GEOTECHNICAL ENGINEERING SERVICES REPORT
PROPOSED RESIDENCE
6840 SW CEDAR FLATS ROAD (PARCEL NO. 1382302020)
OLYMPIA, WASHINGTON

AUGUST 30, 2005

FOR
BRUCE DAVIES

GEOENGINEERS

Resource Stewardship & Land Use

File No. 12221-001-00

Geotechnical Engineering Services
File No. 12221-001-00

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GEOTECHNICAL ENGINEERING SERVICES REPORT
PROPOSED RESIDENCE
6840 SW CEDAR FLATS ROAD (PARCEL NO. 1382302020)
OLYMPIA, WASHINGTON
FOR
BRUCE DAVIES

INTRODUCTION

We are pleased to submit this geotechnical report for a proposed residence to be located at 6840 SW Cedar Flats Road in the Olympia area of Thurston County, Washington. The approximate site location is shown on the Vicinity Map, Figure 1. The general layout of the site is shown on the Site Plan, Figure 2, based on a topographic survey provided by you. The proposed building location has yet to be determined and partially awaits the findings of this study. The property is within an unincorporated area of Thurston County, west of the City limits of Olympia.

We understand that current development plans call for a single-family residence to be located in the area of an existing graded pad in the central portion of the property (Figure 2). It is our understanding that this grading took place prior to your purchase. Based on discussions with you, it is our understanding that you plan to construct a two-story residence in the central portion of the above pad and that the footprint is planned to be approximately 25 feet by 35 feet, with a proposed 20-foot setback from the top of the easterly descending slope at the east edge of the pad. You indicated a preference for either a walk-out basement (in addition to the two stories at and above grade) with a conventional perimeter foundation, or drilled piers for a two-story residence at grade. We have presented recommendations concerning these and other options for development of this building pad area.

PURPOSE AND SCOPE

The purpose of our services is to explore the subsurface conditions at the site as a basis for satisfying Thurston County's permitting requirements as they relate to landslide and erosion hazards and providing geotechnical design recommendations for the proposed improvements. The specific services completed for this project include:

1. Reviewing selected published geologic and soil maps contained in our library.
2. Researching and reviewing selected available historic aerial photographs of the area to evaluate the presence or absence of landslides in the proposed building area.
3. Locating and coordinating clearance of existing utilities.
4. Exploring subsurface conditions by excavating seven test pits in the area of the proposed structure to depths ranging between 4 and 12 feet below existing site grade using a subcontracted backhoe.
5. Performing laboratory testing on selected soil samples obtained from the explorations.
6. Providing a discussion of the subsurface soils encountered, including depth, composition and supporting capacity of existing fill.
7. Preparing a geologic map and cross section based on the survey you provided.
8. Analyzing the stability of existing slopes in the proposed building area.

9. Providing recommendations for site preparation and earthwork, including clearing and stripping, temporary and permanent cut slopes, suitability of on-site soils for use as structural fill, including constraints for wet weather construction, specifications for imported soil for use as structural fill, and fill placement and compaction requirements.

10. Providing recommendations for shallow foundations, including allowable soil bearing pressures, settlement (total and differential) estimates, lateral earth pressures and coefficient of friction for evaluating sliding resistance.

11. Providing alternative recommendations for pier foundations to support the structure, subject to the depth, strength and stability of existing fill and native materials encountered.

12. Providing recommendations for support of on-grade floor slabs, including capillary break, vapor retarder, underslab drainage, and modulus of subgrade reaction, as appropriate.

13. Providing recommendations for design of below grade and retaining walls, including lateral earth pressures and coefficient of friction. In addition, we have provided allowable soil bearing pressures and subgrade preparation recommendations.

14. Discussing seismic considerations, including seismic design criteria consistent with the 1997 Uniform Building Code and/or 2003 International Building Code and our opinion of the liquefaction potential of site soils.

15. Providing recommendation for slough and/or impact wall(s) as may be appropriate.

16. Providing recommendations for site drainage and control of groundwater that may be encountered.

17. Commenting on anticipated construction difficulties identified from the results of our site studies, if applicable.

18. Preparing a written report for the project, presenting our conclusions and recommendations together with supporting field and laboratory information for incorporation into design of the project.

SITE CONDITIONS

GENERAL

The subject property is an approximately triangular-shaped parcel, comprising approximately 11.5 acres in hilly terrain. It is bordered on the north by Maple Valley Road, on the south by Cedar Flats Road and on the east and west by rural residential properties. A power line easement traverses the southern portion of the property. A dirt road traverses the property in a roughly north/south direction, extending from Cedar Flats Road, north to Maple Valley Road. The proposed building site is approximately mid-way along this dirt road, north of the power line easement.

SURFACE CONDITIONS

The proposed building site area consists of a widened portion of the existing dirt road in the central portion of the property. The road contours across the easterly flank of a bedrock (basalt) spur ridge in the northeastern portion of the Black Hills. The widened section of road appears to have been created by cutting and filling. The cut portion appears to have modified an existing swale on the easterly ridge flank and the fill portion likely includes material generated from cuts to the north and south along the dirt road alignment.

An existing cut slope is present to the west of the existing pad area. It is approximately 30 feet high at its maximum height (per the survey by Prizm Surveying, Inc., dated April 7, 2005) and is inclined down to the east at an approximate gradient of 1.3H:1V (horizontal:vertical). The cut slope exposes volcanic bedrock. Upgradient of the cut slope to the west, a natural bedrock slope continues upward at a gradient of approximately 1.5H:1V to a ridge crest to the west.

A fill slope (Figure 3) descends from the east edge of the subject pad and is approximately 32 feet high (per the survey by Prizm Surveying, Inc., dated April 7, 2005) with an approximate gradient of 1.7H:1V. Beyond the toe of the fill slope, an apparently natural wooded slope descends to the east at an approximate gradient of 3H:1V. The extent to which imported soil may have been used for the fill is unknown at this time. The fill appears to have been placed primarily by spreading and depositing over the original ground surface rather than by keying and benching from the toe. This is indicated by several trees that have been partially surrounded by the fill and by an inclined organic-rich layer encountered at the fill/bedrock contact in the test pits. Drainage on the property is generally by sheet flow to the east and northeast.

The subject property is largely wooded, except for the power line easement and the existing dirt road. A well and pump house are located at the northern end of the property and the owner has recently installed an on-site sewage disposal system in the northern portion of the property.

SOIL CONDITIONS

Published Geology

The subject property is located on the northeast flank of a southeasterly descending bedrock spur ridge in the northeastern section of the Black Hills in Thurston County, Washington. The bedrock underlying the property has been assigned to the Crescent Formation basalt (Evc) of lower to middle Eocene age on a published geologic map of the Summit Lake Quadrangle by the Washington Division of Geology and Earth Resources (Logan and Walsh, 2004). North of the proposed building area, the above map shows a contact between basalt and glacial till (Qgt) of the latest stade of glaciation (Vashon) in the region. We did not encounter till in the proposed building area, but, at the scale of the map, it is likely present on site to the north and possibly to the east of the building area. Figure 4 is a regional geologic map based on data provided by the Washington State Department of Ecology (Ecology). It also shows the project area as being underlain by Crescent formation basalt. It shows the till contact as being farther down the slope, in the vicinity of Maple Valley Road. A contact with "Continental glacial outwash, Fraser-age" is shown along the north side of the power line easement, south of the project area.

Topographically, the proposed building area appears to occupy a natural easterly descending swale in the ridge flank. Review of selected available public domain LIDAR shows the fill pad as occupying the central portion of this swale. Review of the LIDAR and selected available historic aerial photographs at Walker and Associates, Inc., did not reveal evidence of landslides in the proposed building area.

Published Soil Conditions

A soil survey of Thurston County by the Soil Conservation Service (SCS) (June, 1990) maps the proposed building area as being underlain by Schneider very gravelly loam, 20 to 40 percent and 40 to 65 percent slopes, respectively (Figure 5). These soils reportedly formed in colluvium derived from basalt, consist primarily of very gravelly loam and silt loam underlain by basalt at 40 to 60 inches, have moderate permeability, low shrink-swell potential and a slight to moderate erosion hazard.

Subsurface Explorations

Subsurface soil conditions were evaluated by excavating seven test pits on June 10, 2005. The test pit explorations were advanced to depths ranging from approximately 4 feet to 12 feet below ground surface (bgs). The approximate locations of the explorations are shown on the Site Plan (Figure 2). The locations of the test pits were determined in the field by taping from existing site features. The exploration locations shown on the Site Plan should be considered accurate to the degree implied by our locating methods. The test pits excavated for our exploration were backfilled after our observations were recorded.

Our representative continuously monitored the test pits during excavation; maintained a log of the subsurface conditions; visually classified the soils encountered; and obtained representative soil samples as needed. Soils were visually classified in the field in general accordance with our Key to Exploration Logs (Figure 6). Logs of the test pits are presented as Figures 7 through 13.

Test pit explorations were selected as they allow continuous logging and sampling of the soil strata and evaluation of groundwater conditions with depth. Test pits are typically 8 to 12 feet in length and provide a continuous exposure of near-surface soil conditions. Based on our understanding of the intended development of the site, it is our opinion that sufficient exploratory depths were attained using test pits and that the use of exploratory borings is not warranted. However, depending on the chosen design alternative and final building location, additional field work may be necessary.

Observed Soil Conditions

A brief description of the soils encountered in our explorations is provided below and more detailed information regarding subsurface soil conditions is included on the test pits logs, Figures 7 through 13 of this report.

- **Fill:** We encountered fill that generally consists of red-brown gravel, gravel with silt, silt, sandy silt and silty sand. The fill in the test pits typically ranged from soft to medium stiff or loose to medium dense. Bark, roots and branches were encountered in the lower portion of the fill in Test Pit 4, indicating vegetation was not stripped prior to fill placement. The maximum depth of fill encountered was 9 feet in Test Pit 4. Deeper areas of fill may be encountered locally.
- **Basalt:** We encountered red-black basalt bedrock in all of the test pits. It is generally in a weathered condition to the depth explored.

In general, the soils encountered in our explorations confirm the mapped stratigraphy.

Observed Groundwater Conditions

No groundwater was encountered or observed within the test pit excavations. The subject property is located on a bedrock ridge flank above a glaciated valley. The site is serviced by an on-site well, located downgradient to the north of the building site. We expect that groundwater levels will fluctuate in response to seasonal changes in precipitation and other factors.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

On this site, the settlement and/or potential instability of the existing fill is a concern. The existing fill appears to have been placed without keying and benching. In addition, it is our opinion that the amount of total and differential settlement of the fill could be detrimental to a shallow foundation system. We recommend the fill slope be regraded to a 2H:1V slope (by cutting or filling) and including a toe buttress at the bottom. In general, the westerly ascending cut and natural slopes in the dense basalt bedrock appear to be relatively stable. However, we recommend a setback from the westerly ascending cut and natural slope because of the potential for surficial sloughing.

As we discussed with you on July 19, 2005, there are several options to support the proposed structure. These include replacing the existing fill with structural fill and using conventional foundations bearing in the structural fill; constructing a basement founded on conventional foundations and bearing in competent basalt bedrock; and a drilled pier foundation support system that must extend through the existing fill and bear in the competent basalt bedrock. We understand that you wish to pursue one of these options. In our opinion, the basement option appears preferable from a geotechnical standpoint because it reduces the slope height and derives support from the basalt bedrock. We have discussed each in more detail below.

It is our understanding that the proposed residential structure will be approximately centered on the existing pad. Soil encountered in the explorations completed typically contains a significant percentage of fines. This material is very sensitive to small changes in moisture content. These soils may be difficult, if not impossible, to work and compact during wet weather conditions. Soil with high fines content is susceptible to disturbance from construction traffic when wet or if earthwork is performed during wet weather. Construction of this area during extended periods of dry weather could reduce the additional costs associated with removal and replacement of wet or disturbed soil.

SLOPE STABILITY

Our review and subsurface investigation indicates that the existing fill was placed without adequate keying and benching or adequate subsurface drainage provisions. Organic material observed near the fill/native contact suggests the presence of a buried topsoil layer that may be present locally at the base of the fill that was not adequately stripped during clearing and grubbing or removed by benching and fill placement. In our opinion, the existing fill is unsuitable for foundation support and that the easterly descending fill slope is marginally stable, requiring regrading and/or buttressing.

SETBACKS

It is our understanding that the preliminary location of the proposed structure will be approximately centered on the existing pad and will be set back approximately 20 feet from the top of the existing easterly descending fill slope. We recommend we be consulted to provide a recommended minimum setback from slopes on the project once a foundation option has been selected. Preliminarily, we recommend a setback from the toe of the cut slope of between 10 and 20 feet and a setback from the existing top of the easterly descending fill slope of 20 feet (provided the building is adequately founded in the dense black basalt and the remaining fill slope is adequately buttressed).

SHALLOW FOUNDATIONS

General

In general, conventional shallow foundations may be utilized to support the residence if the existing fill is removed and replaced with structural fill or if excavation for a basement removes the fill and extends to the basalt. We recommend that for shallow foundations, support should be derived either entirely from native bedrock or entirely from controlled structural fill placed on bedrock. In either case, the remaining fill slope should be regraded to 2H:1V and include a toe buttress.

Foundation Bearing Surface Preparation

Residence Without Basement

The existing fill should be removed and replaced as structural fill in accordance with the recommendations presented in the "Site Development and Earthwork" section of this report. Following preparation of the subgrade, footing excavations made in structural fill should be conducted using equipment with a smooth-edged bucket to limit disturbance. We recommend that a member from our firm observe foundation excavations before placing reinforcing steel in order to confirm that adequate bearing surfaces have been prepared or provide recommendations for removal of unsuitable soil. In general, unsuitable foundation subgrade soils should be removed to firm material, recompacted or removed and replaced with compacted structural fill as recommended by the geotechnical engineer.

Residence With Basement

Based on discussions with you, it is our understanding that you may wish to construct a walk-out basement in lieu of replacing the existing fill with structural fill. As you indicated, a basement would be in addition to the two-story structure proposed. In our opinion, this may be the preferred option from a geotechnical standpoint because it reduces the height of the fill slope and derives support for the structure directly from the dense black basalt bedrock.

The basement foundations should be embedded in the competent black basalt bedrock, which we typically encountered 7 to 9 feet below existing pad grade in the eastern portion of the pad (deeper fill pockets may be encountered). The basement floor elevation is anticipated to be approximately 8 to 10 feet below existing exterior grades. The basement walls should be supported on perimeter strip footings and constructed with formed concrete. All foundations should be extended into competent black basalt bedrock beneath the existing fill. As an alternative, in order to establish a uniform foundation grade elevation, you may consider placing structural fill to establish foundation grade after all existing fill has been removed to expose firm native material. In this case, the removal of existing fill must extend horizontally beyond the footing perimeter a distance equal to the overexcavation depth below foundation grade or 3 feet, whichever is less.

Retaining walls for the basement should backfilled in accordance the recommendations presented in the "Conventional Subgrade and Retaining Walls" section of this report.

Minimum Footing Size and Depth

The exterior footings should be established at least 18 inches below the lowest adjacent grade. The recommended minimum footing depth is greater than the anticipated frost depth. Interior footings can be founded a minimum of 12 inches below the top of the floor slab. Isolated column and continuous wall footings should have minimum widths of 24 and 18 inches, respectively.

Bearing Capacity

For foundation subgrades prepared as recommended, footings may be proportioned using an allowable soil bearing pressure of 3,500 pounds per square foot (psf), for either native bedrock or controlled structural fill. This bearing pressure should be applied to the total of dead and long-term live loads and may be increased by one third when considering total loads, including earthquake or wind loads. This is a net bearing pressure, the weight of the footing and overlying backfill can be ignored in calculating footing sizes.

Foundation Settlement

Provided that foundation bearing surfaces are prepared as recommended, we estimate that settlement of footings designed and constructed as recommended will be less than 1 inch, for column loads up to about 150 kips or wall loads up to about 4 kips per lineal foot. Differential settlements between comparably loaded isolated column footings or along 50 feet of continuous footing should be less than 1/2 inch. Settlement is expected to occur rapidly as loads are applied. Settlements could be larger than estimated if footings are placed on loose or disturbed bearing material.

Lateral Resistance

The ability of the soil to resist lateral loads is a function of frictional resistance, which can develop on the base of footings and slabs, and the passive resistance, which can develop on the face of below-grade elements of the structure as these elements tend to move into the soil. For footings founded in accordance with the recommendations presented above, the allowable frictional resistance may be computed using a coefficient of friction of 0.35 applied to vertical dead-load forces. The allowable passive resistance on the face of footings, grade beams or other embedded foundation elements may be computed using an equivalent fluid density of 225 pounds per cubic foot (pcf) for on-site soil. An equivalent fluid density of 300 pcf may be used if structural fill is extended out from the face of the foundation element a distance at least equal to two and one half times the depth of the element. The passive earth pressuresand friction components may be combined provided that the passive component does not exceed two thirds of the total. The passive earth pressure value is based on the assumptions that the adjacent grade is level and that groundwater remains below the base of the footing throughout the year. The top foot of soil should be neglected when calculating passive lateral earth pressures unless the foundation area is covered with pavement or slab-on-grade. The lateral resistance values include a safety factor of approximately 1.5.

CONVENTIONAL DRILLED PIERS

Conventional drilled piers are constructed by drilling to the specified bearing layer (black basalt), installing reinforcing steel and placing concrete. Casing may be necessary during drilling to maintain the hole diameter and control soil sloughing. An allowable bearing pressure of 10 kips per square foot (ksf) may be used for preliminary design of an individual 24-inch-diameter pier provided that the pier is founded on the competent black basalt bedrock. Piers must not terminate in the weathered bedrock/soil material. This allowable capacity may be increased by one third for seismic loading conditions.

If a drilled pier foundation system is chosen, we should be consulted to provide additional information and review plans and specifications. In addition, it will be necessary to consult a structural engineer to determine structural characteristics of the pier and to assist with grade beam design. Because piers will have to be founded on bedrock, it is possible that they may vary in length. We recommend that a contingency in the project budget be considered if a pier foundation system is used should changes in length and design become necessary during construction.

We considered the settlement potential for the foundation support system discussed above. We estimate that the total post-construction settlement of individual augercast piles should be less than 1/2 inch. Differential settlement between adjacent comparably loaded piles should be less than 1/4 inch. We expect most of the settlements to occur as loads are applied.

SUBGRADE AND RETAINING WALLS

Drainage

Positive drainage is imperative behind any retaining structure. This can be accomplished by using a drainage zone of free-draining material behind the wall with perforated pipes to discharge the collected water. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines based on the fraction of material passing the 3/4-inch sieve. The wall drainage zone should extend horizontally at least 18 inches from the back of the wall.

A perforated smooth-walled rigid PVC pipe having a minimum diameter of 4 inches should be placed at the bottom of the drainage zone along the entire length of the wall, with the pipe invert at or below the elevation of the base of the wall footing. The drainpipes should discharge to a tightline leading to an appropriate collection and disposal system. An adequate number of cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance. Roof downspouts, perimeter drains or other types of drainage systems should not be connected to retaining wall drain systems.

Design Parameters

Our recommended lateral earth pressures for design assume that backfill placed within 2 feet of the wall is compacted by hand-operated equipment to a density of 90 percent of the maximum dry density (MDD) and that wall drainage measures are included as previously recommended. For walls constructed as described above, we recommend using an active lateral earth pressure corresponding to an equivalent fluid density of 35 pcf for a level backfill condition. For walls with backfill sloping upward behind the wall at 2H:1V, an equivalent fluid density of 50 pcf should be used. This assumes that the tops of the walls are not structurally restrained and are free to rotate. For the at-rest condition, an equivalent fluid density of 55 pcf should be used for design for the level backfill condition. For seismic conditions, we recommend a uniform lateral pressure of 5H (where H is the height of the wall) psf be added to these lateral pressures. The recommended pressures do not include the effects of surcharges from surface loads.

If vehicles will be operated within one half the height of the wall, a traffic surcharge should be added to the wall pressure. The traffic surcharge can be approximated by the equivalent weight of an additional 2 feet of backfill behind the wall.

Retaining walls should be founded on competent native bedrock or structural fill as recommended above in the "Shallow Foundations" section of this report. For this condition, the allowable soil bearing values and lateral resistance values presented above in the "Shallow Foundations" section of this report may be used for design of conventional retaining structures provided that foundation subgrades are prepared as recommended. We estimate settlement of retaining structures should be similar to the values previously presented for building footings.

BUILDING PADS AND FLOOR SLABS

In general, on-grade building slabs should derive their support from structural fill underlain by native bedrock. Alternatively, a structural slab may be used and should be supported on a pier foundation system founded in the native bedrock.

On-grade building slabs should be underlain by a minimum of 2 feet of imported granular fill consisting of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and containing less than 5 percent fines, by weight, based on the minus 3/4-inch fraction. Organic matter, debris or other deleterious material should not be present. The material should be placed as recommended in the "Fill Placement and Compaction" section of this report. If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to the slab), a waterproof liner may be placed as a vapor barrier below the slab. A 2-inch thickness of clean sand can be placed over the vapor barrier to protect the liner and serve as a leveling course.

Provided that the slab subgrade is prepared as recommended, a modulus of subgrade reaction of 300 pounds per cubic inch (pci) can be used for designing an on-grade building floor slab.

SEISMIC CONSIDERATIONS

Seismicity

The Western Washington region is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca, and North American plates. The Juan de Fuca plate is subducting beneath the North American plate. It is thought that the resulting deformation and breakup of the Juan de Fuca plate might account for the deep focus earthquakes in the region. Each year, about 1,000 to 2,000 earthquakes occur in Washington and Oregon. However, only 5 to 10 of these are typically felt because the majority of recorded earthquakes are smaller than magnitude 3. Active surface faults in the region are virtually undetectable because of the thick overburden of glacial and recent sediments. Also, the distribution of recorded seismic epicenters is scattered and does not define a mappable fault zone.

In recent history, hundreds of earthquakes have been recorded in Western Washington. Three large earthquakes have resulted in some liquefaction, ground failures, and structural damage. In 1949, a Richter magnitude 7.1 earthquake occurred in the Olympia area. In 1965, a magnitude 6.5 earthquake occurred between Seattle and Tacoma. In 2001, a magnitude 6.8 earthquake (the Nisqually Earthquake) occurred between Olympia and Tacoma very near the location of the 1949 earthquake.

Research is presently underway regarding historical large magnitude subduction-related earthquake activity along the Washington and Oregon coasts. Geologists are reporting evidence that suggests several large magnitude earthquakes (magnitude 8 to 9) have occurred in the last 1,500 years, the most recent of which occurred about 300 years ago. No earthquakes of this magnitude have been documented during the recorded history of the Pacific Northwest. However, if one does occur, the intensity of shaking should be about the same as the design earthquake; except that it will likely last longer.

Liquefaction Potential

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in development of excess pore pressures in loose, saturated soils and subsequent loss of strength in the deposit of soil so affected. In general, soils that are susceptible to liquefaction include

loose to medium dense "clean" to silty sands that are below the water table. In our opinion, the site soils have low susceptibility to liquefaction.

Seismic Zone and Soil Profile Type

As defined in the IBC, 2003 Edition, it is our opinion that the project site meets the criteria for Site Class B. The maximum considered earthquake ground motion for the 0.2 second and 1 second spectral response (S_s and S_1) for the site are mapped as 1.20 and 0.43, respectively. Based on our explorations, review of published geological materials and experience in the area, it is our opinion appropriate values for the site coefficient for short periods and 1 second periods (F_a and F_v) are 1.0 and 1.0, respectively.

SITE DEVELOPMENT AND EARTHWORK

General

We anticipate that site development work will include clearing and stripping, placing fill to establish design grades, excavating for foundations and utility trenches and placing and compacting excavated and/ or backfill materials. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment. The following sections provide recommendations for earthwork, site development and fill materials.

Stripping and Clearing

Existing organic-rich loose surface soils should be stripped from proposed pavement and structural areas and temporarily stockpiled for use as topsoil on the finished fill pad. The primary root systems for shrubs should be completely removed. Required stripping depths should be evaluated based on observations during the stripping operation. We estimate stripping depths could be on the order of 6 to 12 inches to remove the surficial organic material. Greater stripping depths may be required to remove localized zones of loose or organic soil. During stripping, perched groundwater seepage and/or wet soil conditions could be encountered. The extent of the seepage and depth at which it might be encountered often depends on the time of year of construction. Groundwater seepage can soften soil and could create construction difficulties. Additional stripping depths may be required if subgrades become disturbed during stripping operations.

Subgrade Preparation, Evaluation and Protection

Excavations should be performed using smooth-edged buckets/blades to limit subgrade disturbance. Native subgrades should be static compacted to a relatively firm and unyielding condition but should not be overworked. Overworking of native subgrades during grade development could create additional soft areas. We recommend that prepared subgrades be observed by a member of our firm, prior to placement of fill or structures. Our representative will evaluate the suitability of the subgrade by probing or observing proof rolling to identify areas of yielding, which are indicative of soft or loose soil. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment and/or probed with a 1/2-inch-steel rod, where necessary. If soft or otherwise unsuitable areas are revealed during proof-rolling or probing that cannot be compacted to a relatively stable and uniformly firm condition, we recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted; or 2) the unsuitable soils be removed and replaced with structural fill, as needed.

Soil encountered in the explorations contains a significant percentage of fines. This material is very sensitive to small changes in moisture content. Soil with high fines content is susceptible to disturbance from construction traffic when wet or if earthwork is performed during wet weather.

If grading takes place during periods of wet weather, protective surfacing such as placing asphalt-treated base (ATB) or haul roads made of quarry spalls or a layer of free-draining material such as well graded pit-run sand and gravel may be necessary to protect completed areas. Typically, minimum gravel thicknesses on the order of 24 inches are necessary to provide adequate subgrade protection. Additionally, traffic on completed areas should be restricted during wet weather conditions.

Temporary Excavations

Based on our explorations, excavations will need to be sloped or the sides will likely cave. Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA) if the excavation is deeper than 4 feet. The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1-1/2H:1V. This guideline assumes that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of the cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect these slopes during periods of wet weather.

Permanent Cut and Fill Slopes

We recommend permanent cut and fill slopes be constructed at a maximum inclination of 2H:1V. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered. Cut areas should be re-vegetated as soon as practical to reduce the surface erosion and sloughing. Temporary protection should be used until permanent protection is established.

Erosion Control

As previously discussed, weathering, erosion and the resulting surficial sloughing and shallow landsliding are natural processes that affect steeply sloped areas. To reduce and slow these natural processes, we recommend the following:

- No discharge of concentrated surface water or significant sheet flow onto the sloped area.
- Collect groundwater seepage, if any is encountered during construction.
- No percolation of surface water unless the seepage rate is controlled to a slow seep (using an approved infiltration or septic system).
- Maintain and enhance vegetation along the top and face of the steep slopes. The vegetation should consist of ground cover, grass, shrubs, and low-growing (dwarf) trees, which may have strong root systems.

Based on existing site grades and the proposed development, we anticipate that typical erosion control measures required by the city and/or county standards should generally be adequate for the proposed development. However, if construction and grading is staged, slopes may be created and additional erosion control measures may be appropriate. The removal of natural vegetation should be minimized and limited to active construction areas.

Temporary erosion control should be provided during construction activities and until permanent erosion control measures are functional. Surface water runoff should be properly contained and channeled using drainage ditches, berms, swales, and tightlines and should not discharge onto sloped areas. Disturbed sloped areas should be protected with a temporary covering until new vegetation can take effect. Jute or coconut fiber matting, excelsior matting or clear plastic sheeting is suitable for this purpose. Graded or disturbed slopes should be tracked in-place with the equipment running perpendicular to the slope contours so that the track grouser marks provide a texture to help resist erosion.

Permanent measures for erosion control should include reseeding or replanting the disturbed areas as soon as possible and protecting those areas until new vegetation has been established. Permanent site grading should be accomplished in such a manner that stormwater runoff is not concentrated and surface water is not directed to sloped portions or into excavated areas of the site not intended for stormwater disposal.

Catch basins and tightlines should be used where necessary to direct storm or other surface water across sloped areas. Surface water should be directed to appropriate stormwater disposal facilities in portions of the site removed from slopes. Sheet flow from impervious surfaces should be directed to catch basins and the storm drainage system. Roof downspouts should be tightlined to stormwater disposal systems. Additional information regarding recommendations to reduce the erosion potential of the steep slope is included in the "Slope Maintenance" section of this report.

It is our understanding it is desired to remove some of the existing trees to the east and downslope of the existing pad (proposed development area) to enhance views. If the existing fill slope is regraded and replaced with structural fill, we recommend that the trees and root systems within the area to receive fill be entirely removed. Otherwise we recommend that the trees to be removed be cut down, leaving their root systems in place to provide resistance to erosion.

Slope Drainage Considerations

Proper drainage is imperative for long-term slope stability. The influx of water is a major factor in the destabilization of slopes. At no time should surface water be discharged to, or near, slopes or retaining structures.

Curbs, catch basins, and other appropriate measures should be used to direct surface water runoff to collection points. Existing drain lines should be inspected and repaired if leaking. To prevent accidental discharge of stormwater to locations that could reduce slope stability, existing drain lines not currently in use should be thoroughly inspected and repaired as needed and capped, or preferably removed. Drain lines, catch basins and other drainage features should be inspected and maintained on a regular basis.

Surface water should be prevented from flowing over the face of slopes on the property. Surface water from downspouts, foundation drains, and runoff from the driveway and other surfaces should be collected and tight lined to the street or other appropriate discharge facility. The drain discharge location should be armored with rocks to prevent erosion near the toe of the slope.

Slough Wall and Swale

In order to control slough and runoff from the existing westerly ascending cut slope, we recommend that a slough wall with approximately 12 inches of freeboard be provided at the base of the cut slope and that a concrete swale be installed on the slope side (west side) of the slough wall. The swale should convey the runoff away from the building pad area so as not to collect in the rear yard of the proposed residence or pond anywhere on the existing or new fill. The swale should extend to an appropriate discharge facility and should not discharge onto the easterly descending slope. The swale should be maintained clear of soil and vegetation in order to ensure proper function.

FILL MATERIALS

General

Material used for fill should be free of debris, organic contaminants and rock fragments larger than 6 inches. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content. We recommend that select granular fill or crushed rock be used for structural fill during the rainy season. The following paragraphs summarize the material requirements for fill and backfill.

On-Site Soils

Surficial duff and sod are not suitable for structural fill and should be removed from areas to be improved or used in landscaping areas. On-site materials used as structural fill should be free of roots, organic matter and other deleterious materials and particles larger than 6 inches in diameter. During extended periods of dry weather construction, non-organic on-site soil may be considered for use as fill provided it meets the criteria described above and can be compacted as recommended. Based on our explorations, we expect that portions of the excavated material could be over optimum moisture content for compaction. It will likely be necessary to aerate and/or dry the soil prior to placement and compaction.

The site soil may not be suitable for use as fill under wet weather conditions. Compaction of these soils will be difficult, if not impossible, to achieve during wet weather conditions. Even when properly compacted, this material can be easily disturbed and will soften when exposed to moisture.

Select Granular Fill

If construction is performed during wet weather conditions, we recommend using fill consisting of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on the minus 3/4-inch fraction. Organic matter, debris or other deleterious material should not be present. In our opinion, material conforming to Washington State Department of Transportation (WSDOT) Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), 9-03.10 (Aggregate for Gravel Base), or 9-03.14 (Borrow) is suitable for use as import fill material during wet weather with the exception that the fines content should be 5 percent or less. In addition, some larger particle sizes are acceptable, as described above. If prolonged dry weather prevails during the earthwork phase of construction, a somewhat higher fines content may be acceptable.

Pipe Bedding

Trench backfill for the bedding and pipe zone should consist of well-graded granular material with a maximum particle size of 3/4 inch and less than 5 percent fines or as recommended by the pipe manufacturer. The material should be free of roots, debris, organic matter and other deleterious material.

Crushed Rock

Crushed rock fill should consist of clean, durable, crushed angular rock that has a maximum particle size of 4 inches, is well graded between coarse and fine sizes and has less than 5 percent fines. A smaller maximum particle size will be required for some applications as discussed in other sections of this report. Gravel materials should be crushed to have at least two fractured faces. Organic matter, debris or other deleterious material should not be present.

FILL PLACEMENT AND COMPACTION

General

To obtain proper compaction, fill soil should be compacted near optimum moisture content and in uniform horizontal lifts. Lift thickness and compaction procedures will depend on the moisture content and gradation characteristics of the soil and the type of equipment used. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Silty soil and fine grained soil may be difficult or impossible to compact during persistent wet conditions. Generally, 12-inch loose lifts are appropriate for steel drum vibratory roller compaction equipment. Compaction should be achieved by mechanical means. During fill and backfill placement, sufficient testing of in-place density should be conducted to check that adequate compaction is being achieved.

Fill Placement on Slopes

Following stripping, a toe fill key should be established at the base of the regraded fill slope. The key should be approximately 12 to 15 feet wide (approximately the width and one half of the equipment used) and inclined back into the slope at approximately 2 percent, with an approximate 2-foot vertical face at its outboard (eastern) edge. The bottom should be scarified and recompacted to 95 percent relative density per American Society for Testing and Materials (ASTM) D 1557. A representative of our firm should be present to observe the toe fill key and to test the fill compaction. A bench drain should be established at the first bench above the backfilled key. This should consist of a 4-inch-perforated PVC or ABS pipe encased in filter fabric and 3/4-inch gravel along the heel of the bench. This should be connected to 4-inch non-perforated PVC or ABS pipe drains placed at right angles at approximate 50-foot intervals and extended to the face of the slope beyond the toe of the fill. The fill may then be advanced up the slope using 4-foot-wide benches until subgrade level is achieved.

Area Fills and Bases

Fill placed to establish site grades and materials under pavements should be placed on subgrades prepared as previously recommended. In general, fill should be compacted to at least 95 percent of the MDD (ASTM Test Method D 1557, Modified Proctor) except for in utility trenches as discussed below.

Trench Backfill

For utility excavations, we recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction but generally should not be greater than about 18 inches. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

In paved and structural areas, trench backfill should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD in the upper 2 feet below subgrade. Fill placed below a depth of 2 feet from subgrade should be compacted to at least 90 percent of the MDD. In nonstructural areas, trench backfill should be compacted to a firm condition that will support construction equipment, as necessary.

Wet Weather Considerations

Contractors should plan in advance to protect the exposed soil areas and should not open more area than can be covered or otherwise protected during the workday.

Soils exposed during earthwork activities should be protected from stormwater. Areas of exposed soil that are not protected from stormwater could experience additional erosion, sloughing and slope instability. If earthwork activities are delayed due to wet weather, or a prolonged break in the construction process is anticipated, we recommend that an experienced geotechnical engineer or other qualified personnel visit the site to check that the exposed soils have been adequately protected from stormwater.

Use of the on-site soil for structural fill will be increasingly difficult during periods of wet weather, or when the subgrade moisture content is more than a few percentage points above optimum. When wet, the on-site soil is susceptible to disturbance and generally will not provide adequate support for construction equipment. We anticipate that the on-site soil will be difficult, if not impossible, to adequately compact during periods of wet weather.

SLOPE MAINTENANCE

General

Excessive disturbance and/or poor site drainage can destabilize slopes. At no time should organic debris or loose uncontrolled fill be cast over, placed on or stored near the top of the existing steep fill slopes at the site. Proper slope drainage and vegetation can reduce the rate of natural slope deterioration. Recommendations concerning proper slope drainage, erosion control and vegetation are provided below.

Slope stability can be detrimentally affected if site development results in an increase in ground or surface water onto the slope and/or material such as uncontrolled fill is placed on or above the slope. At no time should uncontrolled fill be cast onto, placed on, or stored on or near the top of the existing steep fill slope at the site. Surface water should be routed away from the slope faces and discharged such that the slope will not be impacted. This includes routing storm water drainage from rooftops away from the recommended setback area.

Weathering, erosion, and the resulting surficial sloughing are natural processes that affect slope areas. However, it is our opinion that proper site development can reduce landslide and erosion hazards at the site.

SITE DRAINAGE

Surface Drainage

Surface water from roofs, driveways and landscape areas should be collected and controlled. Curbs or other appropriate measures such as sloping pavements, sidewalks and landscape areas should be used to direct surface flow away from the buildings, erosion sensitive areas and from behind retaining structures. Roof and catchment drains should not discharge into wall or foundation drains.

Groundwater

Groundwater was not encountered in the explorations completed for this project. Based on our explorations, excavations could encounter groundwater depending upon the depth and season. We anticipate that groundwater handling needs will generally be lower during the late summer and early fall months. We anticipate that shallow perched groundwater can be handled adequately with sumps, pumps, and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered.

Foundation and Roof Drains

We recommend perimeter foundation drains be installed. Perimeter drains should typically consist of 4-inch-diameter slotted, smooth-walled rigid PVC pipe bedded in pea gravel or other free-draining soil at the base of perimeter footings. The footing drain system should be tightlined to the street or other appropriate discharge facility. We recommend that all roof drains be collected in tightlines and routed to the street or other appropriate discharge facility. Roof and other drains should not be connected to the perimeter foundation drain.

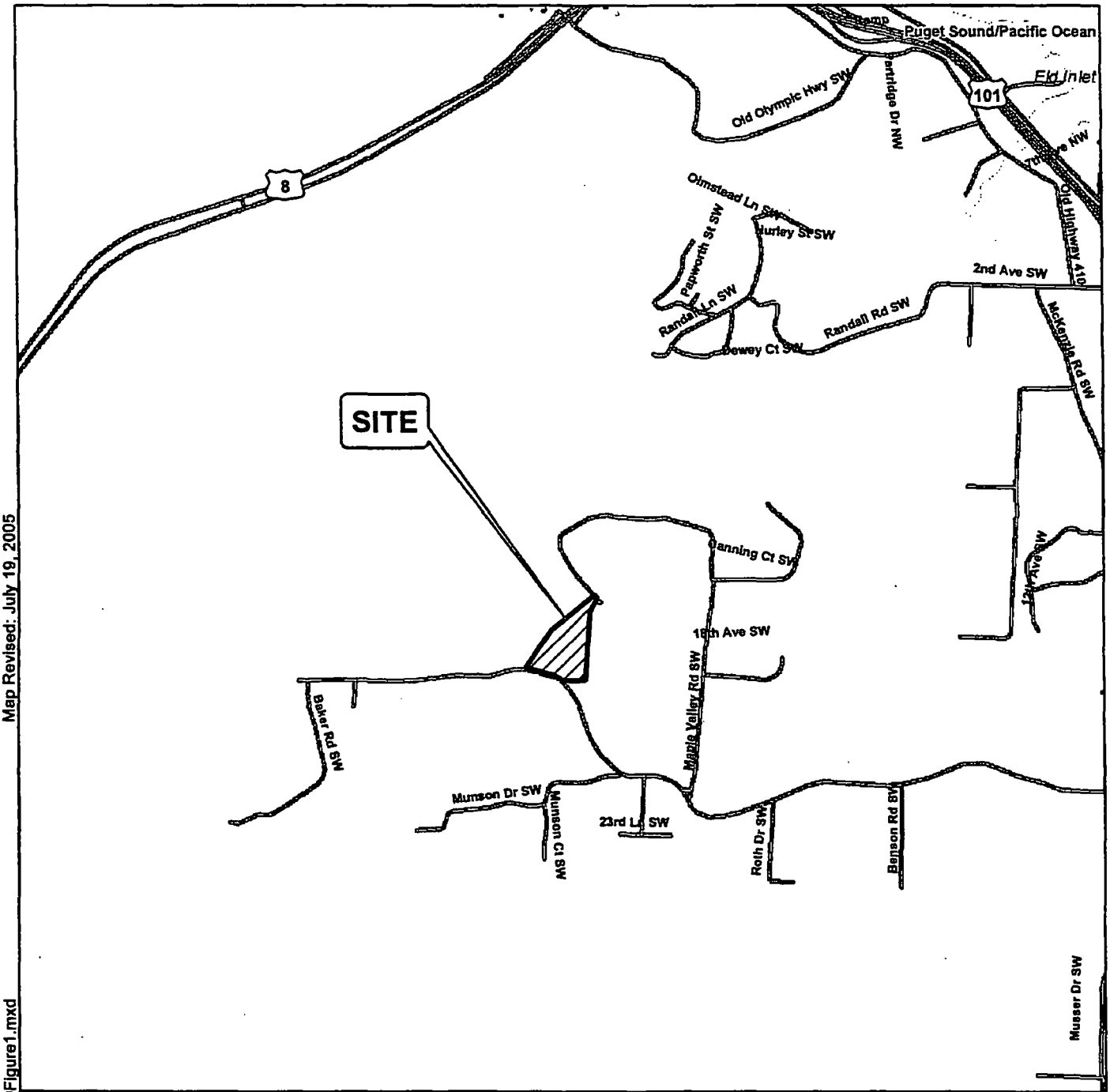
LIMITATIONS

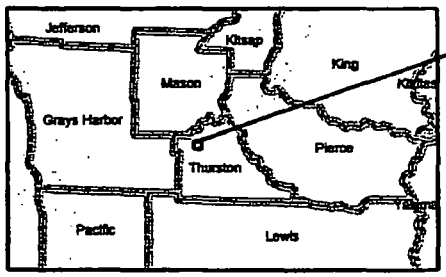
We have prepared this report for use by Bruce Davies and his consultants for use in evaluation of the site located at 6840 SW Cedar Flats Road (Parcel No. 13823120200) in Olympia, Washington.

Our services were provided to assist in the design of foundations for a planned structure to be located on sloping property. Our recommendations are intended to improve the overall stability of the site and to reduce the potential for future property damage related to earth movements, drainage or erosion. However, all construction on slopes involves risk, only part of which can be mitigated through qualified engineering and construction practices. Favorable performance of structures in the near term does not imply a certainty of long-term performance, especially under conditions of adverse weather or seismic activity.

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

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





SITE BOUNDARY

N
W E
S

2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: Roads from TIGER 2000. County boundaries from Department of Ecology. Cities and state routes from Tele Atlas U.S. Street map (obtained July 2005).

Lambert Conformal Conic, Washington State Plane North, North American Datum 1983

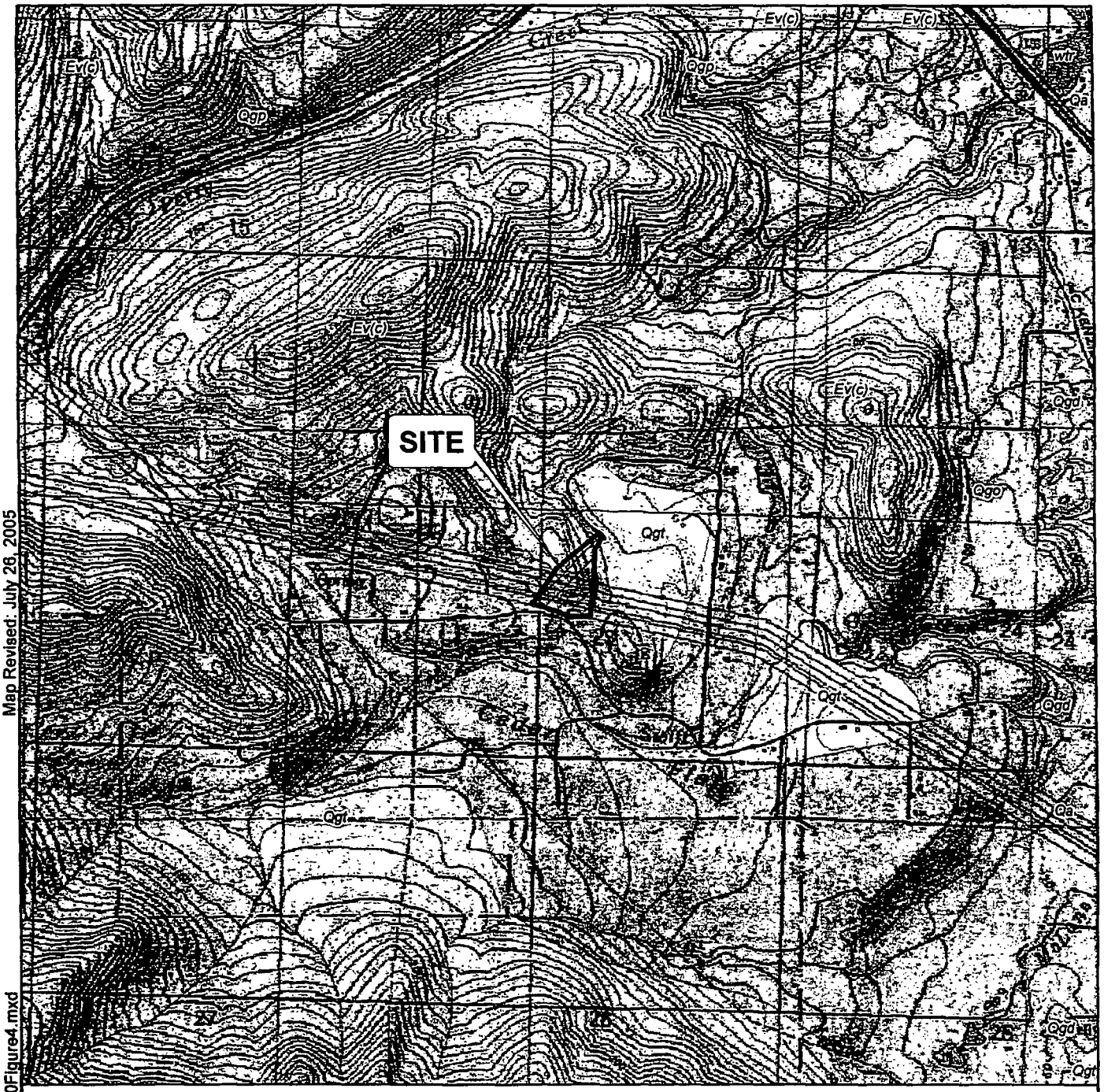
Vicinity Map

Proposed Residence - 6840 SW Cedar Flats Road
Olympia, Washington

GEOENGINEERS

Figure 1

Office: TAC Path: P:\121\122210011\00\GIS\122210010\Figure1.mxd Map Revised: July 19, 2005



SITE BOUNDARY

GEOLOGIC UNITS

Qgo = Continental glacial outwash, Fraser-age
Ev(c) = Basalt flows and flow breccias, Crescent formation
Qgt = Continental glacial till, Fraser-age

N W E S

2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Data Sources: Roads from TIGER 2000. County boundaries from Department of Ecology. U.S. topographic map from National Geographic Society (obtained July 2005). Geology data from Washington State Department of Natural Resources (2000).
Lambert Conformal Conic, Washington State Plane North, North American Datum 1983

Geologic Map

Proposed Residence - 6840 SW Cedar Flats Road
Olympia, Washington

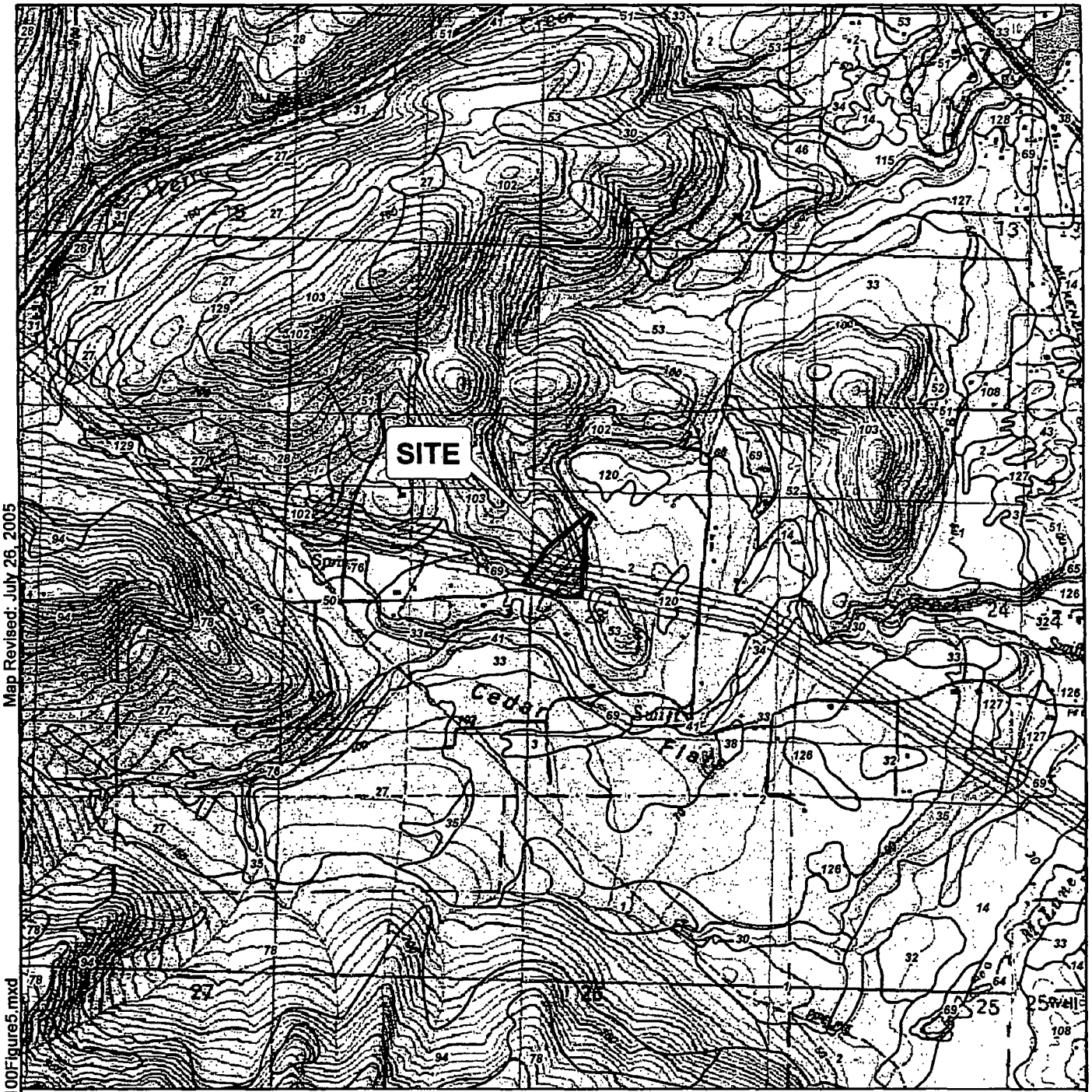
GEOENGINEERS

Figure 4

Map Revised: July 28, 2005

Path: P:\12\12221001\00\GIS\12221001\00Figure4.mxd

Office: TAC



SITE BOUNDARY

SOILS BOUNDARY

2 = ALDERWOOD GRAVELLY SANDY LOAM, 3% TO 15% SLOPES
102 = SCHNEIDER VERY GRAVEELY LOAM, 20% TO 40% SLOPES
103 = SCHNEIDER VERY GRAVEELY LOAM, 40% TO 65% SLOPES

N W E S

2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
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Data Sources: Roads from TIGER 2000. County boundaries from Department of Ecology. U.S. topographic map from National Geographic Society (obtained July 2005).
NRCS soils data from United States Department of Agriculture.
Lambert Conformal Conic, Washington State Plane North, North American Datum 1983

Topography and Soil Survey Map

Proposed Residence - 6840 SW Cedar Flats Road
Olympia, Washington

GEOENGINEERS

Figure 5

Map Revised: July 26, 2005
Path: P:\12\12221001\00\GIS\12221001\00Figure5.mxd
Office: TAC

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

- Measured groundwater level in exploration, well, or piezometer
- Groundwater observed at time of exploration
- Perched water observed at time of exploration
- Measured free product in well or piezometer

Stratigraphic Contact

- Distinct contact between soil strata or geologic units
- Gradual change between soil strata or geologic units
- Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

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

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

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

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

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

KEY TO EXPLORATION LOGS

GEOENGINEERS

FIGURE 6

Resource Stewardship & Land Use

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 200

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
200	0				ML	Red sandy silt with gravel (medium stiff, moist) (weathered basalt)		
					BRX	Black basalt (weathered)		
								Practical refusal at 4.5 feet
195	5					Test pit completed at 4.5 feet on 06/10/05 No groundwater seepage observed No caving observed		
190	10							
185	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT TP-1

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 7
Sheet 1 of 1

V8_GTTPIT P:\12\12221001\00\FINALS\12221001 00.GPJ GEIV8_1.GDT 8/30/05

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 198

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
	0				ML	Red-brown silt with gravel, trace sand (medium stiff, moist) (fill)		
		X	1					
					GP-GM	Brown fine to coarse gravel with silt with sand (medium dense, moist) (fill)		
		X	2				8	
195								
					SM	Red silty sand, occasional gravel (medium dense, moist) (fill)		Fill/native contact slopes approximately 15 degrees to east
	5							
		X	3				30	
					BRX	Red-black weathered basalt		
190								
		X	4					Practical refusal at 10 feet
	10					Test pit completed at 10 feet on 06/10/05 No groundwater seepage observed No caving observed		
185								
	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT TP-2

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 8
Sheet 1 of 1

V6 GTTPIT P:\12\12221001\00\FINALS\12221001\00.GPJ GEIV6_1.GDT 8/30/05

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 201

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
	0				ML	Red sandy silt with gravel (medium stiff, moist) (weathered basalt)		
200					BRX	Red-black basalt (weathered)		
								Practical refusal at 4 feet
						Test pit completed at 4 feet on 06/10/05 No groundwater seepage observed No caving observed		
	5							
195								
	10							
190								
	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT TP-3

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 9
Sheet 1 of 1

V8_GTTPIT P:\12\12221\001\00\FINALS\12221001\00.GPJ GEIV8_1.GDT 8/30/05

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 193

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
	0				ML	Red-brown silt, trace gravel (soft, moist) (fill)		
		X	1				23.2	
190								
					ML	Red silt, trace gravel (soft, moist to wet) (fill)		
	5							Fill/native contact slopes approximately 20 degrees to east
		X	2				29.1	
					ML	Black silt with organics (bark, roots, branches) (soft, moist) (fill)		
185								
					BRX	Red-black weathered basalt		
	10							
						Test pit completed at 12 feet on 06/10/05 No groundwater seepage observed No caving observed		
180								
	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT TP-4

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 10
Sheet 1 of 1

V8_GTTPIT P:\12\12221001\00\FINALS\12221001\00.GPJ GEIV8_1.GDT 8/16/05

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 198

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
	0				ML	Red sandy silt, trace gravel, trace roots (soft, moist) (fill)		
		X	1		GP-GM	Gray fine to coarse gravel with silt with sand (medium dense, moist) (fill)		
195		X	2					
	5							Fill/native contact slopes approximately 20 degrees to east
					BRX	Weathered basalt		
190		X	3					Practical refusal at 9 feet
						Test pit completed at 9 feet on 06/10/05 No groundwater seepage observed No caving observed		
	10							
185								
	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT TP-5

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 11
Sheet 1 of 1

V6_GTTPIT P:\12\12221\001\00\FINALS\12221001\00.GPJ GEIV6_1.GDT 8/30/05

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 192

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
	0				GM	Gray-red silty fine to coarse gravel (loose, moist) (fill)		
190		X	1					
					ML	Red silt with gravel (soft, moist) (fill)		
		X	2					Fill/native contact slopes approximately 25 degrees to east
	5							
185					BRX	Weathered basalt		
						Test pit completed at 9 feet on 06/10/05 No groundwater seepage observed No caving observed		
	10							
180								
	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

V6_GTTPIT P:\12\12221\001\00\FINALS\12221001\00.GPJ GEIV6_1.GDT 8/16/05

LOG OF TEST PIT TP-6

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 12
Sheet 1 of 1

Date Excavated: 06/10/05 Logged by: EWH

Equipment: 580 Backhoe Surface Elevation (ft): 197

Elevation feet	Depth feet	Sample	Sample Number	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	OTHER TESTS AND NOTES
	0				GM	Gray silty fine to coarse gravel with sand (medium dense, moist) (fill)		Fill/native contact slopes approximately 25 degrees to east
195		X	1					
					BRX	Weathered basalt		
		X	2					Practical refusal at 4.5 feet
	5					Test pit completed at 4.5 feet on 06/10/05 No groundwater seepage observed No caving observed		
190								
	10							
185								
	15							

Notes: See Figure 6 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT TP-7

GEOENGINEERS

Project: Proposed Residence - 6840 SW Cedar Flats Road
Project Location: Olympia, Washington
Project Number: 12221-001-00

Figure 13
Sheet 1 of 1

V6_GTTPIT P:\12\12221001\00\FINAL\12221001\00.GPJ GEIV6_1.GDT 8/30/05

GeoEngineers

Appendix A

Report Limitations and Guidelines for Use

APPENDIX A
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

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

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

We have prepared this report for use by Bruce Davies and his consultants for use in evaluation of the site located at 6840 SW Cedar Flats Road (Parcel No. 13823120200) in Olympia, Washington. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. No one except Bruce Davies and his consultants should rely on this report without first conferring with GeoEngineers. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for Bruce Davies. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

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

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

- the function of the proposed structure,
- elevation, configuration, location, orientation or weight of the proposed structure,
- composition of the design team, or
- project ownership.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

SUBSURFACE CONDITIONS CAN CHANGE

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

TOPSOIL

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination, and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report, and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

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

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

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

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

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report.

Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

READ THESE PROVISIONS CLOSELY

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

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

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

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants in or around any structure. Accordingly, this report includes no interpretations, recommendations, findings, or conclusions for the purpose of detecting, preventing, assessing, or abating Biological Pollutants. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.