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September 26, 2012
Project No. 12031

Mr. Eric J. Rystadt
Main Street Development, Inc.
P.O. Box 91096
Portland, OR 97291

Subject: Geotechnical Engineering Report
14000 Block of 41st Ave NE, Parcel No. 2226049017
Seattle, Washington – DPD Project No. 6327107

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 an approximate 18 foot tall 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 105.0 feet along the south side and 98.65 feet along the north side. In the north-south direction the parcel measures 88.73 feet along the east side and 78.23 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.

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 at shallow depth, it is our opinion that the potential risk of damage to the proposed structure by seismically induced landsliding is low. However, the upper approximate 3 feet of loose sand sediments, when saturated, would be subject to movement during a large seismic event. Provided the recommendations for foundation design presented herein are incorporated into the building plans, it is our opinion that this soil movement would primarily be a landscape issue, should it occur.

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 outer 3 feet of loose soil, 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. 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 relatively shallow and spread footing foundations will be suitable for the project. Overexcavation to reach bearing soils will be deeper than normal due to chasing the bearing soils down the slope.

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, 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 loose sand sediments over medium dense or better sand.

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 loose sand soils should not exceed a maximum slope of 1.5H:1V (Horizontal:Vertical). The denser sand and silt soils can likely be safely excavated at a slope of 1H:1V or steeper depending upon actual encountered conditions. 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 sand with some silt. 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. These sediments 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

Conventional spread footings and column pads may be used for building support when founded either directly on medium dense or better existing native soils, or structural fill placed atop these sediments. A maximum allowable foundation soil bearing pressure of 2,500 pounds per square foot (psf) be utilized for design purposes, including both dead and live loads. An increase of one-third may be used for short-term wind or seismic loading.

Where loose soils are encountered the footing trenches must be extended to medium dense or better native soils. The contractor/owner should be aware that chasing bearing soils down a steep slope can result in a significant amount of overexcavation.

It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing, non-structural filled area or loose soil conditions. In addition,

a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

Anticipated settlement of footings founded on soils as described above should be on the order of 1 inch or less with differential settlements of approximately one-half of the total. However, disturbed soil not removed from footing excavations prior to concrete placement could result in increased settlements. All footing areas should be observed by a representative of this firm, prior to placing any backfill or concrete, to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. Such observation will be required by Seattle DPD as part of their special inspection requirements.

Lateral loads can be resisted by friction between the foundation and the supporting soils, and/or by passive earth pressure acting on the buried portions of the foundations. Vertical foundation elements should be embedded a minimum of 12 inches into medium dense or better bearing soils with a minimum of 6 feet horizontal distance from the slope face to the face of the footing. For these conditions an allowable passive earth pressure of 150 pcf (pounds per cubic foot), expressed as an equivalent fluid unit weight, and a coefficient of friction of 0.40 may be used.

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 near the project site along the northern 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. All footings must be embedded a minimum of 12 inches into suitable bearing soil.

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.

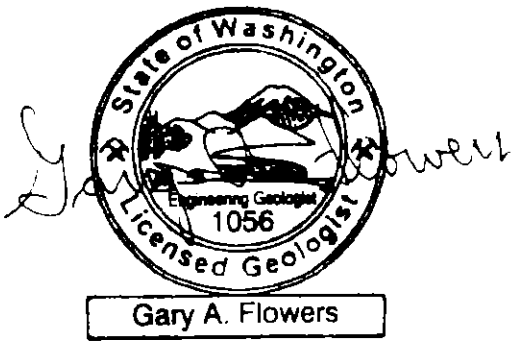
We recommend that we be retained to review those portions of the plans and specifications that pertain to grading, drainage, foundation and shoring installations to determine that they are consistent with the recommendations of this report. This will be required by Seattle DPD along

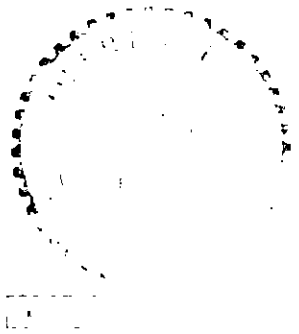
with our issuance of a minimal risk statement following the plan review. Construction monitoring and consultation services should also be provided to verify that subsurface conditions are as expected. Should conditions be revealed during construction that differs from the anticipated subsurface profile, 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.





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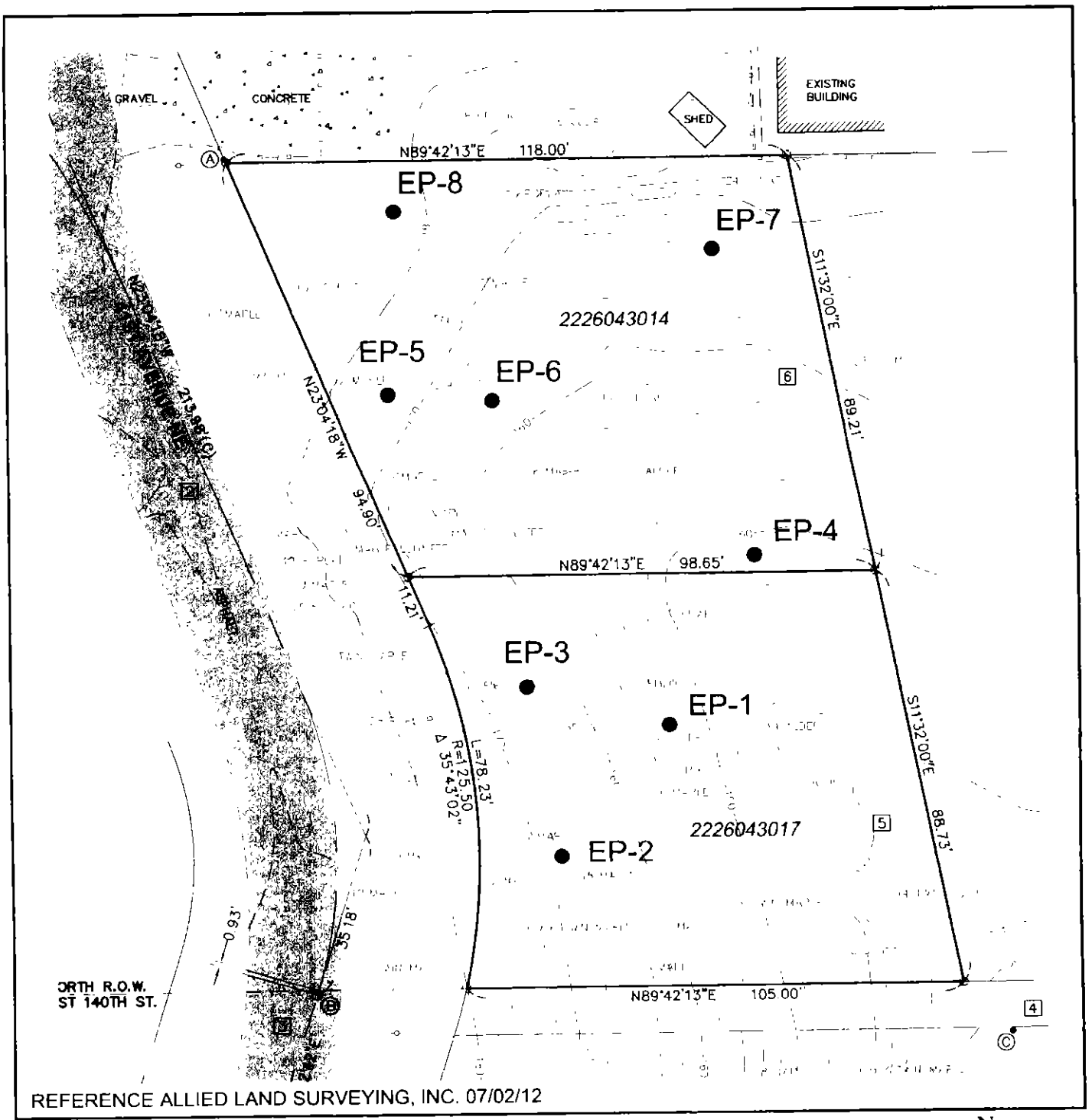
Engineering Geologist

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

N

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APPROXIMATE SCALE IN FEET

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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)

T.D. @ 7.0 feet, 7-18-12. No caving. No ground water.

EP-6

0.0' – 1.0'	Forest duff & topsoil
1.0' – 8.2'	Medium dense, damp to moist, grayish-brown, silty, fine to medium SAND with occasional pieces of concrete and asphalt (Fill). From 5' to 8.2' old concrete rat slab and concrete footing with stem wall and brick laid atop stem wall
8.2' – 11.0'	Medium dense to dense, moist, brown, medium SAND with trace to some silt

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

EP-7

0.0' – 0.7'	Forest duff & topsoil
0.7' – 3.0'	Loose to medium dense, moist, brown, silty, fine to medium SAND (Fill)
3.0' - 4.0'	Intermixed SAND and organics – branches, leaves
4.0' – 8.0'	Loose to medium dense, moist, tan, fine to medium SAND with silt
8.0' – 11.0'	Dense, moist, gray, medium SAND, trace to some silt

T.D. @ 7.0 feet, 7-18-12. Caving in upper 6'. No ground water.
Fill and loose soil may be related to nearby past sewer line construction

EP-8

0.0' – 1.0'	Forest duff, topsoil and many large logs amid heavy brush
1.0' – 10.0'	Loose to medium dense, moist, brown, medium SAND with trace silt and occasional gravel – occasional pieces of concrete and asphalt (Fill)

T.D. @ 10.0 feet, 7-18-12. No caving. No ground water.

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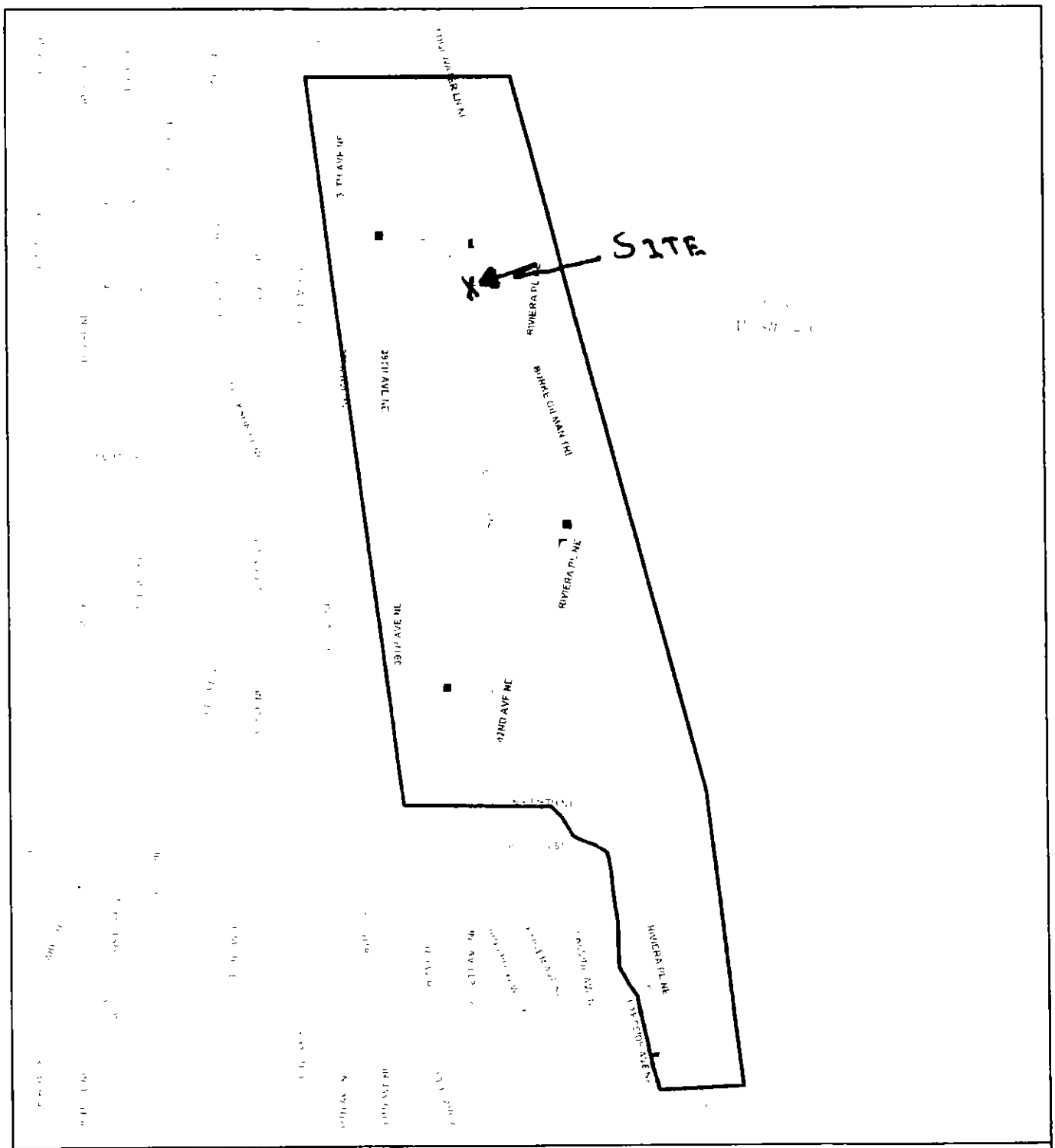

Legend

New Slides
- Unidentified
- Groundwater Blowout
- Deep-Seated
- High Bluff Peeloff
- Shallow Colluvial

Existing Slide
- Unidentified
- Groundwater Blowout
- Deep Seated
- High Bluff Peeloff
- Shallow Colluvial

- Revised Burke Gilman SIA
- "The Contact" (Tubbs, 1974)
- WPA
- 10ft Contour
- Pavement Edge
- Buildings
- Water Bodies

0 500 1,000 Feet

Figure 1

Revised Burke-Gilman Stability Improvement Area

May 2003

Seattle Landslide Study Update
Seattle Public Utilities

RW BECK