PBS

Geotechnical Investigation

Stillaguamish Gardens
18308 Smokey Point Boulevard
Arlington, Washington

Prepared for:
Stillaguamish Senior Center
Arlington, Washington

Geotechnical Investigation Report

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Arlington, Washington

Prepared for
Stillaguamish Senior Center
Arlington, Washington

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PBS Project No:
17249.001

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1.0 GENERAL INFORMATION

PBS Engineering and Environmental (PBS) has completed a geotechnical investigation for the Stillaguamish Gardens Senior Center housing complex located in Arlington, Washington. The purpose of the geotechnical investigation was to evaluate and establish existing subsurface conditions at specific locations, and to assist with the design as it relates to earthwork and foundations. In order to achieve these purposes, we performed the following scope of work:

1. Visited the property to observe the geotechnical and geologic setting of the area to be developed;
2. Reviewed relevant, readily available published geologic maps;
3. Excavated five test pits around the site;
4. Performed laboratory moisture content on collected soil samples;
5. Conducted infiltration testing of the subsurface soil
6. Assessed the collected information and prepared this report.

This report presents the results of our investigation and includes geotechnical engineering recommendations for design and construction.

This report was prepared for your use in the design of the subject facility and the information contained herein should be made available to potential contractors and/or the Contractor for informational purposes only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the boring logs and/or discussion of subsurface conditions contained herein.

2.0 PROJECT AND SITE DESCRIPTIONS

The project site is located in the City of Arlington, in Snohomish County, Washington as shown on the location map in Figure 1. The Arlington area lies within the Stillaguamish River basin. This large alluvial basin is filled with young Holocene fluvial sands and gravels.

The site is bounded north and east by the existing property apartment units, and by private residential properties to the south and west. The grades across the site are nearly level. The ground surface is covered with dense native grass and trees and blackberry brush. Figure 2 shows the proposed configuration of the housing complex site.

We understand that the proposed project includes the construction of a three-story wood-frame apartment building, with associated driveway/parking and landscaping improvements. At this point in time, no significant cuts or fills are expected to be required to adjust site grades. Additionally, no retaining walls are currently proposed.

3.0 SITE INVESTIGATION

3.1 Field Exploration

The field investigation consisted of excavating five soil test pits to depths between 5 and 12 feet below grade. The approximate locations of the test pits are shown on the Site Plan (Appendix A, Figure 2). The excavations were observed and logged by an engineer from our firm. The soils encountered were described in general accordance with the Unified Soil Classification System (USCS). The geotechnical log is attached to this report as Figure B2 in Appendix C.

3.2 Subsurface Soil Conditions

The analysis, conclusions and recommendations contained in this report are based on site conditions as they existed at the time of explorations and assume the test pit explorations are representative of the subsurface conditions throughout the site. If during construction, subsurface conditions are found to differ from those encountered in the explorations, we should be advised at once so that we may review these conditions and reconsider our recommendations where necessary.

The site is underlain by Holocene alluvial sands and gravels (Qal). Published mapping (Mullineax, 1987) indicates that this alluvium extends to depths of hundreds of feet. These sediments were deposited in the former channels and floodplain of the Stillaguamish River basin by stream action during the latest Pleistocene and Holocene time period. As encountered in our test pits, this alluvium generally consists of a surfical veneer of sand silt topsoil overlying a variable deposit of poorly graded sand to sand with gravel (USCS soil type SP).

The subsurface conditions at the site disclosed by the test pits were relatively uniform. The test pits first penetrated a 18 to 24 inch layer of loose, moist, silt topsoil. The topsoil had very heavy root growth. Underlying the topsoil, clean sand with some intermittent gravels were encountered in all of the test pits. All of the test pits were terminated in the coarse sand/fine gravel at depths of 4.5 to 11 feet below grade. Pocket penetrometer (PP) readings in the upper sand soils (2 to 4 feet) soil ranged between 1.5 and 2.5 tons per square foot (tsf), which would correlate to published friction angle (ϕ) values of 30 to 35 degrees.

We note the correlations between blow counts and friction angle (ϕ) were based upon local knowledge of the soil formations and from relationships in Peck, et al (1974). Refer to Table 1 at the end of this report for further detail regarding the classification of the soils collected during the subsurface exploration.

The test pit logs (Figures C1 through C5) provide a more detailed description of the soils encountered during our exploration. This site geology has been interpreted from our test pits, which provided information to a depth of up to 11 feet below grade. Published geologic information was used for geologic interpretation below this depth.

3.3 Groundwater Conditions

Groundwater was not encountered in our test pits during our field investigation on April 9, 2004. Well logs in the general vicinity indicate that the depth to the permanent groundwater surface may be anticipated from 5 to 15 feet. Winter water table levels, however, may approach the ground surface during an extreme wet season.

3.4 Infiltration Testing

Infiltration tests were performed at two test pit locations (TP-1A and TP-1B) in the Parking lot area. The approximate locations of these tests are shown on Figure 2. These tests were conducted in basic conformance with the EPA Standard for Onsite Wastewater Treatment and Disposal Systems (1980). The infiltration test pit was saturated prior to running the tests. At the end of the saturation period, the drop in water level versus time was observed inside a 6-inch diameter standpipe. Water infiltration at each test location was moderate at depths of approximately 4 feet below ground surface. The testing indicated average infiltration rates of approximately 1 minute per inch of water column drop.

3.5 Laboratory Testing

All of the soil samples were visually examined in our laboratory to refine the field classification in general accordance with the Unified Soil Classification system (visual-manual procedure), described in Table 1 in Appendix B. Laboratory testing included:

- Moisture contents on all applicable samples (ASTM D 4959). Test results are shown on the right side of the test pit logs provided in Appendix C, Figure B1. Moisture contents of the upper sands varied from 8% to 13%.

4.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The recommendations contained within this report should be incorporated into the design and construction of the proposed development.

4.1 Site Preparation

4.1.1 Stripping

Prior to mass grading, the topsoil within the new structure footprint and at all areas to receive new slabs or paving shall be stripped to an average depth of 6-12 inches. Thicker zones of organic-rich topsoil may be present locally around the site. All strippings shall be spoiled separately from any cut soils retained for structural backfill. Stripped organic-rich materials may be retained only for use as landscaping materials.

Tree stumps and all roots greater than 1 inch in diameter should be removed from any building, slab, or pavement subgrade areas. The voids resulting from the removal of the trees and roots should be backfilled with compacted soil or baserock.

In areas to receive new slabs or paving the exposed subgrade shall be compacted to at least 95% of its Maximum Dry Density (MDD) as determined by the Standard Proctor Test (ASTM D-698).

4.2 Earthwork

4.2.1 Excavations

In our opinion, all excavations can be accomplished with conventional excavating equipment. All excavations for footings and subgrades in the fine-grained silt should be performed by an excavator or backhoe equipped with a smooth-faced bucket (no teeth).

Due to the granular nature of the site soils, there is a high probability that even shallow vertical excavations will tend to slough or run. Therefore, the Contractor should plan on trimming back excavations to an appropriate stable angle. Any excavations made proximate to existing building foundations (e.g. within a horizontal distance equal to the height of the proposed cut) will need to be shored, or the existing foundations will need to be underpinned.

Because of safety considerations and the nature of temporary excavations, the Contractor should be made responsible for maintaining safe temporary cut slopes and supports for utility trenches, etc. We recommend that the Contractor incorporate all pertinent safety codes during construction, including the latest OSHA revised excavation requirements, and based on soil conditions and groundwater evidenced in cuts made during construction.

4.2.2 Structural Fills

Depending upon finished building pad elevations, structural fills may be required to raise the site grades. Native or imported material may be used for fill, provided the soil is free of organics, cobbles larger than 6 inches in maximum diameter, or other deleterious matter; is of low plasticity; and, is *at the proper water content*. The existing near-surface soils may prove to have too high of an organic content and be too wet to utilize for structural fill.

Fills should be placed on <u>level</u> benches in thin lifts and compacted to a dry density of at least 95% of its Maximum Dry Density (MDD) as determined by the Standard Proctor Test (ASTM D-698). Lifts should not exceed 6 inches in compacted depth.

Structural fill slopes should be placed and compacted a minimum of 2 feet beyond the final slope configuration and then trimmed back to final grade.

The thickness of the lifts will need to be determined in the field, but generally for self-propelled compactors, the lifts should not exceed about 9 inches as measured in a loose condition. For small vibratory plate compactors, the lifts will need to be reduced to about 3 to 4 inches loose measure.

For any over-excavation completed in the area of footings or slabs, the backfill material shall consist of free-draining, well-graded, crushed aggregate base with a maximum particle size of ¾ inch. The rock shall not contain more than 5% fines (material passing the No. 200 sieve, as tested by ASTM D-1140). The rock shall be compacted to a dry density of at least 95% of its MDD.

A minimum of three days prior to the placement of any fill, our office should be contacted to arrange for collection, testing and approval of a 30-pound sample (approximately a full 5-gallon bucket) of any soil or baserock to be used as fill (including native and import materials).

4.3 Foundation Design

Based on the field exploration, laboratory testing, our experience with this soil formation, and our understanding of the project, it is our opinion that proposed new foundation systems may consist of continuous spread-footings founded on native soils or on new, compacted structural fill.

4.3.1 Preparation

Each footing excavation should be evaluated by a qualified Geotechnical Engineer or their representative to confirm suitable bearing conditions. Observations should also confirm that all loose or soft material, organics, unsuitable fill, prior topsoil zones, and softened subgrades, if present, have been removed. Localized deepening of footing excavations may be required to penetrate through the upper, softer site soils.

In order to reduce disturbance to the silty soil found at the site, we recommend all excavations for footings be accomplished with an excavator or backhoe equipped with a smooth-faced bucket (e.g., no teeth). The bases of the footings should be compacted to a dry density of at least 95% of its Maximum Dry Density (MDD) as determined by the Standard Proctor Test (ASTM D-698).

If construction is undertaken during periods of rain, then we recommend a 2-inch (or greater) layer of compacted, ¾-inch crushed rock be placed over the bases of the excavations to help protect them from disturbance due to the elements and workers in the trenches.

4.3.2 Dimensions

Continuous wall footings should have a minimum width of 18 inches, and isolated column footings should have a minimum width of 2.0 feet. All perimeter footings should be founded at least 2.0 feet below the lowest exterior grade, and 18 inches below the finished floor elevation, whichever is deeper. Interior footings may also be founded at a depth of 18 inches below the finished floor elevation.

The footings should be founded below an imaginary line projecting at a 1:1 slope from the base of any adjacent, parallel utility trenches. The footings must also be embedded so there is a minimum of 10 feet of horizontal distance between the face of the footings and any adjacent, parallel slope.

4.3.3 Capacities

The new footings should be designed for a maximum allowable bearing pressure of 1,500 pounds per square foot (psf). When sizing footings for seismic considerations, the allowable bearing pressure may be increased by 1/3 to 1,333 psf. Lateral pressures may be resisted by friction between the bases of the footings and the underlying ground surface. A frictional coefficient of 0.40 may be utilized.

If it is necessary to increase the bearing capacity of the soils, over-excavation and backfill will be required in the footing locations subject to the Geotechncal Engineer's approval. Soil that is removed shall be replaced with a well-graded, ¾-inch crushed rock, not containing more than 5 percent material passing the number 200 sieve (wet sieve analysis). All backfill material shall be compacted to at least 95 percent of the standard Proctor maximum dry density described in the structural fill section of that report.

4.3.4 Settlement

Based on our preliminary knowledge of the project scope, and for footings designed as described in the preceding paragraphs, we estimate a maximum settlement of 1.0-inch or less. Differential settlement should be on the order of 50 to 75% of the maximum settlement over a horizontal distance of 50 feet. Our settlement estimate assumes that no disturbance to the foundation soils would be permitted during excavation and construction, and that footings are prepared as described in the preceding paragraphs. Additionally, the new footings should be doweled to any adjacent existing footings to help limit direct differential shifting between footings.

4.4 Slabs-on-Grade

4.4.1 Design

Load-bearing concrete slabs (including garage and driveway slabs) shall be designed assuming a modulus of subgrade reaction, k, of 150 pounds per square inch per inch (psi/i). This assumes a compacted soil subgrade combined with a minimum 6-inch thick layer of compacted aggregate base over filter fabric.

Exterior slabs (e.g. patio, walkway, and driveway) and interior garage slabs shall remain structurally independent from the building foundations. Expansion joints shall be provided between the slabs and foundations. This will allow minor shifting of the slabs to occur as a result of vehicular loading, tree root growth, etc., while reducing the potential for slab cracking around the perimeter. However, interior slabs may be tied to the building's foundation system.

Slabs shall be reinforced according to their proposed use and per the structural engineer's recommendations. Adequate control joints and slump tests should also be provided for all slabs, to control undesirable shrinkage and cracking.

4.4.2 Soil Subgrade Preparation

Prior to placing slab baserock, the upper 12 inches of the soil subgrade shall be compacted to 95% of their MDD (per ASTM D-698) or until proof-rolling with a loaded 15 cy dump or water truck indicates an unyielding, non-pumping subgrade is present. It may be necessary to rip and moisture condition (wet or dry) the subgrade in order to achieve this level of compaction. A woven filter fabric should be placed on the subgrade soils after compaction and prior to placement of the baserock.

4.4.3 Baserock Preparation

Slabs shall be founded on a minimum 8-inch layer of free-draining, well graded, crushed, aggregate base with a maximum particle size between ¾ and 1½ inches. The thickness of this rock layer may be decreased to 6 inches for *unloaded* interior building slabs. The base rock shall not contain more than 5% fines (material passing the No. 200 sieve, as tested by ASTM D 1140). The baserock shall be compacted to a dry density of at least 95% of its MDD (per ASTM D-698).

Ideally, a moisture vapor barrier overlain by 1 to 2 inches of clean sand would also be placed beneath any slabs in finished, heated areas, or where moisture-sensitive floor coverings may be installed.

4.5 Site Drainage

4.5.1 Temporary

The Contractor should be made responsible for temporary drainage of surface water and groundwater as necessary to prevent standing water and/or erosion at the working surface.

4.5.2 Surface

The ground surface around any structure should be sloped to create a minimum gradient of 2% away from the building foundations for a distance of at least 5 feet. Surface water should be directed away from all buildings into drainage swales or into a storm drainage system. "Trapped" planting areas should not be created next to any buildings without providing means for drainage.

The roof downspouts should discharge onto splash blocks or paving that direct water away from the building, or into smooth-walled underground drain lines that carry the water to appropriate discharge locations at least 10 feet away from the buildings.

4.5.3 Subsurface

It would be prudent, though not required, to install footing drains around the building perimeter to help intercept any water migrating towards the building subgrade.

4.5.4 Infiltration Pits/Trenches

We understand it is desired to discharge storm water on site, into a system of infiltration pits or trenches. As discussed previously, infiltration testing was conducted during our subsurface exploration. Based upon our testing and our experience with the soil formations in the site vicinity, it is our opinion that the use of an infiltration system which releases water into the soils encountered 4 or more feet below grade is acceptable.

Debris settlement basins shall be installed to remove debris from the storm water before it is discharged into the infiltration system(s). Also, an overflow shall be provided for each infiltration trench/pit to prevent back up into the storm drain system in the event the infiltration system becomes overwhelmed during unusually heavy rainstorms.

4.6 Utility Trenches

Any new utility trenches in paved areas should be backfilled with granular material containing less than 7% fines (passing #200 wet sieve). The backfill should be compacted to a dry density of at least 95% of its MDD (per ASTM D-698). Compaction by jetting or flooding should not be permitted.

We recommend that typical footing drains be placed on the exterior of the foundations to intercept any water "chasing" the utility lines, or that an impermeable trench plug (e.g. concrete, etc.) be installed to stop water before it reaches the building envelope.

5.0 QUALITY CONTROL

For this site, we recommend the following quality control program:

- Geotechnical review of construction plans and specifications;
- Geotechnical engineering observation of excavations and foundation bearing surfaces;
- Observation and/or compaction testing of slab section soil and rock subgrades;
- Observation and/or compaction testing of pavement section soil and rock subgrades;
- Observation and/or compaction testing of structural fills; and,
- Observation of the installation of drainage improvements.

The review, observations, and testing should be performed by an individual experienced in geotechnical construction methods and familiar with the recommendations herein. In order to best assure conformance with this report, we recommend that PBS provide these services.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers for aiding in the design and construction of the proposed development. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations.

The opinions, comments and conclusions presented in this report were based upon information derived from our literature review, field investigation, and laboratory testing. Conditions between, or beyond, our exploratory borings may vary from those encountered. Unanticipated soil conditions and seasonal soil moisture variations are commonly encountered and cannot be fully determined by merely taking soil samples or soil borings. Such variations may result in changes to our recommendations and may require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

If there is a substantial lapse of time between the submission of this report and the start of work at the site; if conditions have changed due to natural causes or construction operations at, or adjacent to, the site; or, if the basic project scheme is significantly modified from that assumed, it is recommended this report be reviewed to determine the applicability of the conclusions and recommendations.

Our work has been conducted in general conformance with the standard of care in the field of geotechnical engineering currently in practice in the Pacific Northwest for projects of this nature and magnitude. No warranty, express or implied, exists on the information presented in this report. By utilizing the design recommendations within this report, the addressee acknowledges and accepts the risks and limitations of development at the site, as outlined within the report.

Sincerely,
PBS Engineering and Environmental

Randy S. Goode, P.E.
Senior Engineer

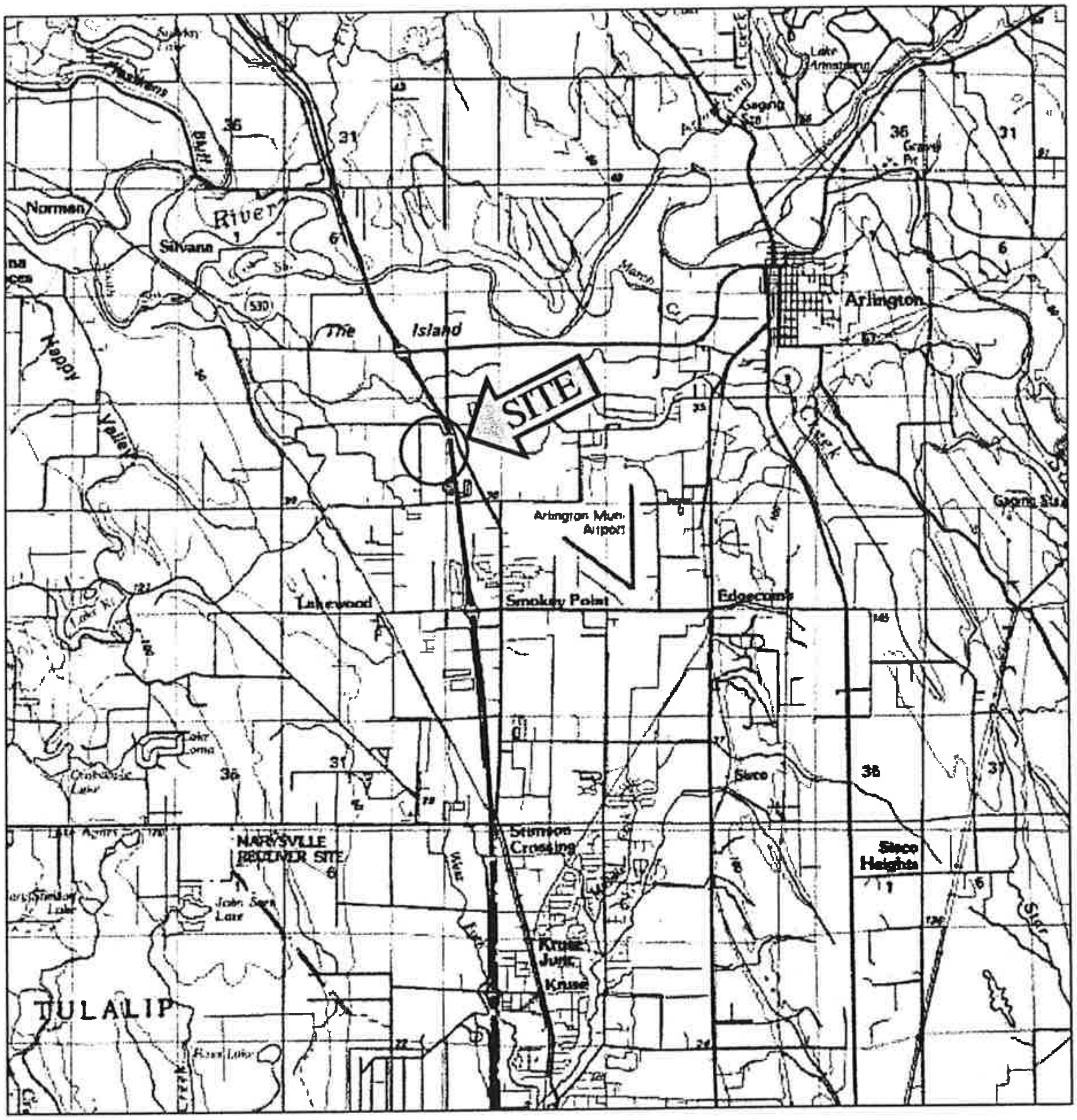
Walter L. Wright, P.E.
Senior Geotechnical Engineer

Attachments: Appendix A - Figures
Appendix B - Tables
Appendix C - Boring Logs

7.0 REFERENCES

Peck, R.B., W.E. Hanson, and T.H. Thornburn, 1974, *Foundation Engineering – 2nd Edition*, John Wiley and Sons, Inc

APPENDIX A - FIGURES



0 1/2 MILE 1 MILE 2 MILE 4 MILE

SOURCE: USGS ARLINGTON WEST QUADRANGLE, WA 1989

Prepared for: STILLAGUAMISH SENIOR CENTER

PBS	Project #: 17249.000 Date: APRIL 2004	SITE LOCATION MAP STILLAGUAMISH GARDENS SENIOR CENTER ARLINGTON, WASHINGTON	FIGURE 1

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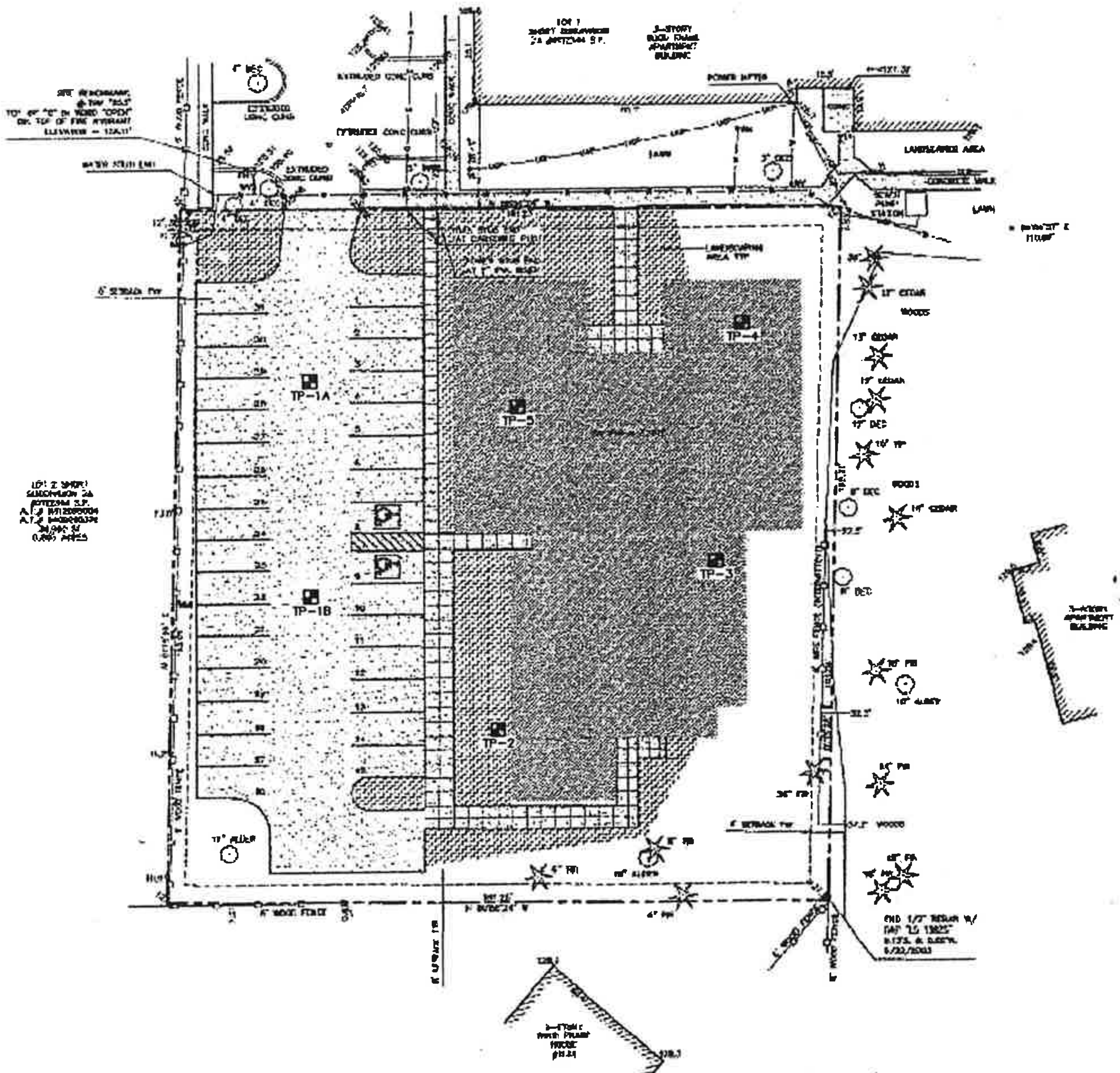

BASE SOURCE: SHEET A1.21 "PHASE 1 SCHEMATIC DESIGN"
SCC HOUSING COMPLEX: MINAKER ARCHITECTURE/
ZERVAS GROUP ARCHITECTS, JANUARY 2004

NOT TO SCALE

LEGEND

TP-1 TEST PIT AND TEST PIT NUMBER

Prepared for: STILLAGUAMISH SENIOR CENTER

PBS	Project #: 17249.000 Date: APRIL 2004	**TEST PIT LOCATION MAP** STILLAGUAMISH GARDENS SENIOR CENTER ARLINGTON, WASHINGTON	FIGURE **2**

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APPENDIX B - TABLES

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TABLE 1: Soil Classification Criteria and Terminology

Classification of Terms and Content	USC Grain Size		
NAME – MINOR Constituents (12-50%) MAJOR Constituents (>50%)	Fines		<#200 (.075mm)
Slightly (5-12%)	Sand	Fine	#200 - #40 (.425mm)
Relative Density or Consistency		Medium	#40 - #10 (2.0mm)
Color		Coarse	#10 - #4 (4.75mm)
Moisture Content	Gravel	Fine	#4 - .75 inch
Plasticity		Coarse	.75 inch – 3 inches
Trace Constituents (0-5%)	Cobbles		3 to 12 inches; scattered <15% est., numerous >15% est.
Other: Grain Shape, Approximate Gradation, Organics, Cement, Structure, Odor…	Boulders		>12 inches
Geologic Name or Formation: (Fill, Willamette Silt, Till, Alluvium…)			

Relative Density or Relative Consistency (after Terzaghi and Peck, 1967)

Granular Materials		Fine-Grained (cohesive) Materials				
SPT Blows/ft	Relative Density	SPT Blows/ft	Relative Consistency	Torvane (tsf) Shear Strength	Pocket Pen. (tsf) Unconfined	Manual Penetration Test
0-4	Very Loose	<2	Very Soft	<0.13	<0.25	Easy several inches by fist
4-10	Loose	2 – 4	Soft	0.13 – 0.25	0.25 – 0.50	Easy several inches by thumb
10-30	Medium Dense	4 – 8	Medium Stiff	0.25 – 0.50	0.50 – 1.00	Moderate several inches by thumb
30-50	Dense	8 – 15	Stiff	0.50 – 1.00	1.00 – 2.00	Readily indented by thumb
>50	Very Dense	15 – 30	Very Stiff	1.00 – 2.00	2.00 – 4.00	Readily indented by thumbnail
		>30	Hard	>2.00	>4.00	Difficult by thumbnail

Moisture Content

Dry: Absence of moisture, dusty, dry to the touch
Damp: Some moisture but leaves no moisture on hand
Moist: Leaves moisture on hand
Wet: Visible free water, from below water table

Plasticity	Dry Strength	Dilatancy	Toughness
ML Non – Med	None to Low	Slow to Rapid	Low, can't roll
CL Low – Med	Medium to High	None to Slow	Medium
MH Med – High	Low to Medium	None to Slow	Low to Med.
CH Med – High	High to V. High	None	High

Structure

Stratified: Alternating layers of material or color >6mm
Laminated: Alternating layers <6mm thick
Fissured: Breaks along definite fracture planes
Slickensided: Striated, polished, or glossy fracture planes
Blocky: Cohesive soil that can be broken down into small angular lumps Which resist further breakdown
Lenses: Has small pockets of different soils, note thickness
Homogeneous: Same color and appearance throughout

Unified Soil Classification Chart (Visual-Manual Procedure); (Similar to ASTM Designation D2488)

Major Divisions			Group Symbols	Typical Names
Coarse-Grained Soils: More than 50% Retained on No. 200 sieve	Gravels: 50% or more retained on the No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands: more than 50% passing the No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils: 50% or more passes No. 200 sieve	Silt and Clays Low Plasticity Fines		ML	Inorganic silts, rock flour, clayey silts
			CL	Inorganic clay of low to medium plasticity, gravelly clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silt and Clays High Plasticity Fines		MH	Inorganic silts, clayey silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

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TABLE 2: Modified Mercalli Intensity Scale & Comparison of Peak Bedrock Acceleration

Modified Mercalli Intensity Scale (abridged)	
I	Not felt, except by a very few under especially favorable circumstances.
II	Felt by only a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing cars may rock slightly. Vibration like passing truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls made cracking sound. Sensation like heavy truck striking building. Standing cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows, etc. broken.; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage **negligible** in buildings of good design and construction; **slight** to moderate in well-built ordinary structures; **considerable** in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars.
VIII	Damage **slight** in specially designed structures; **considerable** in ordinary substantial buildings, with partial collapse; **great** in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving cars disturbed.
IX	Damage **considerable** in specially designed structures; well-designed frame structures thrown out of plumb; **great** in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward in the air.

Peak Bedrock Acceleration (units of g)	Approximate modified Mercalli intensity (after Madin and Mabey, 1996)
0.04	V
0.06	VI
0.08	VI+
0.10 to 0.14	VII
0.16 to 0.24	VII+
0.26 to 0.30	VIII
0.32 to 0.48	VIII+
0.50 to 0.55	IX
0.65 to 0.75	X
0.85+	X+

APPENDIX C – TEST PIT LOGS

TEST PIT LOG

Project Name: STILLAGUAMISH GARDENS SENIOR CENTER
Project Number: 17249.000
Excavated: JERRY'S EXCAVATING, INC.
Recorded By: RSG

Test Pit Number: TP-1A – TP1B
Reference Elevation: N/A
Completed Depth: 5 FEET
Date: 4/9/04

DEPTH (FEET BGS)	LITHOLOGIC COLUMN	SOIL DESCRIPTION AND STRATIGRAPHY	SAMPLE LOCATION	FIELD TEST RESULTS	DEPTH
0'–2'	ML	Dark-brown, sandy **SILT**, moist, firm, containing roots.	☒ (11.4) 1-1@ 2'		
2'–5'	SP	Coarse-**SAND**, yellow-brown, moist, medium stiff, trace gravel.	☒ (13.3) 1-2@ 4'	PP = 1.5 to 2.0 tsf	
5'		**BOTTOM OF HOLE** No groundwater encountered Infiltration test conducted at 4.0 feet. Measured average rate of 1 minute/inch at T1A and T1B locations.			

Depth scale: 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12'

LEGEND

☒ S-1 GRAB SAMPLE LOCATION AND NUMBER
PP = POCKET PENETROMETER READING
(15) WATER CONTENT (PERCENT)
O~ SEEPAGE ↓ CONTINUOUS
• NO SAMPLE RECOVERED

PBS
4412 SW CORBETT
PORTLAND, OREGON
97239
(503) 248-1939
FAX
(503) 248-0223

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TP-1

C1
FIGURE

TEST PIT LOG

Project Name: STILLAGUAMISH GARDENS SENIOR CENTER
Project Number: 17249.000
Excavated: JERRY'S EXCAVATING, INC.
Recorded By: RSG

Test Pit Number: TP-2
Reference Elevation: N/A
Completed Depth: 8 FEET
Date: 4/9/04

DEPTH (FEET BGS)	LITHOLOGIC COLUMN	SOIL DESCRIPTION AND STRATIGRAPHY	SAMPLE LOCATION	FIELD TEST RESULTS	DEPTH
0'–2'	SM-ML	Silty **SAND** to sandy **SILT**, light brown, with organics (roots).		PP = 1.0 tsf	
2'–4'	SP	Coarse-**SAND**, mottled gray and brown, medium-dense.		PP = 2.0 tsf	
4'–8'	SP	Coarse-**SAND**, gray, moist, dense.	☒ (3.8) 2-1@ 5' ☒ (13.4) 2-2@ 8'		
8'		**BOTTOM OF HOLE** No groundwater encountered			8'

Depth scale: 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12'

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LEGEND

- ☒ S-1 GRAB SAMPLE LOCATION AND NUMBER
- PP = POCKET PENETROMETER READING
- (15) WATER CONTENT (PERCENT)
- O⟶ SEEPAGE ↓ CONTINUOUS
- • NO SAMPLE RECOVERED

TP-2

C2
FIGURE

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TEST PIT LOG

Project Name: *STILLAGUAMISH GARDENS SENIOR CENTER*
Project Number: *17249.000*
Excavated: *JERRY'S EXCAVATING, INC.*

Test Pit Number: *TP-3*
Reference Elevation: *N/A*
Completed Depth: *8 FEET*
Date: *4/9/04*

Recorded By: *RSG*

DEPTH (FEET BGS)	LITHOLOGIC COLUMN	SOIL DESCRIPTION AND STRATIGRAPHY	SAMPLE LOCATION	FIELD TEST RESULTS	DEPTH
0'–2'	SM-ML	Silty **SAND** to sandy **SILT**, light brown, with organics (roots).	⊠ (7.8) 3-1@ 2'		1'
2'–6'	SP	Medium-fine-grain-**SAND**, yellow-brown, trace gravel, moist.	⊠ (5.7) 3-2@ 5'	PP = 1.50 tsf	2' 3' 4' 5'
6'–8'	SP	Coarse **SAND** and gravel, moist, medium-stiff.	⊠ (4.9) 3-3@ 8'		6' 7'
8'		**BOTTOM OF HOLE** No groundwater encountered			8'
9' 10' 11' 12'					9' 10' 11' 12'

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LEGEND

⊠ S-1 GRAB SAMPLE LOCATION AND NUMBER
PP = POCKET PENETROMETER READING
(15) WATER CONTENT (PERCENT)
SEEPAGE ↓ CONTINUOUS
• NO SAMPLE RECOVERED

TP-3

C3
FIGURE

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TEST PIT LOG

Project Name: STILLAGUAMISH GARDENS SENIOR CENTER
Project Number: 17249.000
Excavated: JERRY'S EXCAVATING, INC.

Recorded By: RSG

Test Pit Number: TP-4
Reference Elevation: N/A
Completed Depth: 10 FEET
Date: 4/9/04

DEPTH (FEET BGS)	LITHOLOGIC COLUMN	SOIL DESCRIPTION AND STRATIGRAPHY	SAMPLE LOCATION	FIELD TEST RESULTS	DEPTH
0'–2'	SM-ML	Silty **SAND** to sandy **SILT**, light brown, with organics (roots).	☒(10.0) 4-1@ 2'		
2'–6'	SP	Medium-fine-grain-**SAND**, yellow-brown, trace gravel, moist.	☒(9.7) 4-2@ 4'	PP = 1.5 tsf	
6'–10'	SP-SG	Coarse-**SAND** with gravels, yellow-brown, stiff.	☒(4.9) 4-3@ 10'		
10'		**BOTTOM OF HOLE** No groundwater encountered			

Depth scale: 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 11' 12'

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LEGEND

☒S-1 GRAB SAMPLE LOCATION AND NUMBER
PP = POCKET PENETROMETER READING
(15) WATER CONTENT (PERCENT)
O⌒→ SEEPAGE ↓ CONTINUOUS
• NO SAMPLE RECOVERED

TP-4

C4
FIGURE

TEST PIT LOG

Project Name: STILLAGUAMISH GARDENS SENIOR CENTER
Project Number: 17249.000
Excavated: JERRY'S EXCAVATING, INC.
Recorded By: RSG

Test Pit Number: TP-5
Reference Elevation: N/A
Completed Depth: 11 FEET
Date: 4/9/04

DEPTH (FEET BGS)	LITHOLOGIC COLUMN	SOIL DESCRIPTION AND STRATIGRAPHY	SAMPLE LOCATION	FIELD TEST RESULTS	DEPTH
0'–2'	SM-ML	Silty **SAND** to sandy **SILT**, light brown, with organics (roots).	(20.8) 5-1@ 2'		
2'–5'	SP	Medium-fine-grain-**SAND**, yellow-brown, trace gravel, moist.	(10.3) 5-2@ 4'	PP = 1.5 to 2.0 tsf	3'
5'–11'	SP-SG	Coarse-**SAND**s, medium-stiff, moist, mottled brown.	(20.5) 5-3@ 8'		
10'		Very moist, coarse-**SAND**.	(4.9) 5-4@ 11'		
11'		**BOTTOM OF HOLE** No groundwater encountered			

LEGEND

⊠ S-1	GRAB SAMPLE LOCATION AND NUMBER
PP =	POCKET PENETROMETER READING
(15)	WATER CONTENT (PERCENT)
O~	SEEPAGE ↓ CONTINUOUS
•	NO SAMPLE RECOVERED

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TP-5

C5
FIGURE

PBS Engineering and Environmental
Attn: Gary Stensland
130 Nickerson Street Suite 107
Seattle, WA 98109
(206) 233-9639 (206) 762-4780 Fax

Amended Notice to Proceed

Effective Date: March 30, 2004
Amended: April 19, 2004

This notice is to amend PBS Engineering and Environmental to proceed with preparing the **Geotechnical Assessment Report for an amount not to exceed $3,500** ***to include an amended amount of $500*** for the Stillaguamish Senior Center (SSC) 2003 Housing Complex known as Stillaguamish Gardens located at 18308 Smokey Point Blvd in Arlington Washington which is due in 3-weeks, on or before April 22, 2004. There is no time extension.

Zervas Group Architects along with Minaker Architect are the project architects and will provide PBS with the necessary details required for this site in relations to the civil engineering required for the site. Common Ground Senior Developer, Linda Johnson is SSC's representative coordinating the development process for this project. Should you have any questions you can contact Ms Johnson or I. She can be reached at (206) 461-4500 ext 119.

Sincerely,

Jo Olson, Executive Director

CC Dan Webster, Chair of Housing Committee &
Stillaguamish Gardens Board
Sharon Robinson, Zervas Group Architects
Gregory Minaker, Minaker & Associates
Linda Johnson, Housing Development Consultant

PBS

PORTLAND
SEATTLE
VANCOUVER
EUGENE
BEND
TRI-CITIES

April 7, 2004

Linda Johnson
Common Ground
110 Prefontaine Place S. #504
Seattle, WA 98104

**RE: SCOPE MODIFICATION REQUEST - INFILTRATION TESTING
PROPOSED NEW SENIOR CENTER
18308 SMOKEY POINT BLVD
ARLINGTON, WASHINGTON**

COPIES: Sharon Robinson / Zervas Group Architects

Dear Ms. Johnson:

As discussed, the project civil engineer requests we gather storm infiltration data during our exploratory pit trenching for the soils investigation. We are providing a brief scope description and budget for your review and approval of this scope modification.

The purpose of the infiltration testing will be to establish and evaluate storm perculation rates in accordance with approved water quality agency methods. The specific locations and depths of the testing will coincide with the planned storm detention and infiltration basins in the main parking subsurface area. The method of testing shall meet the requirements of EPA Methods for determing infiltration rates using the falling head method. We anticipate performing two to three infiltration test locations. We will utilize the same staffing and equipment provided for the exploratory backhoe trenching. Results and recommendations of the infiltration testing study will be contained with the final geotechnical engineering report.

FEE

We propose to perform the additional scope of work described above for an additional fee not to exceed $800.

This fee assumes any modifications to the scope of services described above, or work following our submission of the final report will be considered additional work. Any additional work will be billed at the hourly rates indicated on the General Terms and Conditions for Professional Service (8/2002).

PBS

APPROVAL

Please indicate acceptance of this Agreement by returning a signed copy of this proposal. If you issue another form of authorizing document, please incorporate/attach this proposal.

We appreciate this opportunity to submit our proposal to you and look forward to your favorable consideration. If you have any questions or wish to discuss further the scope of work or cost, please contact me at (503) 248-1939.

Sincerely,

____

Randy S. Goode, P.E.
Senior Engineer

ACCEPTED BY:

____

Name (Please Print)

____

Signature