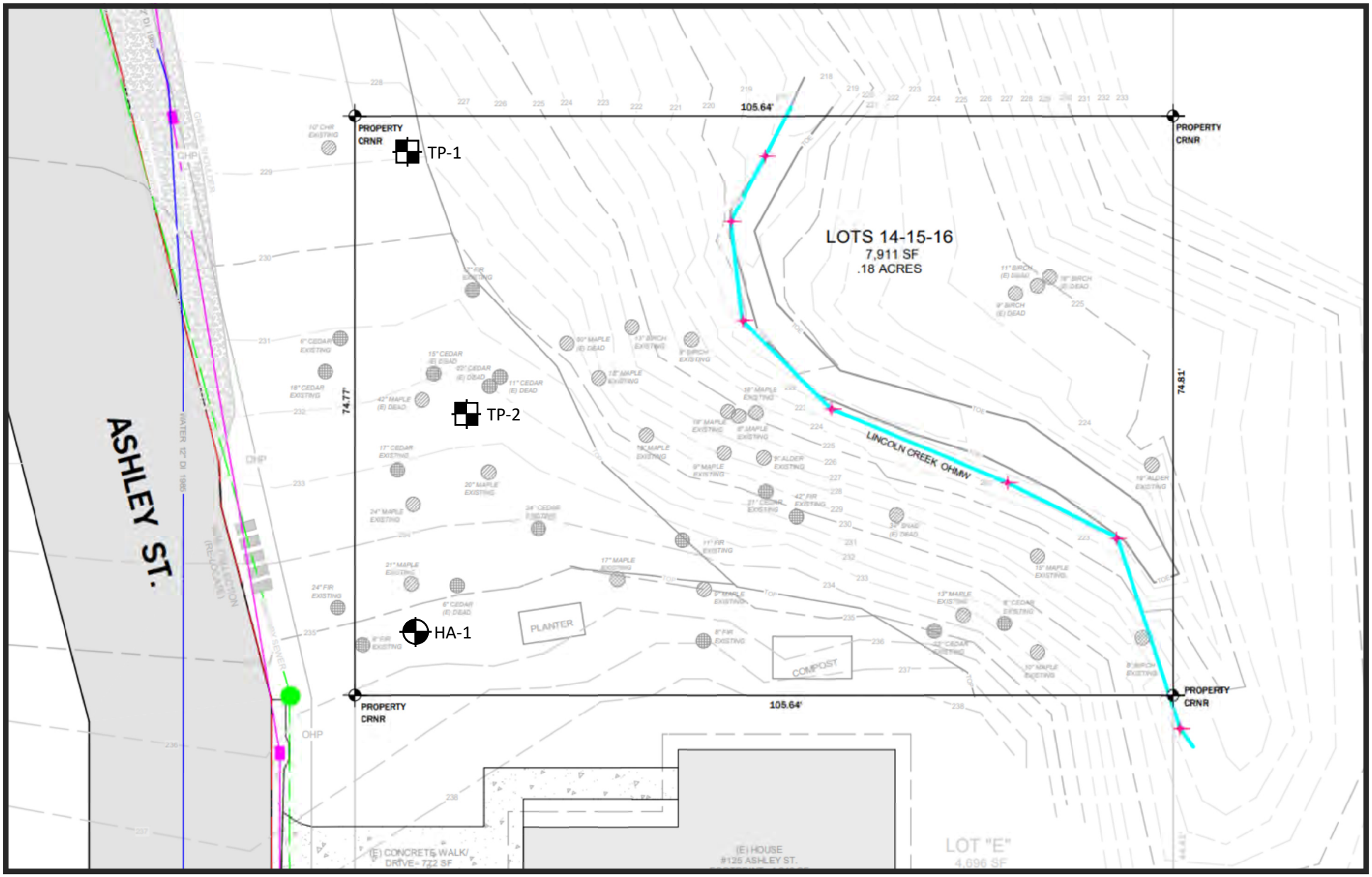
Ashley Street Residence

119 Ashley Street

Bellingham, Washington

Figure 2

EXISTING CONDITIONS MAP PROVIDED BY SLUSHER LUXURY HOMES



N

TP-# = Approximate Test Pit Location

HA-# = Approximate Hand Auger Location

GEOTEST
An RMA Company

Date: 7-30-2024	By: DK	Scale: NTS	Project 24-2327

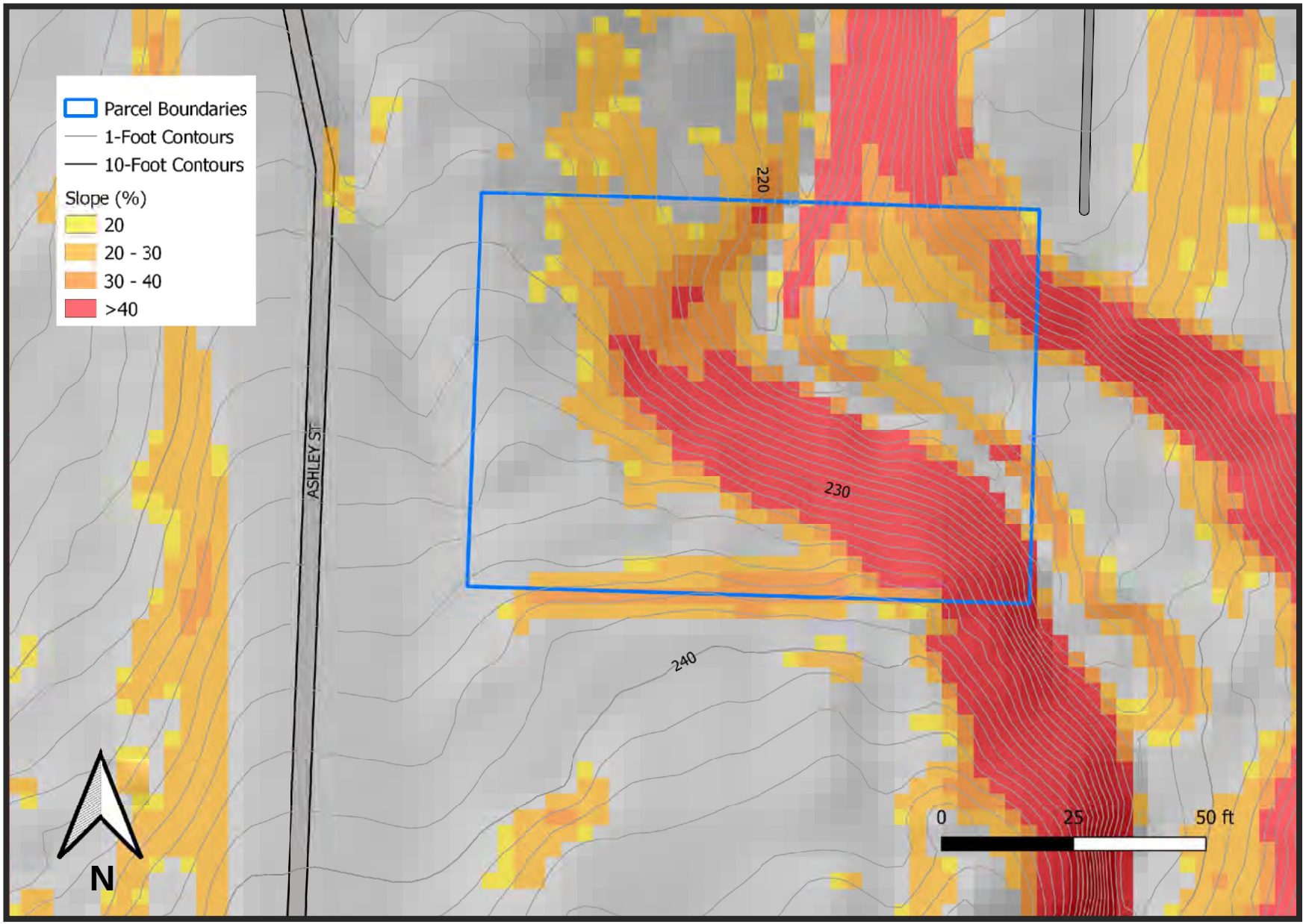
SITE AND EXPLORATION PLAN

ASHLEY STREET RESIDENCE

119 ASHLEY STREET

BELLINGHAM, WASHINGTON

Figure 2B



DATA SOURCE(S):				
PARCELS & ROADS : COB GIS DATA ELEVATION, SLOPE, AND HILLSHADE: DERIVED FROM BELLINGHAM_2013 LIDAR SURVEY BY WSI APPLIED REMOTE SENSING AND ANALYSIS	GEOTEST An RMA Company	Date: 8-7-2024	By: DK	Scale: As Shown

SITE AND EXPLORATION PLAN

ASHLEY STREET RESIDENCE

119 ASHLEY STREET

BELLINGHAM, WASHINGTON

Project **24-2327**

Figure **3**

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL	TYPICAL DESCRIPTIONS[1][2]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

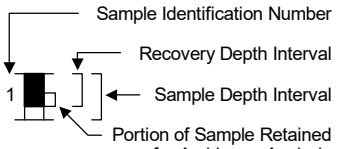
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
2. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 12% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 12% - "slightly gravelly," "slightly sandy," "slightly silty," etc.
	≤ 5% - "trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Other - See text if applicable

Groundwater

▽ ATD — Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

GEOTEST
An RMA Company

Ashley Street Residence
119 Ashley Street
Bellingham, Washington

Soil Classification System and Key

Figure 4

HA-1

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Determined Excavated By: D. Keogh	
0					ML	Soft, brown, dry, gravelly, sandy SILT, frequent organics and woody debris (Forrest Duff)	Groundwater not encountered.
1	1	d			SM	Dense, tan, dry, gravelly, very silty SAND, frequent roots (Weathered Glacial Till)	
2	2	d			SM	Very dense, gray, damp, gravelly, very silty SAND (Glacial Till)	
3						Hand Auger Terminated at Planned Depth	
4							
5							

Test Pit Completed 07/29/24
Total Depth of Test Pit = 3.0 ft.

TP-1

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): Not Determined Excavated By: Lukes Enterprise / D. Keogh	
0					ML	Soft, brown, dry, gravelly, sandy SILT, frequent organics and woody debris (Topsoil)	Groundwater not encountered.
2	3	d	W = 9 GS		SM	Dense, tan, dry, gravelly, very silty SAND (Weathered Glacial Till)	
4	4	d	W = 12 GS		ML	Hard, gray, damp, gravelly, very sandy SILT (Glacial Till)	
6	5	d				Test Pit Terminated at Planned Depth	
8							

Test Pit Completed 07/29/24
Total Depth of Test Pit = 6.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST

Ashley Street Residence
119 Ashley Street
Bellingham, Washington

Log of Test Pits

Figure 5

TP-2

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): Not Determined Excavated By: Lukes Enterprise / D. Keogh	
0					ML	Soft, brown, dry, gravelly, sandy SILT, frequent organics and woody debris (Forrest Duff)	Groundwater not encountered.
	6	d			SM		
2						Dense, tan, dry, slightly gravelly, very silty SAND, frequent large roots (Weathered Glacial Till)	
	7	d	W = 10 GS		SM		
4						Dense, gray, damp, gravelly, very silty SAND (Glacial Till)	
	8	d					
6							
	9	d	W = 11 GS				
8						Test Pit Terminated at Planned Depth	
10							

Test Pit Completed 07/29/24
Total Depth of Test Pit = 8.0 ft.

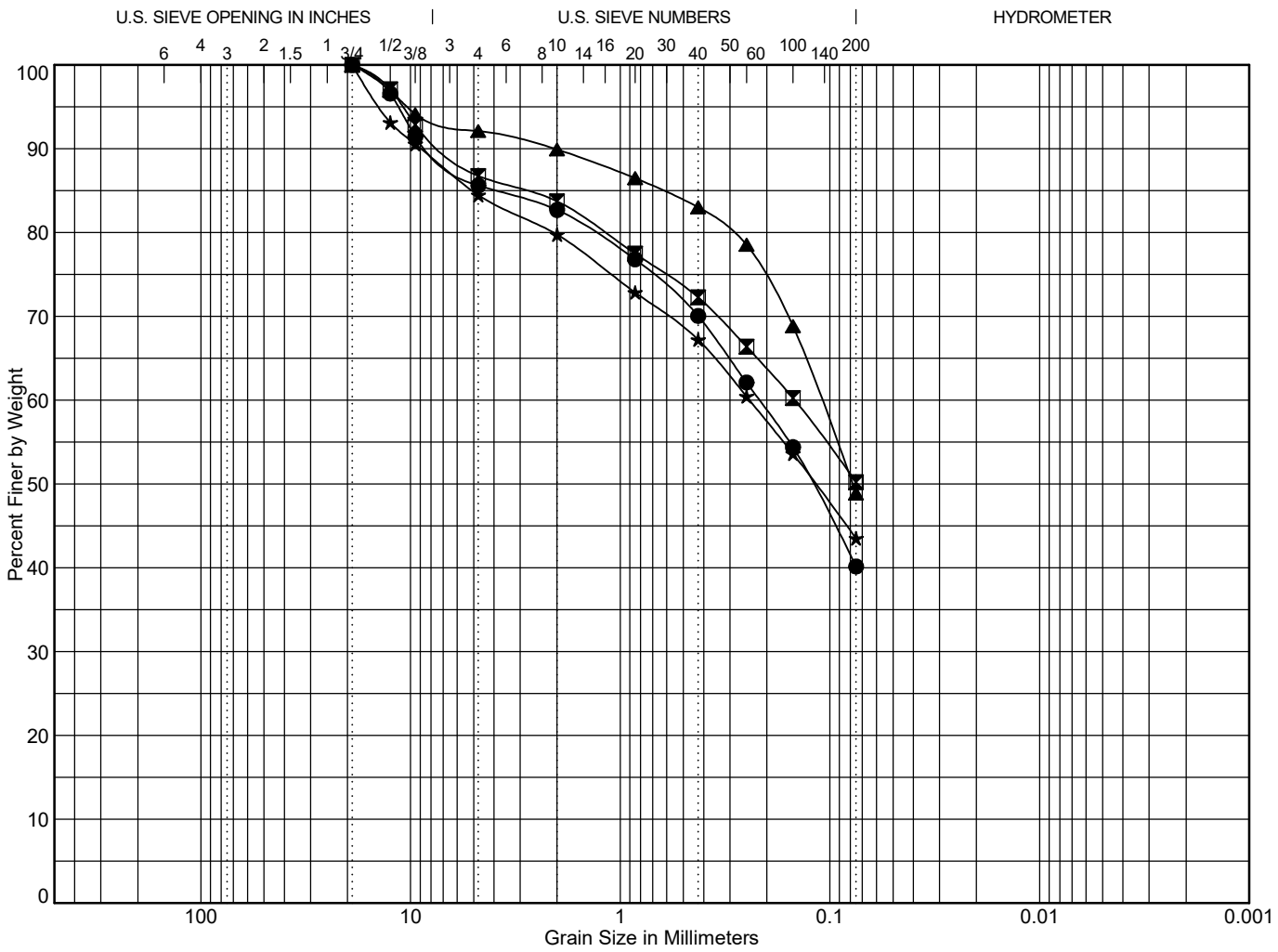
Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST
An RMA Company

Ashley Street Residence
119 Ashley Street
Bellingham, Washington

Log of Test Pits

Figure
6



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	TP-1	0.6	Gravelly, very silty SAND (SM)					
⊠	TP-1	3.4	Gravelly, very sandy SILT (ML)					
▲	TP-2	2.8	Slightly gravelly, very silty SAND (SM)					
★	TP-2	7.5	Gravelly, very silty SAND (SM)					

Point		Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	TP-1	0.6	8.009	0.217	0.121			0.0	14.4	2.9	12.6	29.9	40.2
⊠	TP-1	3.4	6.869	0.147				0.0	13.2	3.0	11.5	22.0	50.2
▲	TP-2	2.8	2.075	0.11	0.078			0.0	7.9	2.2	6.9	34.2	48.9
★	TP-2	7.5	8.926	0.242	0.117			0.0	15.5	4.7	12.5	23.7	43.5

$C_c = D_{30}^2/(D_{60} * D_{10})$
$C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST
An RMA Company

Ashley Street Residence
119 Ashley Street
Bellingham, Washington

Grain Size Test Data

Figure
7

REPORT LIMITATIONS AND GUIDELINES FOR ITS USE[1]

Subsurface issues may cause construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help:

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

At GeoTest our geotechnical engineers and geologists structure their services to meet specific needs of our clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of an owner, a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineer who prepared it. And no one – not even you – should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

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

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

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

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

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

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

- the function of the proposed structure, as when it's changed, for example, from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed construction,
- alterations in drainage designs; or
- composition of the design team; the passage of time; man-made alterations and construction whether on or adjacent to the site; or by natural alterations and events, such as floods, earthquakes or groundwater fluctuations; or project ownership.

Always inform GeoTest's geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. Do not rely on the findings and conclusions of this report, whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact GeoTest before applying the report to determine if it is still relevant. A minor amount of additional testing or analysis will help determine if the report remains applicable.

Most Geotechnical and Geologic Findings are Professional Opinions

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

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

A Report's Recommendations are Not Final

Do not over-rely on the construction recommendations included in this report. Those recommendations are not final, because geotechnical engineers or geologists develop them principally from judgment and opinion. GeoTest's geotechnical engineers or geologists can finalize their recommendations only by observing actual subsurface conditions revealed during construction. GeoTest cannot assume responsibility or liability for the report's recommendations if our firm does not perform the construction observation.

A Geotechnical Engineering or Geologic Report may be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. Lower that risk by having GeoTest confer with appropriate members of the design team after submitting the report. Also, we suggest retaining GeoTest to review pertinent elements of the design teams plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having GeoTest participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do not Redraw the Exploration Logs

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

Give Contractors a Complete Report and Guidance

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

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

In addition, it is recommended that a contingency for unanticipated conditions be included in your project budget and schedule.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering or geology is far less exact than other engineering disciplines. This lack of understanding can create unrealistic expectations that can lead to disappointments, claims, and disputes. To help reduce risk, GeoTest includes an explanatory limitations section in our reports. Read these provisions closely. Ask questions and we encourage our clients or their representative to contact our office if you are unclear as to how these provisions apply to your project.

Environmental Concerns Are Not Covered in this Geotechnical or Geologic Report

The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated containments, etc. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. Do not rely on environmental report prepared for some one else.

Obtain Professional Assistance to Deal with Biological Pollutants

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts biological pollutants from growing on indoor surfaces. Biological pollutants includes but is not limited to molds, fungi, spores, bacteria and viruses. To be effective, all such strategies should be devised for the express purpose of prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional biological pollutant prevention consultant. Because just a small amount of water or moisture can lead to the development of severe biological infestations, a number of prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of this study, the geotechnical engineer or geologist in charge of this project is not a biological pollutant prevention consultant; none of the services preformed in connection with this geotechnical engineering or geological study were designed or conducted for the purpose of preventing biological infestations.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)