Soils

3014960

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September 26, 2012
Project No. 12031

Mr. Eric J. Rystadt
Main Street Development, Inc.
P.O. Box 91096
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Subject: Preliminary Geotechnical Engineering Report
14000 Block of 41st Ave NE, Parcel No. 2226049014
Seattle, Washington – DPD Project No. 6327131

This report presents the results of our geological/geotechnical evaluation of a proposed new residence to be located on the above noted parcel in the 14000 Block of 41st Avenue NE in Seattle, Washington. The residence will be a Waterford Design, three story, wood framed structure that steps down the steep hillside on the east side of 41st Avenue NE. Access will be via a new driveway off of 41st Avenue NE that will require a large concrete wall along the west side of the structure. The area between the concrete wall and the existing street will be backfilled to support the new driveway.

The subject property is comprised primarily of a steep slope that is characterized as an environmentally critical area by the city of Seattle. As such, a geotechnical study is required prior to issuance of a building permit for the property. The purpose of our study was to characterize the subsurface soil and ground water conditions underlying the subject parcel and to determine the feasibility of constructing the new residence. Once it was determined to be feasible to construct the residence we were to provide geotechnical design recommendations for the structure. These would include grading recommendations, foundation design parameters, retaining wall design parameters, slope stability and seismic hazards identification and mitigation, if required, shoring design recommendations, if required, and erosion and drainage considerations.

EXISTING CONDITIONS

The subject property consists of an approximate 9,000 square foot parcel that is generally rectangular in shape. In the east-west direction the parcel measures 99.5 feet along the south side and 118.0 feet along the north side. In the north-south direction the parcel measures 89.21 feet along the east side and 94.9 feet along the west side. The odd dimensions are due to the radius of the 41st Avenue right-of-way along the west side of the property. The east property line is located near the bottom of a steep slope.

LAND USE FULL C SF/D $1000000 14012 41ST AVE NE
Appl:4/18/2013 Prty: Filed at:14012 41ST AVE NE Use:Y
Land use application to allow a three story 3,477 sq.ft. single family dwelling unit with an attached garage in an environmentally critical area.
Parent: Related AP:6327107 Build ID:NONE 3014960

The subject parcel slopes downward from the northwest to the southeast to the bottom of a large ravine with overall relief of about 36 feet over a distance of 160 feet or an overall slope gradient of about 22 percent. The northwest portion of the site is nearly flat over a distance of about 40 to 50 feet. However, steep slopes dropping downward to the southwest from the top of the slope in this area are about 100 percent gradient or 1H:1V. The slope downward to the east from 41st Avenue NE, near the southwest corner of the property has a gradient of about 40 percent.

The steep slope areas of the site are heavily vegetated with grass, brambles and both small and large trees. No visual indications of past slope movement were apparent on the slope. There were no indications of erosion, ground water seepage or hydrophilic vegetation on the property. Past illegal dumping has resulted in surficial garbage and debris on the face of the slope.

A culvert currently dumps water near the top of the slope on the east side of 41st Avenue NE just north of the south property line. Erosion below this culvert did not appear to be significant at this time.

Subsurface Soil and Ground Water Conditions

In order to characterize the subsurface soil and ground water conditions on the property five exploration pits were excavated on the site on July 18, 2012. The exploration pits (EP-4 through EP-8) were placed at the approximate locations shown on the attached Site & Exploration Plan.

Underlying 8 to 12 inches of organic forest duff, fill soils were encountered in each of the exploration pits. The fill generally consisted of loose to medium dense, silty, fine to medium sand. The fill soils extended beyond the full depth of the excavations in EP-5 (7.0 feet) and EP-8 (10 feet). In EP-6 the fill extended to the bottom of the buried foundation at a depth of 8.2 feet. In EP-4 and EP-7 the fill extended to about 4 feet below existing grade. Small amounts of debris, typically pieces of concrete and asphalt, were observed in EP-5, EP-6 and EP-8. A buried concrete foundation was observed in EP-6 and an approximate 12 inch thick layer of organics was observed from 3 to 4 feet below existing grade in EP-7. Many large logs were observed within the heavy bramble bush vegetation at the top of the slope in the northwest corner of the parcel.

Beneath the fill soils the native soils generally consisted of medium dense to dense, medium sand with trace to some silt. In EP-4, at a depth of 8 feet, a 12 inch thick layer of very stiff, moist, white (chalky) with some mottling, SILT was observed.

The published map of the area, the *Geologic Map of Seattle by Troost, Booth, Wisher and Shimel, 2005*, indicates that the site is underlain by pre-Fraser age glacial deposits (Qpf). These deposits generally consist of interbeds of sand, silt, gravel and diamicts of indeterminate age and origin. These deposits are generally very dense or hard and have localized areas of iron oxide cemented layers and interbedded and intermixed fine and coarse grained layers. The entire slope area, from well above the subject site down to the edge of Lake Washington is also mapped as mass wasting deposits.

According to the *Geologic Map of King County, Washington, by Booth, Troost and Wisher, 2007,* the subject site is mapped as pre-Fraser fine grained deposits (Qpff) which is the finer grained portion of the pre-Fraser deposits and generally consists of hard silt and clay with sand interbeds.

Our experience in the area indicates that the upper portion (above 142nd Ave NE) of this east facing slope generally consists of the coarse grained pre-Fraser deposits while the lower portion of the slope (below 142nd Avenue NE) generally consists of the finer grained deposits.

Hydrology

No ground water was observed within the exploration pits excavated for this study nor emanating anywhere on the project site. No indication of standing or flowing water was present on the property at the time of our field work. There was no evidence of erosion anywhere on the parcel.

Seismic Hazards

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture; 2) seismically induced landslides; 3) liquefaction; and 4) ground motion. The potential for each of these to impact the site is discussed below.

The nearest known fault traces to the project are the Seattle Fault to the south and the South Whidbey/Lake Alice Fault to the north, both located many miles away. Due to the distance involved the potential for surficial ground rupture is considered to be low.

Due to the presence of dense/hard, glacially consolidated sediments within the core of the slope, it is our opinion that the potential risk of damage to the proposed structure by seismically induced landsliding of native soils is low. However, the fill soils which comprise much of the northern and western portions of the steep slope area, when saturated, would be subject to movement during a large seismic event. Provided the recommendations presented herein are incorporated into the building plans and suitable site drainage is provided, it is our opinion that development of this site will serve to reduce the potential for soil movement.

Liquefaction is the result of the loss of shear strength in soils when they are subjected to saturated conditions and seismic shaking. Typical soils that are susceptible are those that are saturated, poorly graded (all one size), relatively fine-grained and in a loose condition. During a seismic event, severe shaking may cause liquefaction to occur and differential settlement may result. The encountered stratigraphy has a low potential for liquefaction due to its gradation and consolidated nature of the natural sediments. No mitigation of liquefaction hazards is warranted.

Based on the encountered stratigraphy, it is our opinion that any earthquake damage to the proposed structures when founded on suitable foundation bearing strata in accordance with the recommendations provided in this report would be caused by the intensity and acceleration associated with the event and not any of the above-discussed impacts. Design of the project should be consistent with 2009 *International Building Code* (IBC) guidelines. In accordance with the 2003 IBC, Table 1615.1.1, the parcel is classified as Site Class D.

Seattle Landslide Study

Based on our review of the updated 2003 Seattle Landslide Study, there are 54 recorded landslides within the area of the project site which is included in the Burke-Gilman Stability Improvement Area. Forty-three of the slides in this study zone occurred to the south of the project site. The vast majority of the recorded slides are shallow colluvial failures and most or all involved poor drainage control and fill soils. Three deep seated slides, 1 ground water blowout and 2 high bluff peeloffs have been recorded. The closest slide to the project site occurred immediately across the 141st Avenue NE and was a very shallow colluvial slide on an oversteepened street cut. The nearest serious landside is a deep seated that occurred 2 to 3 blocks to the north along 141st Avenue NE. This slide appears to have been in road fill where the road crosses a steep sided ravine. The slide did not progress to the east as the rest of the slides in the area have done, but moved northward into the steep ravine in that area. The Tubbs Contact is located down slope and across the bottom of the large ravine from the project site. Based on the attached Figure 1 from the Seattle Landslide Study Update, the vast majority of the slides within the Burke-Gilman Stability Improvement Area have occurred down slope of the Tubbs Contact.

Existing Slope Stability

The sediments that comprise the slope, other than the encountered fill soils which were generally at least medium dense in consistency, have been glacially consolidated on at least two occasions and are generally in a dense condition. In the absence of water these soils are considered to be stable with a factor of safety well in excess of 1.5 for static and 1.2 for pseudostatic or seismic conditions. No indications of ground water were observed on the site or within a reasonable distance above and below the parcel. In addition, the structure will be supported on pipe piles that extend well below the fill soils. As such, a slope stability analysis of the existing slope was not undertaken for purposes of this study.

CONCLUSIONS AND RECOMMENDATIONS

Our exploration indicates that, from a geotechnical standpoint, the subject site is suitable for the proposed development provided the recommendations contained herein are properly followed. Bearing soils are located below a relatively thick fill sequence and foundation support should be provided with small diameter pipe piles.

Site Grading

Prior to any excavation on the site, erosion and surface water control should be established around the perimeter of the excavation to satisfy City of Seattle requirements. All existing debris, vegetation, root masses, unsuitable fill, and any other deleterious materials should be removed if they are located below the planned building area. Sediments encountered in our explorations near planned footing elevation consisted of fill sediments over dense sand with trace to some silt.

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, we anticipate that temporary, unsupported cut slopes in the existing native loose sand soils should not exceed a maximum slope of 1.5H:1V (Horizontal:Vertical). The medium dense existing fill soils can likely be safely excavated at a maximum slope of 1H:1V. Dense native sand soils can likely be excavated on a temporary basis steeper than 1H:1V but this should be further evaluated in the field at time of construction. These estimated slope angles are for areas where there is no ground water seepage and surface water is not allowed to flow over the slope. Where ground or surface water is present the slope angles may need to be reduced. As is typical with earthwork operations, some sloughing and raveling may occur and cut slopes may have to be adjusted in the field. WISHA/OSHA regulations should be followed at all times.

Structural fill to establish desired grades should be placed and compacted according to the recommendations presented in this section. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer or engineering geologist, placed in maximum 8-inch loose lifts with each lift being compacted to a dense and nonyielding condition. Prior to placing any structural fill the exposed soils must first be compacted to a dense, nonyielding condition and approved for structural fill placement. In the case of roadway and utility trench filling within a city right-of-way, the backfill should be placed and compacted in accordance with City of Seattle standards.

The on-site soils consist primarily of fine to medium silty sand (fill) or medium sand with some silt (native). These sediments will generally be suitable for use as structural fill when placed near optimum moisture content. The upper approximate 3 feet of soils were very dry at the time of the field exploration for this project. The silty sand soils are not considered to be free draining.

The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened/disturbed soils should be removed down to competent soil.

Foundation Recommendations

Due to the presence of a significant thickness of fill soils on the property typical shallow spread footing foundations are not considered suitable for this site. In order to extend the foundation loads to suitable bearing soils it will be necessary to use a pile foundation. Although several different types of pile foundations are available, small diameter pin piles offer the most economical installation. Although exploration borings were not advanced on this parcel and actual blow counts not available, it is anticipated that pile lengths will vary depending upon location on the slope and may range from 30 feet high on the slope to 15 feet lower on the slope. Pile lengths will vary depending upon actual encountered conditions and site grades at the time of installation.

Small Diameter Pipe Piles

The piles should be Schedule 40 or greater, 6" diameter, galvanized steel pipe that is driven to refusal into the underlying natural, dense sediments with an air or hydraulic hammer. The piles should be driven with a minimum 1100 pound hammer. Refusal criteria will be determined by the actual hammer used to install the piles. For a 1000 pound hydraulic hammer refusal is defined as less than 1 inch of penetration for 10 seconds of continuous driving over a minimum of 3 cycles with a minimum of 2 feet of embedment into bearing soils. These piles have an allowable axial capacity of 30 kips per pile. A select number of piles must be load tested to verify axial capacity.

Each pile or group of piles should be connected to other piles using a grade beam. Resistance to lateral loads should be provided by use of batter piles. The lateral resistance would be equal to the horizontal component of the axial pile load. The maximum recommended batter is 1H:5V.

Batter piles should be used to resist lateral loads for this site. Due to the presence of the fill soils no passive soil resistance should be used for this calculation. For batter piles the lateral resistance would be equal to the horizontal component of the axial pile load. The maximum recommended batter is 1H:5V.

Anticipated settlement of footings atop a pin pile foundation as described above should be on the less than 1 inch with differential settlements of approximately one-half of the total.

The actual total length of each pile will be determined and adjusted in the field based on required capacity and conditions encountered during installation and may be different than estimated above. Since completion of the pile takes place below ground, the judgment and experience of the geotechnical engineer or his field representative must be used as a basis for determining the required penetration and acceptability of each pile. Consequently, use of the presented capacities in the design requires that a qualified geotechnical engineer or engineering geologist from our firm, who will interpret and collect the installation data and examine the contractor's operations, inspect all piles. We would determine the required lengths of the piles and keep records of pertinent installation data. A final summary report would then be distributed following completion of pile installation.

Floor Support Recommendations

The only concrete slab-on-grade anticipated for the project will be the driveway between the edge of the street and the garage door. This concrete slab will be placed atop structural backfill that is placed to fill behind the westernmost retaining wall. The backfill must be placed and compacted as structural fill to support the concrete slab but must not be over-compacted or excessive lateral pressure may be placed against the wall. Consideration should be given to thickening this slab and using bar reinforcement to provide structural capacity to bridge over any soils that may settle beneath it in the future. The bar reinforcement could extend into the retaining wall along the outer edge of the garage to provide a rigid point of support.

Site Drainage

Based on the design of the structure perimeter footing drains are not considered necessary for this project except for the cast in place concrete retaining wall along the west side of the residence. All storm water runoff from the site should be collected and piped, via tightline pipe, to an approved storm water conveyance system. If detention is a project requirement we recommend that HDPE pipe be used for the detention facility in order to minimize the potential for leakage.

At present a culvert from beneath 41st Ave NE daylights on the project site near the southern property border. Water from this structure must also be collected and handled as per city code to prevent future erosion and/or saturation of the soils on the steep slope.

Retaining Walls

A large cast in place concrete retaining wall is currently planned near the west property line. This wall will function to support the west side of the structure and, when backfilled, to provide a level driveway access from the nearby street. Retaining walls taller than 3 feet must be lined with a minimum of 12 inches of washed rock to within 1 foot of finish grade or with an engineered drain mat such as Inca Drain or Mira Drain. The drainage layer must tie into the footing drain for the wall footing. The footing drain may discharge into the native soils at the toe of the slope.

This retaining wall should be designed for an active pressure of 55 pcf (triangular distribution) with level backfill. A surcharge of 8H (rectangular distribution) should be added for potential seismic loading. Passive resistance to lateral movement will be as discussed in the foundation recommendations section of this report.

Additional surcharges such as traffic, other structures, or heavy equipment must be added to these design values.

Erosion Protection

The soils that will be exposed on the site have a moderate to high erosion potential under both concentrated and sheet flow regimes. Therefore the contractor must take all necessary caution to prevent storm water from impacting these soils during the construction process. Best management practices would include properly installed and maintained silt fencing along the lower portions of the site, keeping soil stockpiles covered, and rocking the construction entrance.

It should be noted that the down slope property below the planned construction area is common ownership with the subject site. This down slope property is heavily vegetated and will provide significant protection from any sediment laden water leaving the commonly owned properties.

SUMMARY

Based on our site reconnaissance, literature research and subsurface explorations the site appears to be suitable for the proposed development provided the recommendations provided herein are properly implemented.

We recommend that we be retained to review those portions of the plans and specifications that pertain to grading, drainage, foundation and shoring installations to determine that they are consistent with the recommendations of this report. This will be required by Seattle DPD along with our issuance of a minimal risk statement following the plan review. Construction monitoring and consultation services should also be provided to verify that subsurface conditions are as expected. Should conditions be revealed during construction that differs from the anticipated subsurface profile, we will evaluate those conditions and provide alternative recommendations where appropriate.

Field construction monitoring and observation services should be considered an extension of this initial geotechnical evaluation, and are essential to the determination of compliance with the project drawings and specifications. Such activities would include site clearing and grading, subsurface drainage, soil bearing capacity verification, and fill placement and compaction.

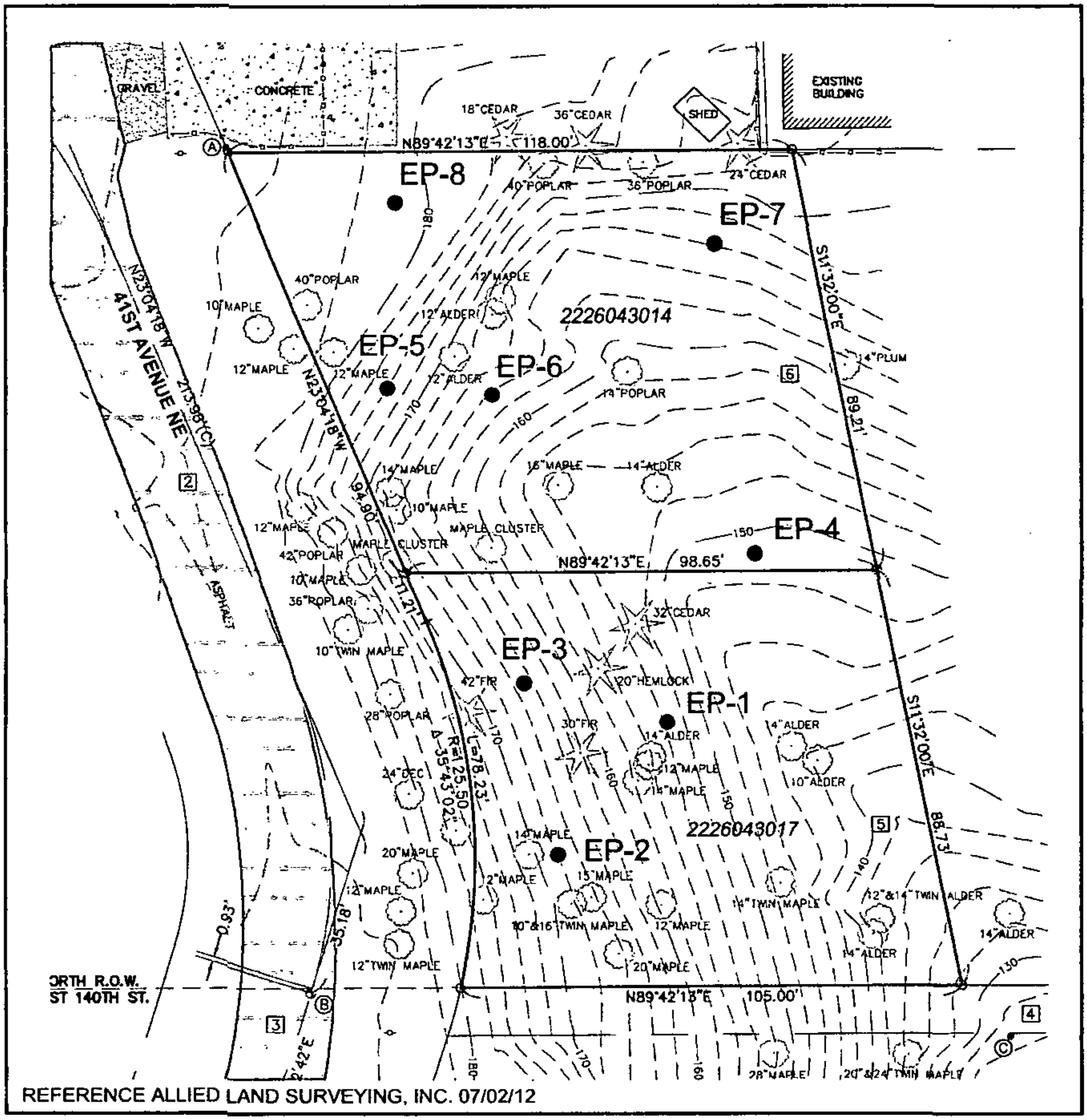
Our findings and recommendations provided in this report were prepared in accordance with generally accepted principles of engineering geology and geotechnical engineering as practiced in the Puget Sound area at the time this report was submitted. We make no other warranty, either express or implied.

Respectfully submitted,

Gary A. Flowers, P.G., P.E.G.
Engineering Geologist

Robert M. Pride, P.E.
Geotechnical Engineer

Attachments: Site and Exploration Plan
Exploration Logs
Revised Burke-Gilman Stability Improvement Area, May 2003



LEGEND

EP-1 ● Approximate location of exploration pit

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APPROXIMATE SCALE IN FEET

GARY A. FLOWERS, PLLC	**SITE AND EXPLORATION PLAN** MAIN STREET DEVELOPMENT, INC. 14100 BLOCK OF 41ST AVE NE SEATTLE, WASHINGTON	FIGURE 1 DATE 09/12 PROJECT NO. 12-030 & 12-031

EXPLORATION PIT LOGS

Main Street Development Property
14000 Block of 41st Avenue NE
SEATTLE, WASHINGTON

EP-1

0.0' – 1.5'	Forest duff & topsoil
1.5' – 3.0'	Loose, dry, tan, fine SAND with some silt – heavy root mass to 34 inches
3.0' – 4.0'	Medium dense, moist, grayish-brown, silty fine SAND
4.0' – 5.0'	Very stiff, moist, gray, SILT, massive with blocky appearance
5.0' – 8.0'	dense, moist, brown, fine-medium SAND with some silt

T.D. @ 8.0 feet, 7-18-12. Caving in upper 3 feet. No ground water.

EP-2

0.0' – 0.7'	Forest duff & topsoil
0.7' – 2.5'	Loose, dry, tan, fine SAND with some silt – heavy root mass to 24 inches
2.5' – 8.0'	Medium dense to dense, moist to very moist, brownish-gray, medium SAND with interbeds of mottled, reddish brown, silty SAND

T.D. @ 8.0 feet, 7-18-12. Caving in upper 2 feet. No ground water.

EP-3

0.0' – 0.7'	Forest duff & topsoil
0.7' – 2.5'	Loose, dry, tan, fine SAND with some silt – heavy root mass to 40 inches
2.5' – 8.0'	Medium dense to dense, moist to very moist, brownish-gray, medium SAND with interbeds of mottled, reddish brown, silty SAND

T.D. @ 8.0 feet, 7-18-12. Caving in upper 2 feet. No ground water.

EP-4

0.0' – 0.8'	Forest duff & topsoil
0.8' – 4.0'	Dense, moist, blackish-gray, interbedded silty SAND and sandy SILT (Fill)
4.0' – 8.0'	Medium dense, moist, brown, silty, fine to medium SAND
8.0' – 9.0'	Very stiff, moist, white (chalky) with some mottling, SILT
9.0' – 11.0'	Dense, very moist, brown, fine to medium SAND, some silt

T.D. @ 11.0 feet, 7-18-12. No caving. No ground water.

EP-5

0.0' – 0.9'	Forest duff & topsoil
0.9' – 7.0'	Medium dense, damp to moist, grayish-brown, silty, fine to medium SAND with occasional pieces of concrete and asphalt (Fill)

[redacted]

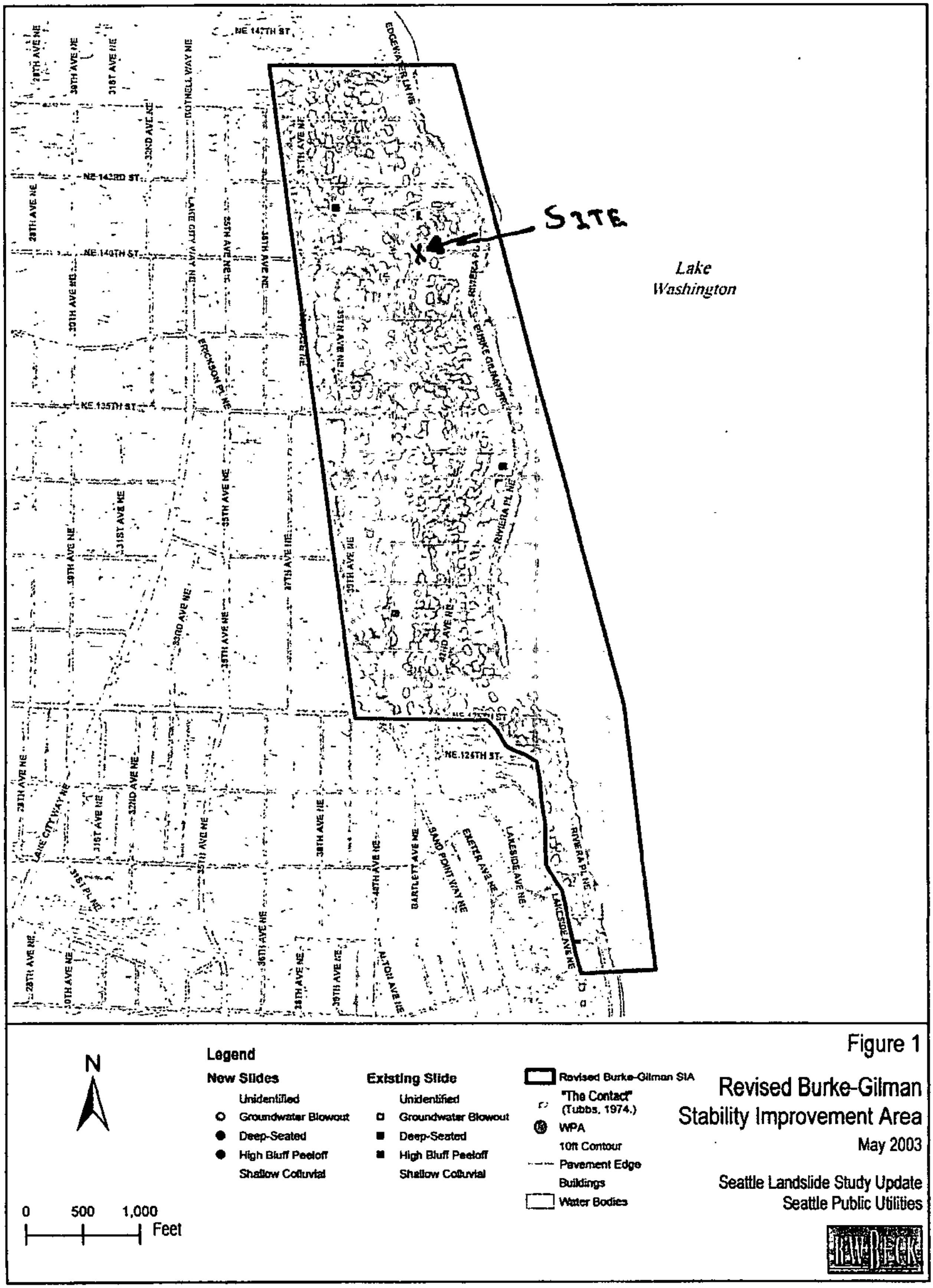

Figure 1

Revised Burke-Gilman Stability Improvement Area

May 2003

Seattle Landslide Study Update
Seattle Public Utilities