GEOTECHNICAL ENGINEERING EVALUATION

Proposed New "Beach House" Residence

Runstad – Whaleback Estate
Blakely Island, Washington

August 17, 2010

Prepared for

Jon Runstad

S.J.C. COMMUNITY
AUG 26 2010
DEVELOPMENT & PLANNING
OFFICE COPY

GEOTEST

741 Marine Drive
Bellingham, Washington

GeoTest

741 Marine Drive
Bellingham, WA 98225

20611-67th Avenue NE
Arlington, WA 98223

PHONE
360 733_7318

TOLL FREE
888 251_5276

FAX
360 733_7418

August 17, 2010
Job No. 10-0351

Jon Runstad
C/o Sullivan Conrad Architects
1305 East Jefferson Street
Seattle, WA 98122

Attn.: Jon Runstad

Re: Geotechnical Engineering Evaluation *for*
Proposed New "Beach House" Residence
Runstad - Whaleback Estate
Blakely Island, Washington
Unplatted Parcel, Proposed Parcel A (10.62 Acres)
TPN 151024002

Dear Mr. Runstad,

As requested, GeoTest Services, Inc. is pleased to submit this report summarizing the results of our geotechnical engineering evaluation for the proposed single family residence "Beach House" to be located on the proposed 10.62 acre Parcel A lot on Blakely Island, Washington (see Figure 1, Vicinity Map). The purpose of this evaluation is to establish general subsurface conditions beneath the site from which conclusions and recommendations for foundation design and general site development can be formulated. Specifically, our scope of services included the following tasks:

- Near surface exploration of soil and groundwater conditions underlying the site by excavating four exploratory test pits with a tractor mounted backhoe.

- Laboratory testing on representative samples in order to classify and evaluate the engineering characteristics of the soils encountered.

- Provide this written report containing a description of subsurface soil and groundwater conditions, test pit logs, findings and recommendations pertaining to site preparation and earthwork, fill and compaction, wet weather earthwork, erosion control, seismic design, foundation recommendations, concrete slab-on-grade construction, foundation and site drainage/infiltration potential, utilities, temporary and permanent slopes, slope stability, roof downspout runoff control, geotechnical consultation and construction monitoring.

PROJECT DESCRIPTION

We understand that there are plans to construct a new wood frame single family residence referenced as the "Beach House". The residence will be generally one story with a partial second story loft. The structure will be supported by a conventional shallow cast-in-place concrete foundation with slab-on-grade floor. The proposed structure will be located approximately 50 feet back from the shoreline along a small un-

named bay along Thatcher Pass. The proposed residence main finish floor elevation is still undetermined at this time, however it will most likely be located at approximately elevation 30 based on the preliminary topographic site plan, dated June 18, 2010, provided by Sullivan Conard Architects. The proposed new driveway will consist of a single lane gravel drive that splits from the main road near the existing caretaker's residence and traverses the existing slope terminating at the east end of the residence.

SITE CONDITIONS

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

General Geologic Conditions

Geologic information for the project site was obtained from the interactive *Geologic Map of Washington State*, published by the Washington State Department of Natural Resources (DNR). According to the DNR map, subsurface soils within the project area consist of Pleistocene continental glacial till (Qgt) deposited during the Vashon Stade of Fraser glaciation. Soils defined as glacial till typically consist of a dense, unsorted mixture of boulders, cobbles, gravel, and sand in a matrix of silt and clay with some lenses of sorted, stratified sand and gravel. This unit typically exhibits low permeability and high shear strength, characteristics resulting from compaction by the weight of a glacier. Based on our subsurface explorations within the project site, the near surface soils consist of a mix of variable depths of regraded fill and shallow silty sand deposits associated with adjacent surface drainage features, which are intern underlain by the mapped glacial till deposits. We anticipate that the majority of the proposed residence foundation elements will be bearing on the less dense alluvial deposits and/or weathered till horizons.

Soil Survey

According to the United States Department of Agriculture (USDA) Natural Resource Conservation Service website, the subject property slope is mapped as Hoypus Sandy Loam (3012), 10 to 40 percent slopes. According to the Soil Survey, the Hoypus Sandy Loam is considered a "low" erosion hazard and has an erosion factor K (susceptibility of a soil to sheet and rill erosion by water) of 0.05. Values of K range from 0.02 to 0.69, and, the higher the value, the more susceptible the soil is to water erosion. Native site soils observed on the property slope were generally consistent with the Soil Survey.

Coastal Zone Atlas

According to the Coastal Zone Atlas (Washington State Department of Ecology), the subject property is mapped as being located within a stable shoreline slope area.

Surface Conditions

The property consists of a south facing shoreline slope and terraced area within a currently unplatted lot within the Runstad – Whaleback Estate on the south side of Blakely Island. The proposed residence is located at the base of a forested slope with

minimal underbrush and prevalent field grass. The proposed residence location is setback approximately 50 feet from the active shoreline slope, which was observed to vary from approximately 6 to 10 feet in height. The shoreline is part of an unnamed cove that is relatively protected from large wave storm events. Accordingly, we anticipate that the toe of the shoreline slope is subject to a low erosion rate. Please refer to the attached Site and Exploration Plan, Figure 2, for more detail.

The topography of the site slopes down to the south at a relatively constant slope from the main road that crosses the upper approximate third of the property. The slope inclination was measured to be approximately 23 degrees or approximately 40 to 45 percent. The property then becomes relatively flat, generally less than 10 percent, from the toe of the slope to the existing shoreline embankment.

Vegetation within the upslope portions of the site consists of a sparse evergreen forest with an understory composed of mostly field grass with few native shrubs. Based on our observations of the site slope, no indications of large scale slides or slumps appeared to have occurred in the past. Due to the presence of rock cliffs located upslope and off the subject property to the north, some overland rock boulders have tumbled down the slope throughout its history. No significant surface boulders were observed near the base of the slope and it would appear that the potential for new boulders to reach the proposed home location would be low as long as the slope remains forested.

At the time of our subsurface investigation, surface water was not observed on the site slope. However, a seasonal stream ravine is present immediately above the eastern portion of the proposed residence/garage location. We understand that this ravine will support overland water flow in the wetter winter and early spring seasons depending on rain fall events. Accordingly, we recommend that improvements to the main road drainage system, located upslope and at the head of the ravine, be implemented in the site development plan. We also recommend that appropriate site grading and creek capture and diversion measures be included in the design and construction of the proposed home location in order to sufficiently divert the seasonal creek around the proposed home location. We anticipate that with appropriate design and construction methodology that this can be successfully implemented.

Within the observed areas of the property slope, no obvious signs of recent slope failure, significant erosion, or evidence of significant soil creep (usually evidenced by a significant number of pistol-butted trees) were observed. Normal surficial soil movement (creep), as is typical will any soil slope at the observed inclination, should be anticipated throughout the live of property and would not be considered a hazard.

Subsurface Soil Conditions

Subsurface conditions were explored by excavating four test pit explorations (TP-1 through TP-4) on July 1, 2010. The test pits were advanced to depths between 2 and 5.5 feet below ground surface (BGS). Approximate locations of these explorations are depicted on Figure 2, Site and Exploration Plan.

Approximately 6 to 8 inches of topsoil/forest duff was observed on the site, except within test pit TP-1 where approximately 1 foot of fill was present at the ground surface. Within test pit TP-1, we encountered approximately 1 foot of soft, brown/gray, wet, sandy clay fill (CL) overlying approximately 1.5 feet of relic topsoil (OL). At a depth of approximately

3 feet BGS, we encountered an approximate 10 inch thick layer of medium stiff, moist, gray clay (CL). Below a depth of approximately 3.5 to 4 feet BGS, we encountered dense, brown, moist gravelly, very silty sand (SM-glacial till) with cobbles and boulders to the full exploration depth of approximately 5 feet BGS. Within the remaining test pits and below the surficial topsoil, we encountered medium dense, brown to gray, moist, gravelly very silty sand (SM-weathered glacial till) with significant cobbles and boulders to the full depths of exploration except within test pit TP-3 where limited cobbles and boulders were encountered. Our exploration depths were generally limited due to the presence of the cobbles during excavation. Please reference the attached test pit logs, Figures A-2 and A-3, within Appendix A for more detail.

Groundwater

In general groundwater was not observed within our explorations except for isolated perched seepage lenses within test pit TP-1 at depths of 1 and 3.5 feet BGS. The observed seepage was perched within the relic topsoil layer and above the glacial till contact at depth. Accordingly, it is our opinion that perched groundwater conditions both within the upper near surface slope soils and/or above the dense glacial till at deeper contacts between various soil horizons will be encountered during site development. Accordingly, all site development is recommended to account for drainage provisions during the design and construction phases.

The groundwater conditions reported on the test pit logs are for the specific locations and dates indicated, and therefore may not necessarily be indicative of other locations and/or times. Groundwater levels and/or seepage rates are not static and it is anticipated that groundwater conditions will vary depending on local subsurface conditions, season, precipitation, changes in land use both on and off site, and other factors.

CONCLUSIONS AND RECOMMENDATIONS

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

We recommend that all topsoil, fill and the upper soft portions of the native soil (generally 2 to 4 feet) be removed from below all structural areas and that footings be placed on native, medium dense/dense glacial till soils or on a suitably prepared gravel pad over till soils.

Reuse of portions the native sand and gravel as structural fill is considered feasible. However, cobbles and boulders greater than 12 inches should be removed from any replaced fill soils. We do not recommend the re-use of fine grained clayey native soils as structural fill under load bearing areas due to their high clay content. Re-use of suitable non-organic native soils with high fines contents is considered feasible in non-structural areas and/or other landscaped areas.

Site Preparation and Earthwork

Portions of the site to be occupied by proposed residential foundations, retaining walls or slab-on-grades should be prepared by removing any topsoil, fill, unsuitable native soils and/or significant accumulations of organics from the areas to be developed. Prior to placement of any structural fill, the exposed subgrade under all areas to be developed should be recompacted to a dense and unyielding condition and proof rolled with a loaded dump truck, large self-propelled vibrating roller, or equivalent piece of equipment applicable to the size of the excavation. The purpose of this effort is to identify possible loose or soft soil deposits and recompact the soil exposed during site excavation activities.

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

Fill and Compaction

Structural fill used to obtain final elevations for foundations elements, soil-supported floor slabs or driveway fills must be properly placed and compacted. In general, any suitable, non-organic, predominantly granular soil may be used for fill material provided the material is properly moisture conditioned prior to placement and compaction, and the specified degree of compaction is obtained. Excavated site material containing topsoil, wood, organic material, or other debris will not be suitable for reuse as structural fill and should be properly disposed offsite.

Due to the site topography, we do not recommend that any fills be placed on the site slopes other than those necessary to properly support the proposed driveway and/or other applicable foundation elements. All fills on the site should be appropriately retained and/or sloped. We recommend low-impact design methodology be utilized as much as possible to mitigate against the potential for slope instability associated with large cuts and fills.

Reuse of Onsite Soil

Generally, any granular site soils with relatively low fines contents are suitable for reuse. However, due to the anticipated limited nature of the planned site excavations within the residence footprint, reuse of applicable portions of suitable site soils appears limited.

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

Imported Structural Fill

We recommend that imported structural fill consist of clean, well-graded sandy gravel, gravelly sand, or other approved naturally occurring granular material (pit run) with at least 40 percent retained on the No. 4 sieve, or a well-graded crushed rock. Structural fill for dry weather construction may contain on the order of 10 percent fines (that portion passing the U.S. No. 200 sieve) based on the portion passing the U.S. No. 4 sieve. Soil containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is greater than optimum.

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

Backfill and Compaction

Structural fill should be placed in horizontal lifts 8 to 10 inches in loose thickness and thoroughly compacted. All structural fill placed under load bearing areas should be compacted to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. The top of the compacted structural fill should extend outside all foundations and other structural improvements a minimum distance equal to the thickness of the fill beneath the foundation elements. We recommend that compaction be tested periodically during the placement of the fill pad, as applicable.

Wet Weather Earthwork

The onsite near surface native soils are moisture sensitive. It is our experience that moisture sensitive native and/or imported soil is particularly susceptible to degradation during wet weather. As a result, it may be difficult to control the moisture content of the site soils during the wet season. If construction is accomplished during wet weather, we recommend that structural fill consist of imported, clean, well-graded sand or sand and gravel as described above. If fill is to be placed or earthwork is to be performed in wet weather or under wet conditions, the contractor may reduce soil disturbance by:

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

Erosion Control

The following recommendations are intended to prevent excessive erosion from occurring during and after the construction phase of the project:

- All clearing and grading activities for the proposed development will need to incorporate Best Management Practices (BPMs) for erosion control in compliance with current San Juan County codes and standards. This report does not include an Erosion Control and Sediment Plan for the proposed development. This type of plan is typically prepared by a licensed civil engineer and goes beyond the scope of our geotechnical evaluation of the site.

- We recommend leaving as much of the existing vegetation both upslope and/or downslope of the proposed improvements as possible. Leaving the existing vegetation and planting additional brush and vegetation as soon as is reasonably possible on subject slopes or within disturbed areas will help maintain near surface slope stability by providing a stable root base within the near surface soils. Removal of vegetation and trees, without proper mitigation, may increase the risk of failure for the surficial soils during periods of wet weather.

- Proper drainage controls have a significant effect on reducing excessive erosion. Therefore, we recommend that drainage features include collection of all roof water, footing drain and any other drainage features. Discharge from these facilities should be directed into a suitable drainage system. All surface water and any collected drainage water should not be allowed to run down the face of site slopes or outlet onto or near the top of the site slopes.

- All areas disturbed by 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, or hydroseeded with an approved seed-mulch-fertilizer mixture. We recommend that appropriate silt fencing be incorporated into the construction plan for erosion control.

- Typically, subsurface conditions may result in the concentration of seepage within particular soil zones. Two zones of potential near surface seepage are anticipated: first, at the contact between the surficial fill/topsoil and the underling silty native soils and second, at the weathered/unweathered native contact above the dense glacial till horizon. To intercept seepage and to limit erosion on cut slopes and excavated areas that intercept groundwater seepage, it may be necessary to place gravel drainage material or other mitigation methods over the selected seepage zones. The need for drainage mitigation methods can best be determined during construction and will most likely require field fitting.

Based on observations made during our site visit and assuming that the above recommendations are incorporated into project construction, as well as appropriate maintenance being carried out for the life of the project, it is our opinion that it is possible to prevent significant erosion from occurring during site grading activities.

Seismic Design Considerations

The Pacific Northwest is seismically active and the site could be subject to ground shaking from a moderate to major earthquake. Consequently, moderate levels of earthquake shaking should be anticipated during the design life of the project, and the proposed residence structure should be designed to resist earthquake loading using appropriate design methodology. The general absence of saturated sand conditions below the site effectively precludes seismically induced soil liquefaction. In addition, due to the generally stable slope conditions, it is anticipated that the residence location would not be subject to seismically induced landslides, lateral spreading, or other ground failure. However, impacts from a large magnitude seismic event can be somewhat unpredictable.

Based on the seismic design provisions of the 2006 International Building Code, structures comprising support within the generally dense (glacial till) or a suitably prepared gravel pad should be designed for Site Class D, stiff soil profile, according to Site Class Definitions, Table 1613.5.2. The corresponding values for calculating a design response spectrum for the assumed soil profile type is considered appropriate for the site.

Foundation Support and Settlement

It should be anticipated that 1.5 to 4 feet of uncontrolled fill, loose/soft organic topsoil, relic topsoil and/or significantly weathered upper portions of the native soil may have to be removed to reach suitable bearing conditions at the project site.

Foundation support for the proposed improvements may be provided by continuous or isolated spread footings founded on:

- Proof-rolled, undisturbed, medium dense/dense, moist, gravelly, very silty sand (glacial till) or on properly compacted structural fill placed directly over suitably prepared undisturbed native soil. We recommend that qualified geotechnical personnel verify that suitable bearing conditions have been reached prior to placement of structural fill or foundation formwork.

To provide proper support, we recommend that all existing uncontrolled fill, topsoil and relic topsoil, and loose/soft, upper weathered portions of the native soil be removed from beneath the residence foundation area(s) or replaced with properly compacted structural fill as described above. In areas requiring overexcavation to competent native soil, the limits of the overexcavation should extend laterally beyond the edge of each side of the footing a distance equal to the depth of the excavation below the base of the footing.

In addition, we recommend that all foundation elements for the proposed residence bear entirely on similar soil conditions in order to help reduce the potential for differential settlement between varying foundation elements.

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

Allowable Bearing Capacity

Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings founded directly on the near surface native medium dense/dense, moist, gravelly, very silty sand (weathered glacial till) may be proportioned using a maximum net allowable soil bearing pressure of 2,000 pounds per square ft (psf). For foundations placed on imported granular structural fill placed directly over suitably prepared undisturbed native soils, a net allowable soil bearing pressure of 2,500 psf may be utilized in design.

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

Foundation Settlement

Settlement of shallow foundations depends on foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying soil. Assuming construction is accomplished as previously recommended and for the maximum allowable soil bearing pressure recommended above, we estimate the total settlement of residence foundations should be less than about one inch and differential settlement between two adjacent load-bearing components supported on competent soil should be less than about one half the total settlement. The soil response to applied stresses caused by building and other loads is expected to be predominantly elastic in nature, with most of the settlement occurring during construction as loads are applied.

Resistance to Lateral Loads

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

An allowable coefficient of base friction of 0.25 for undisturbed native soil and an allowable coefficient of base friction of 0.30 for import structural fill, applied to vertical dead loads only, may be used between the underlying soil and the base of the footing. However, if passive and frictional resistance are considered together, one half the recommended passive soil resistance value should be used since larger strains are required to mobilize the passive soil resistance as compared to frictional resistance. A safety factor of about 1.5 is included in the base friction design value. We do not recommend increasing the coefficient of friction to resist seismic or wind loads.

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

We recommend that yielding walls with level backfill under drained conditions be designed for an equivalent fluid density of 35 pounds per cubic ft (pcf) for structural backfill (pit run) in active soil conditions. Nonyielding walls with level backfill under drained conditions should be designed for an equivalent fluid density of 55 pcf for at-rest conditions. Design of subsurface walls should include appropriate lateral pressures caused by surcharge loads located within a horizontal distance equal to or less than the height of the wall. For uniform surcharge pressures, a uniformly distributed lateral pressure equal to 35 percent and 50 percent of the vertical surcharge pressure should be added to the lateral soil pressures for yielding and nonyielding walls, respectively.

Concrete Slabs-on-Grade

Conventional slab-on-grade floor construction is considered feasible for the planned site improvements. Floor slabs may be supported on properly prepared native subgrade or on properly placed and compacted structural fill placed over properly prepared native soil. Prior to placement of the structural fill, the native soil should be approved as recommended in the *Site Preparation and Earthwork* section of this report.

We recommend that interior concrete slab-on-grade floors be underlain by a minimum of 6 inches of compacted, clean, free-draining gravel with less than 5 percent passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The purpose of this layer is to provide uniform support for the slab, provide a capillary break, and act as a drainage layer. To help reduce the potential for water vapor migration through floor slabs, at a minimum a continuous impermeable membrane of 6- to 10-mil polyethylene sheeting with tape-sealed joints should be installed below the slab. The American Concrete Institute (ACI) guidelines suggest that the slab may either be poured directly on the vapor retarding membrane or on a granular curing layer placed over the vapor retarding membrane depending on conditions anticipated during construction. We recommend that the architect or structural engineer specify if a curing layer should be used. If moisture control within the building is critical, we recommend an inspection of the vapor retarding membrane to verify that all openings have been properly sealed. Use of waterproofing additives to the concrete and/or a thicker vapor barrier membrane can also be considered depending on the level of moisture protection desired.

Due to the location of the seasonal ravine within the upslope portion of the property located behind the residence, it may also be advisable to include design provisions for under-slab gravel drainage ditches that will help reduce the potential for ponded water to collect beneath the proposed residence location.

Exterior concrete slabs-on-grade, such as driveway slabs and/patios, may be supported directly on undisturbed native or on properly placed and compacted structural fill; however, long-term performance will be enhanced if exterior slabs are placed on a layer of clean, durable, well-draining granular material.

Foundation and Site Drainage

To reduce the potential for groundwater and surface water to seep into interior spaces we recommend that an exterior footing drain system be constructed at the applicable areas around the perimeter of new residence foundation as shown in the Typical Footing and Wall Drain Section, Figure 3. The drain should consist of a minimum 4-inch diameter perforated pipe, surrounded by a minimum 12 inches of filtering media with the discharge sloped to carry water to a suitable collection system. The filtering media may consist of open-graded drain rock wrapped by a nonwoven geotextile fabric (such as Mirafi 140N, Synthetic Industries 351, or equivalent) or a graded sand and gravel filter. The drainage backfill should be carried up the back of the foundation wall to within approximately 1 foot of the finished grade and contain less than 3 percent by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The invert of the footing drain pipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent floor slab grade, whichever is deeper, so that water will not seep through walls or floor slabs. The footing drain should discharge to an approved drain system and include cleanouts to allow periodic maintenance and inspection.

Positive surface gradients should be provided adjacent to the proposed residence to direct surface water away from the foundation and toward suitable drainage facilities. Roof drainage should not be introduced into the perimeter footing drains, but should be separately discharged directly to the stormwater collection system or other appropriate outlet. Pavement and sidewalk areas should be sloped and drainage gradients should be maintained to carry all surface water away from the structure towards the local stormwater collection system. Surface water should not be allowed to pond and soak into the ground surface near the structure or paved areas during or after construction. Construction excavations should be sloped to drain to sumps where water from seepage, rainfall, and runoff can be collected and pumped to a suitable discharge facility.

Based on our review of the upslope portions of the seasonal drainage ravine, it would appear that a significant portion of the runoff volume could be collected and diverted by improving the drainage collection at the main road culvert crossing located upslope of the residence location. Redirection and/or regrading of existing surface water runoff paths and roadside ditches could divert a significant portion of the seasonal runoff. If significant near surface seepage is encountered, installation of a French drain cut off trench could also be implemented into the drainage improvement design.

At the residence location, a suitable overland water runoff collection point, such as a concrete pond or other feature is recommended such that the seasonal runoff is suitably diverted into a stream channel or culvert system that directs the runoff around the residence location. We recommend that the designed collection and/or diversion system not be located beneath any portion of the residence and/or garage foundation elements in order to avoid long term maintenance and/or replacement conflicts.

Utilities

It is important that utility trenches be properly backfilled and compacted to minimize the possibility of cracking or localized loss of foundation, slab-on-grade or driveway support. It is anticipated that excavations for new underground utilities will be in medium dense slightly to very gravelly silty sand with significant cobbles and/or boulders (native soils).

Trench backfill in improved areas (beneath structures, slabs or driveway) should consist of structural fill as defined earlier in this report with all oversized cobbles and/or boulders removed. Outside of improved areas, trench backfill may consist of re-used onsite native fill. Trench backfill should be placed and compacted in accordance with the report section *Fill and Compaction*.

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

Temporary and Permanent Slopes

Actual construction slope configurations and maintenance of safe working conditions, including temporary excavation stability, shall be the responsibility of the contractor, who is able to monitor the construction activities and has direct control over the means and methods of construction. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored during and after excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring.

Temporary excavations in excess of 4 ft should be shored or sloped in accordance with Safety Standards for Construction Work Part N, WAC 296-155-657.

Temporary unsupported excavations in the generally medium dense native soils encountered at the project site are classified as a Type C soil according to WAC 296-155-657 and may be sloped as steep as 1½H:1V. All soils encountered are classified as Type C soil in the presence of groundwater seepage. Flatter slopes or temporary shoring may be required in areas where groundwater flow is present and unstable conditions develop.

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

We recommend that permanent cut or fill slopes be designed for inclinations of 2H:1V or flatter. All permanent cut slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction.

Landslide Hazard and Slope Stability

Based on the information gathered during our geotechnical evaluation, it is our opinion that geologically hazardous areas – specifically landslide hazard conditions are minimal above the proposed home site. No obvious signs of recent or historic instability or evidence of severe soil creep were observed on the property slope at the time of our evaluation. Due to the presence of relatively dense native glacial deposits observed and interpreted to underlie the near surface soil horizon at the site, a deep-seated rotational type failure affecting the proposed residence improvements appears unlikely to occur.

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 are head scarps, tension cracks, sag ponds, seepage zones, hummocky ground surface and slump blocks. Obvious visual indications of large scale slope instability, such as those referenced above, or signs of excessive soil creep, as indicated by excessive numbers or curvatures of pistol-butted tree trunks, were not observed within the subject property.

The occasional rock toppled boulder was observed within the upper slope portion of the property, however it is our opinion that the potential for an overland rolled boulder to reach the residence location is minimal provided the slope remains forested.

We recommend leaving as much of the existing vegetation on the slope as possible. Leaving the existing vegetation and planting additional brush and vegetation will help maintain near surface slope stability by providing a stable root base within the near surface soils. Removal of vegetation and trees, without proper mitigation, may increase the risk of failure for the surficial soils during periods of wet weather.

Surface water runoff should not be allowed to flow over the face of site slopes. To reduce the chance of initiating instability, drain water collected from impervious surfaces should be tightlined to a suitable discharge point located at the base of the site slope.

Due to the apparent global stability at the subject site and assuming the above mentioned recommendations are carried out for the life of the project, it is our opinion that large scale landslides are unlikely to occur which would affect the site of the proposed new residence construction.

Stormwater/Roof Downspout Runoff Control

We recommend that all roof downspout runoff and/or any other collected drainage water for the proposed residence and site development be either tightlined to the base of the shoreline slope, outlet into a suitable overland water course or discharged within a properly designed infiltration trench, dispersion trench and/or point discharge (splash block) location.

From the explorations excavated at the site, three representative soil samples were selected and mechanically tested for grain size distribution and interpretation according to the United States Department of Agriculture (USDA) soil textural classification. Subsurface infiltration rates corresponding to the United States Department of Agriculture (USDA) soil textural classification were obtained from the 2005 Washington

State Department of Ecology *Stormwater Management Manual for Western Washington*, Table 3.7, and are reproduced in Table 1 below.

TABLE 1
Test Pit Soil Sample Infiltration Rates
Based On The 2005 DOE Stormwater Management Manual Table 3.7

Test Pit Number	Sample Depth (ft)	Classification (USDA)	Geologic Unit	Infiltration Rate (Inches/Hour)
TP-1	4.5	Sandy Loam	Glacial Till	0.25
TP-2	2	Sandy Loam	Glacial Till	0.25
TP-3	4	Sand	Local Alluvium	2

Note: Listed infiltration rates are long term (design) rates as stated in Table 3.7.

Based on the USDA textural classifications above and our interpretations of our soil logs, we recommend a long-term design infiltration rate of 2 inches per hour be utilized for preliminary stormwater design purposes within the area of test pit TP-3. Although an infiltration rate of 0.25 can be obtained by sieve correlation of the glacial till unit, it is our experience that the glacial till unit will perch groundwater and the actual infiltration rate of glacial till is much slower in the in-situ condition. Accordingly, a small infiltration trench and/or drywell appears feasible within the area of test pit TP-3, however dispersion trenches, splash blocks and/or other direct discharge methods should be utilized within the other planned stormwater discharge locations around the proposed new residence.

Geotechnical Consultation and Construction Monitoring

GeoTest Services recommends that we be allowed to review the earthwork and foundation portions of the design drawings and specifications prior to the start of construction. The purpose of the review is to verify that the recommendations presented in this report have been properly interpreted and incorporated in the final design and specifications.

We recommend that geotechnical construction monitoring services be provided. These services should include observation by GeoTest personnel during, foundation element construction, applicable fill placement/compaction activities and subgrade preparation operations to verify that design conditions are obtained beneath the proposed residence improvements. We also recommend that periodic field density testing be performed, where applicable, to verify that the appropriate degree of compaction is obtained. The purpose of these services would be to observe compliance with the design concepts, specifications, and recommendations of this report, and in the event subsurface conditions differ from those anticipated before the start of construction, provide revised recommendations appropriate to the conditions revealed during construction. GeoTest Services would be pleased to provide these services for you.

GeoTest Services is also available to provide a full range of materials testing and special inspection during construction as required by the local building department and the International Building Code. This may include specific construction inspections on materials such as reinforced concrete, structural steel and other aspects of the planned

construction. These services are supported by our fully accredited materials testing laboratory.

USE OF THIS REPORT

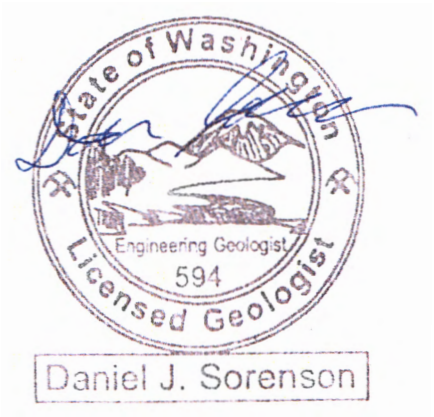
GeoTest Services has prepared this report for the exclusive use of Jon Runstad and his design consultants for specific application to the design of the proposed "Beach House" residence to be located on the proposed 10.62 acre parcel A within the Runstad – Whaleback Estate on Blakely Island, Washington. Use of this report by others is at the user's sole risk. This report is not applicable to other sites. Our services have been conducted in accordance with generally accepted practices of the geotechnical engineering profession; no other warranty, either 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 they are representative of subsurface conditions at other locations and times. The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth of our explorations at the time of our exploration program, a brief geological reconnaissance of the area, and review of published geological information for the site. We assume that the explorations are representative of the subsurface conditions throughout the site during the preparation of our recommendations. If variations in subsurface conditions are encountered during construction, we should be notified for review of the recommendations of this report, and revision of such if necessary. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

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

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

Respectfully Submitted,
GeoTest Services, Inc.



Dan Sorenson, L.E.G.
Engineering Geologist

Dong-Soo Lee, P.E.
Geotechnical Engineer

Attachments:	Figure 1	Site Vicinity Map
	Figure 2	Site and Exploration Plan
	Figure 3	Typical Footing and Wall Drain Section
	Appendix A	Field Explorations and Laboratory Testing

References:

Washington State Department of Natural Resources, Accessed May 2009. Washington Interactive Geologic Map, Division of Geology and Earth Resources – Washington's Geological Survey.

Soil Survey website, Skagit County Area, WA, prepared by the USDA National Resource Conservation Service. http://www.or.nrcs.usda.gov/pnw_soil/wa_reports.html.

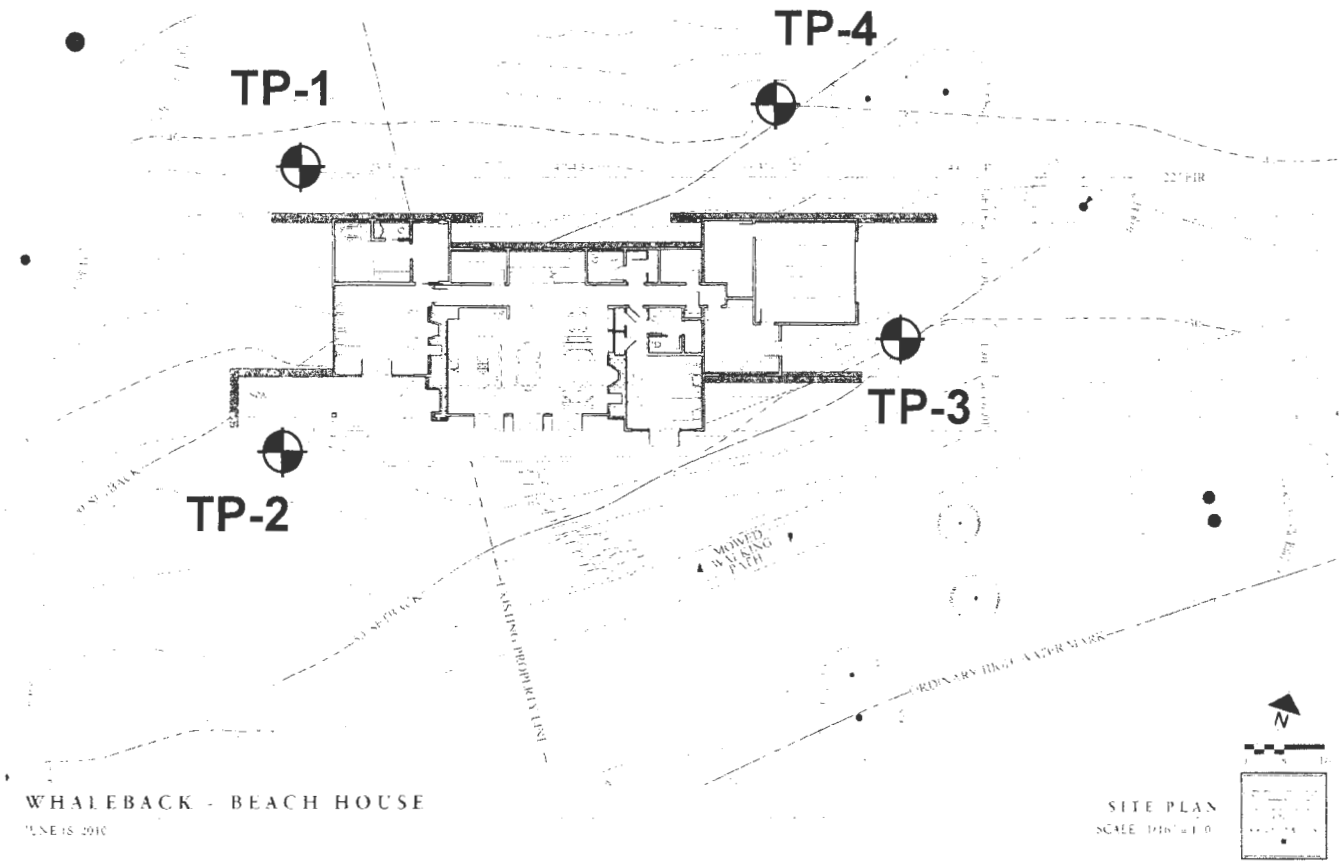
Reference Map Provided By
Google Earth

PROJECT LOCATION

NORTH

GEOTEST SERVICES, INC.
741 Marine Drive
Bellingham, WA 98225
phone: (360) 733-7318
fax: (360) 733-7418

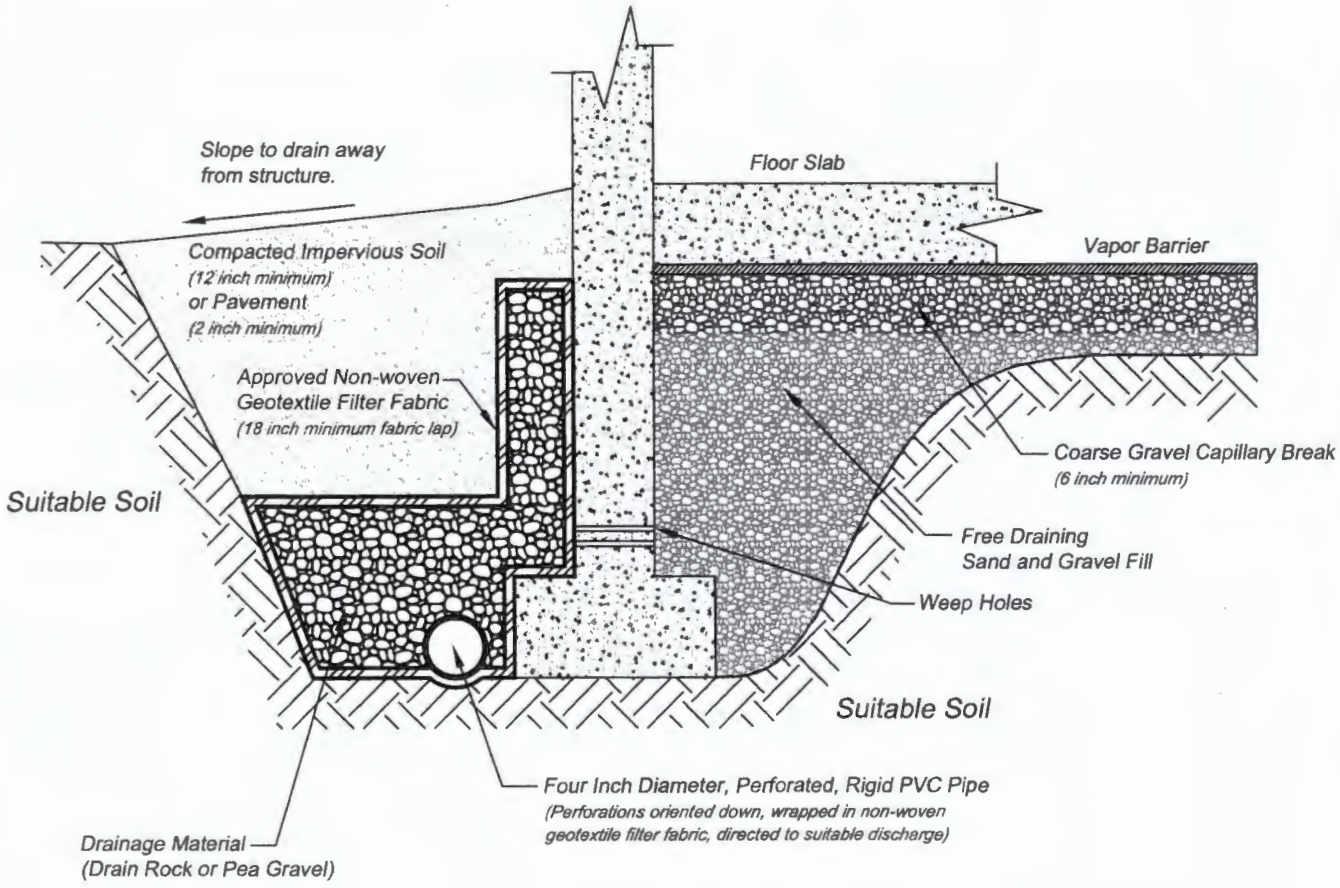
Date: 8-17-10	By: DS	Scale: NONE	Project
SITE VICINITY MAP **BEACH HOUSE LOCATION** **RUNSTAD - WALEBACK ESTATE** **BLAKELY ISLAND, WASHINGTON**			10-0351
			Figure 1



GEOTEST SERVICES, INC.
741 Marine Drive
Bellingham, WA 98225
phone: (360) 733-7318
fax: (360) 733-7418

Date: 8-17-10	By: DS	Scale: As Shown	Project
SITE AND EXPLORATION PLAN **BEACH HOUSE LOCATION** **RUNSTAD - WALEBACK ESTATE** **BLAKELY ISLAND, WASHINGTON**			**10-0351** Figure **2**

SHALLOW FOOTINGS WITH INTERIOR SLAB-ON-GRADE



Notes:
Footings should be properly buried for frost protection in accordance with International Building Code or local building codes.
(Typically 18 inches below exterior finished grades)

GEOTEST SERVICES, INC. 741 Marine Drive Bellingham, WA 98225 Phone: (360) 733-7318 Fax: (360) 733-7418	Date: 8-17-10	By: DS	Scale: NONE	Project **10-0351**
	TYPICAL FOOTING & WALL DRAIN SECTION **Beach House Location** **Runstad - Waleback Estate** **Blakely Island, Washington**			Figure **3**

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Subsurface conditions at the site were explored on July 1, 2010. The exploration program consisted of excavating 4 test pits (TP-1 through TP-4) at the approximate locations illustrated on the Site and Exploration Plan, Figure 2 of this report. The test pits were advanced with a tractor mounted backhoe to depths ranging between 2 and 5.5 feet below the existing ground surface. The backhoe was supplied by the owner. The explorations were located in the field by taping from existing property features shown the referenced plan. Exploration locations should be considered accurate to the degree implied by the methods used.

The field explorations were coordinated and monitored by an engineering geologist from our staff who obtained representative soil samples, maintained a detailed record of observed subsurface soil and groundwater conditions, and described the soil encountered by visual and textural examination. Each representative soil type observed was described using the soil classification system shown on Figure A-1, in general accordance with ASTM D 2488, *Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)*. Logs of the test pit explorations are presented on Figures A-2 and A-3. These logs represent our interpretation of subsurface conditions identified during the field explorations. The stratigraphic contacts shown on the individual test pit logs represent the approximate boundaries between soil types; actual transitions may be more gradual. Also, the soil and groundwater conditions depicted are only for the specific date and locations reported, and therefore, are not necessarily representative of other locations and times.

Representative soil samples encountered in the test pit explorations were obtained at selected intervals, placed in sealed plastic bags, and transported to our laboratory for further classification and testing. Laboratory tests were performed on representative soil samples to characterize certain physical properties of the site soil. The laboratory testing program was limited to visual inspection to confirm field soil descriptions, determination of natural moisture content and soil grain size distribution.

The natural moisture contents of selected soil samples were determined in general accordance with ASTM D 2216 test procedures. The results from the moisture determinations are indicated on the summary logs, adjacent to the corresponding samples. Grain size analyses of selected soil samples were conducted in general accordance with ASTM D 422 test procedures. The results are presented in the form of grain size distribution curves on Figure A-4.

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

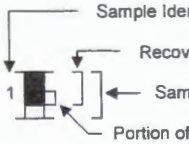
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

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

Beach House
Runstad - Whaleback Estate
Blakely Island, Washington

Soil Classification System and Key

Figure A-1

8/17/10 X:\0-PROJECTS GEO\00000-PROJECTS 2010-GEO\FULL GEO EVALUATIONS\RUNSTAD RESIDENCES - 10-0351 - BLAKELY ISLAND\RUNSTAD RESIDENCES - 10-0351- BLAKELY ISLAND.GPJ SOIL CLASS SHEET

TP-1

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Determined
0					CL	Soft, brown gray, wet, sandy, CLAY (Uncontrolled Fill)
	1	d	W = 37		OL	Soft, dark brown, moist, organic, SILT / SILTY SAND (Relic Topsoil)
2					CL	Medium stiff, gray, moist, sandy, CLAY (Apparent Glacial Drift)
4					SM	Dense, brown, damp, gravelly, very silty, SAND (Glacial Till) with cobbles and boulders
	2	d	W = 11 GS			
6						

Slight groundwater seepage encountered at 1.5 ft.

Slight groundwater seepage encountered at 3.5 ft.

Test Pit Completed 07/01/10
Total Depth of Test Pit = 5.0 ft.

TP-2

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Determined
0					OL	Soft, dark brown, moist, organic, sandy, CLAY (Topsoil)
					SM	Medium dense, brown and gray, damp, gravelly, very silty, SAND (Weathered Glacial Till) with significant cobbles and boulders
2	3	d	W = 10 GS			Difficult digging due to boulders
4						
6						

Groundwater not encountered.

Test Pit Completed 07/01/10
Total Depth of Test Pit = 4.0 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	Beach House Runstad - Whaleback Estate Blakely Island, Washington	Log of Test Pits	Figure A-2

10-0351 8/17/10 X:\0-PROJECTS GEO\00000-PROJECTS 2010-GEO\FULL GEO EVALUATIONS\RUNSTAD RESIDENCES - 10-0351 - BLAKELY ISLAND\RUNSTAD RESIDENCES - 10-0351- BLAKELY ISLAND.GPJ TEST PIT LOG

10-0351 8/17/10 X:\0-PROJECTS GEO\00000-PROJECTS 2010-GEO\FULL GEO EVALUATIONS\RUNSTAD RESIDENCES - 10-0351 - BLAKELY ISLAND\RUNSTAD RESIDENCES - 10-0351 - BLAKELY ISLAND.GPJ TEST PIT LOG

TP-3

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Determined	
0					OL	Soft, dark brown, moist, organic, sandy, CLAY (Topsoil)	Groundwater not encountered.
					SM	Loose to medium dense, red-brown, damp, silty SAND (Weathered Alluvial Horizon)	
					SP-SM	Medium dense, brown and gray, damp, slightly silty, gravelly SAND (Apparent Local Alluvial Deposit) with gravel and cobbles	
2							
4	4	d	W = 8 GS				
6							

Test Pit Completed 07/01/10
Total Depth of Test Pit = 5.5 ft.

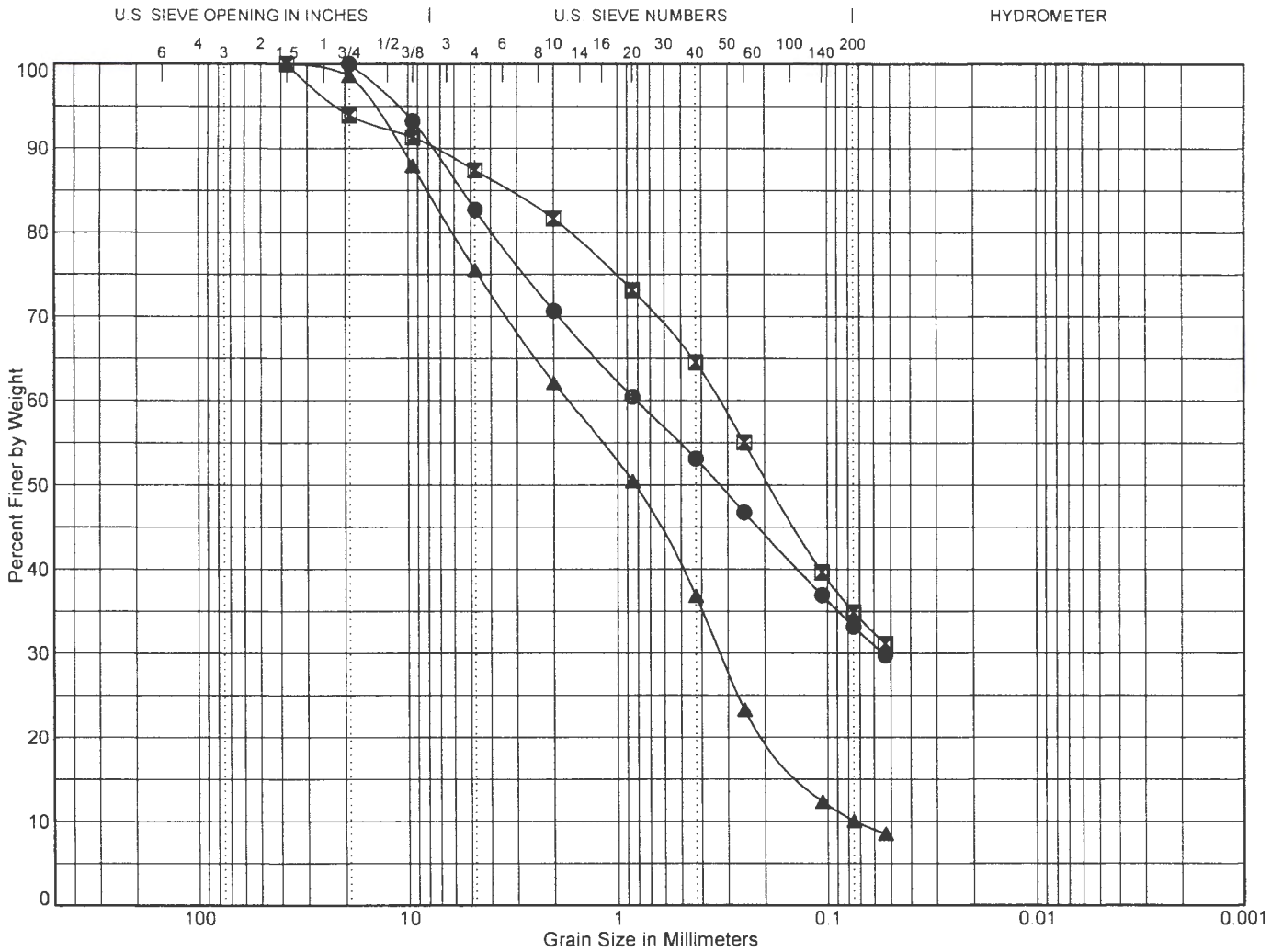
TP-4

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not Determined	
0					SM	Medium dense, light brown, damp, gravelly, very silty, SAND (Glacial Till) with cobbles and boulders	Groundwater not encountered.
2						Test pit terminated at 2 feet BGS due to boulders	
4							
6							

Test Pit Completed 07/01/10
Total Depth of Test Pit = 2.0 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	Beach House Runstad - Whaleback Estate Blakely Island, Washington	Log of Test Pits	Figure A-3



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Point	Depth	Classification	LL	PL	PI	C_c	C_u
●	TP-1	4.5	Gravelly, very silty, fine to coarse SAND (SM)					
⊠	TP-2	2.0	Gravelly, very silty, fine to coarse SAND (SM)					
▲	TP-3	4.0	Slightly silty, gravelly, fine to coarse SAND (SP-SM)				0.84	23.20

	Point	Depth	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	TP-1	4.5	19	0.815	0.328	0.054		0.0	17.3	12.1	17.5	20.0	33.2
⊠	TP-2	2.0	37.5	0.33	0.189			6.1	6.5	5.7	17.1	29.6	34.9
▲	TP-3	4.0	37.5	1.716	0.83	0.326	0.074	1.4	23.1	13.4	25.3	26.7	10.1

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

$C_u = D_{60}/D_{10}$

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

GEOTEST

Runstad Residences
Runstad Estate
Blakely Island, Washington

Grain Size Test Data

Figure
A-4

10 0351 7/19/10 X:\0-PROJECTS GEO\0000-PROJECTS 2010-GEO\FULL GEO EVALUATIONS\RUNSTAD RESIDENCES - 10-0351 - BLAKELY ISLAND\RUNSTAD RESIDENCES - 10-0351- BLAKELY ISLAND GPJ GRAIN SIZE WSTATS