Appendix 9 – Geotechnical Survey of Mt. Baker Slopes

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

ALASKA
COLORADO
FLORIDA
MISSOURI
OREGON
WASHINGTON

January 22, 2007

Ms. Katie Moller
Seattle Parks and Recreation
1600 South Dakota Street
Seattle, WA 98108

RE: ENGINEERING GEOLOGIC EVALUATION OF PROPOSED LAKE WASHINGTON BOULEVARD SOUTH VEGETATION MANAGEMENT PLAN, SEATTLE, WASHINGTON

Dear Ms. Moller:

This letter presents our observations and conclusions regarding the engineering geologic aspects of a vegetation management plan proposed for an approximately one-mile interval of Lake Washington Boulevard South in the Lakewood neighborhood of Seattle, Washington. We understand that Seattle Parks and Recreation (Seattle Parks) has proposed to adopt a vegetation management plan for a long and narrow steep slope area between Lake Washington Boulevard South and private properties to its west. Some adjacent property owners have raised a concern that the change in vegetation, particularly the presence of large trees, would have a destabilizing effect on this east-facing slope. This geologic evaluation was performed in conjunction with a vegetation inventory and planning effort by Seattle Parks of the section of park land for which the plan is proposed. We understand that no immediate projects are planned within the study area.

The scope of our services included:

- Review of existing reports from Shannon & Wilson files.
- Review of existing historical information from City of Seattle files.
- Site visit on December 29, 2006.
- Preparation of this letter report.
- Attendance at a public meeting for this project on January 17, 2007.

Our work was authorized by Mr. Woody Wilkinson of Seattle Parks on January 4, 2007.

400 NORTH 34TH STREET · SUITE 100
P.O. BOX 300303
SEATTLE, WASHINGTON 98103
206-632-8020 FAX 206-695-6777
TDD: 1-800-833-6388
www.shannonwilson.com

21-1-20669-001

SITE AND PROJECT DESCRIPTION

The proposed park vegetation management plan area is located in the Lakewood area of southeast Seattle, as shown in a Vicinity Map, Figure 1. The study area is about 5,100 feet long and ranges from about 25 to 150 feet wide, the distance from the western edge of Lake Washington Boulevard South to the eastern boundaries of private properties to the west of the boulevard. A narrow strip of level ground is located immediately west of the roadway, then the ground surface slopes up to the west. Slope inclinations range from gentle to precipitous. Most of this slope is steeper than 40 percent and therefore is designated by the Seattle Department of Planning and Development as a steep slope, environmentally critical area.

Nearly all of the long, narrow area is forest land without any active uses; however, the park land is broken by South Horton Street, a paved road, near the southern end, and by an unimproved right-of-way of South McClellan Street with overhead utilities near the middle of the project. The toe of the northern 1,200 feet of the sloping park land is supported by a short (1.5- to 3-foot-high) concrete retaining wall.

Where the slope is not too steep, informal trails wind through the park property. No erosion or slope instability was observed to be associated with these informal paths. Most of the slope is sparsely to moderately vegetated with deciduous and evergreen trees and moderate to thick undergrowth. Many of trees at the toes of slopes are bowed downhill (pistol-butted), indicating creep (imperceptible downhill soil movement) of the upper few feet of soil. Evidence of deep-seated movement was not observed in the study area.

GEOLOGIC CONDITIONS

"The Geologic Map of Seattle" by Troost, Booth, Wisher, and Shimel (2005) indicates that the subject slope is underlain by granular glacial soils from the last glaciation of the Seattle area and granular and fine-grained deposits of previous glaciations. The glacially overridden soils are in a very dense or hard condition, overlain by a loose, heterogeneous layer of colluvium that commonly ranges from 3 to 10 feet thick in the Seattle area. Colluvium is the soil that is emplaced by gravity, owing to such processes as freeze/thaw, root penetration, landsliding, and erosion. Finally, we observed deposits of fill on the western edges of the upland and masses of yard waste that had been placed on the steep slopes.

The locations, identification numbers, and occurrence dates of seven previous landslides are presented in Figures 2 and 3. These landslides and their information were obtained from the Seattle Landslide Study database (Shannon & Wilson, 2000). All of the reported landslides were classified as shallow, colluvial, and initiated on private property; although in most cases, the debris runout reached Seattle Parks property and/or Lake Washington Boulevard South. All occurred on moderate to very steep slopes and two were associated with broken drain pipes.

A Light Detection and Ranging (LiDAR) (airborne laser image) map of the area indicates that the central portion of the study area (between the South McClellan and South Hanford Streets rights-of-way) is comprised of large, deep-seated landslide(s); however, there were no indicators of historical activity on this feature.

Springs and seepage zones were observed in the field. Their approximate locations are shown in Figures 2 and 3. Some of the seepage runs overland to Lake Washington Boulevard South and then into a stormwater collection system; whereas, other waters run for a limited distance and then re-infiltrate into the colluvium.

GEOMORPHIC ZONES

The slope between the Lake Washington Boulevard South and residences on the upland to the west has a wide range of heights and inclinations, so we have parsed the project area into eight geomorphic zones. These are areas that have similar heights and slope gradients. Their geographic extents and characteristics are presented in Figure 2. These topographic differences are the result of the terrain created during the last glaciation and post-glacial geologic processes, such as erosion and landsliding.

DISCUSSION AND CONCLUSIONS

Based on our evaluation of existing data and observations in the field, it does not appear that there is any particular relationship between the locations of landslides and vegetation, except in the one case where a recent shallow colluvial landslide has occurred on a slope where the private property owner has removed most of the overstory. There are, however, many examples of large trees buttressing the colluvial soils along the toe of the slope; just west of Lake Washington Boulevard South.

Nearly all of the literature regarding vegetation and steep/unstable slopes extols the virtues of a vegetative cover to prevent and/or minimize mass wasting through (1) root reinforcement, (2) soil moisture reduction by evapotranspiration and interception of rainfall, and (3) soil buttressing and arching. In certain circumstances, such as all or most of the trees on a slope being at the top of the slope, the weight of trees could possibly have a deleterious effect, but where the trees are scattered and evenly distributed, the weight of trees on a slope is negligible with regard to slope stability. In cases where large trees are located on the lower one-half to one-third of the slope, they can have a stabilizing effect on the slope. In cases where trees are blown down, the exposed root wads can create a soil sediment source, but the effects are most commonly very local and temporary. Such blowdown is a natural process in a forest and does not contribute in a significant way to slope instability.

We understand that the vegetation management plan calls for maintenance or planting of large trees about 150 feet apart. Our observations (and those of Seattle Parks) in the field were that in most of the study area, the large trees are already 150 feet apart, so new plantings of those trees would be limited.

Although large trees can and do grow on very steep slopes and throughout the full height of slopes, the following two recommendations are made as a planning guideline for this slope:

1. We recommend that the large trees (big leaf maple, western red cedar, and Douglas fir) be planted or managed only on the lower one-third of a slope. In this way, any increased weight (albeit very small) will be on the resisting or buttressing portion of the slope; i.e., weight will not be added to the driving or neutral part of the slope. A map showing the lower one-third of the slope (by vertical measurement) is presented in Figure 2.

2. We also recommend that the large tree plantings be limited to the flatter slopes (<70 percent) to increase the probability of tree survival and to reduce the risk of blowdown. Figure 3 shows the lower one-third of the slope, but with the slope areas steeper than 70 percent subtracted. A recent tree inventory by Seattle Parks for this study indicated that very few large trees were located on slopes steeper than 70 percent.

CLOSURE

The conclusions presented in this letter are based on observed site conditions as they existed at the time of our site visit and on existing information. No subsurface explorations were

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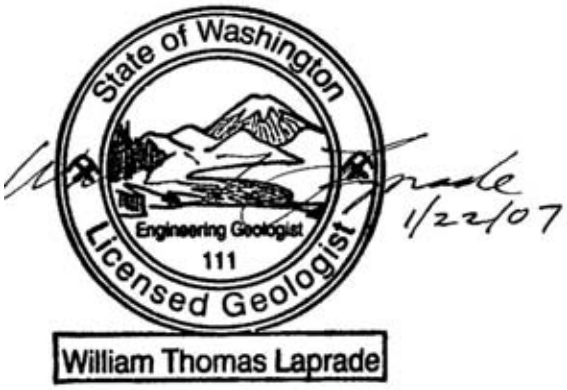
performed for this evaluation. This work was done in accordance with generally accepted engineering geologic practice in this area at this time. No other warranty is made, either expressed or implied.

We recommend that Shannon & Wilson be consulted when specific plans are formulated to review the appropriateness of the vegetation management plan for the study area. The enclosure, "Important Information About Your Geotechnical Report," is to assist you in the use of this letter report.

We appreciate the opportunity to serve you. If you have any questions or comments, please contact me at 206-632-8020.

Sincerely,

SHANNON & WILSON, INC.



William T. Laprade, L.E.G.
Senior Vice President

WTL:WAH/wtl

Enclosures: Figure 1 – Vicinity Map
Figure 2 – Site Plan with Lower One-third Slopes
Figure 3 – Site Plan with Lower One-third Slopes and Slopes Flatter Than 70 Percent
Important Information About Your Geotechnical Report

Lake Washington Boulevard
Vegetation Management Plan
Seattle, Washington

VICINITY MAP

January 2007 21-1-20669-001

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Geotechnical and Environmental Consultants

FIG. 1

NOTE

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

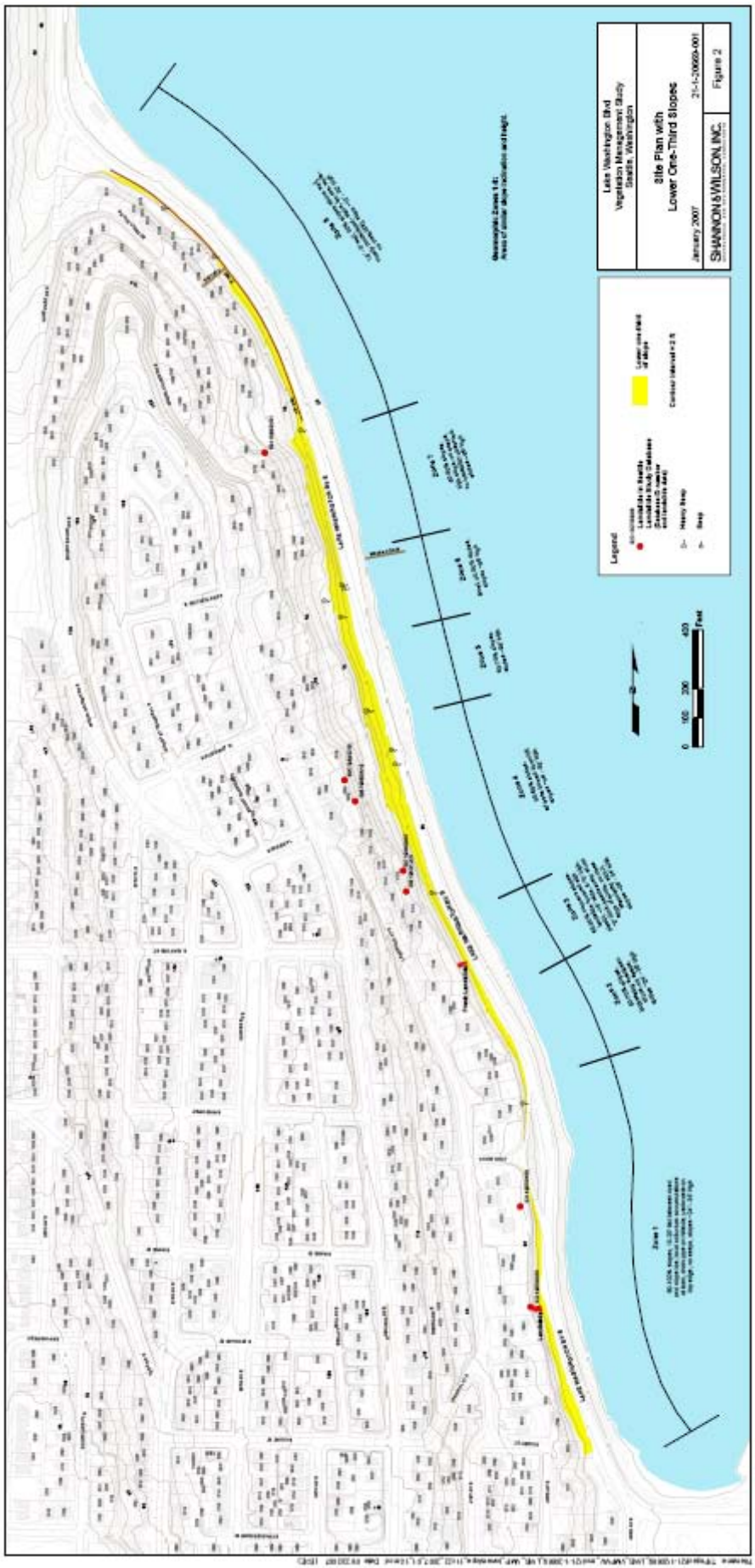
Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland


Lake Washington Blvd
Vegetation Management Study
Seattle, Washington
Site Plan with
Lower One-Third Slopes
January 2007
21-1-10000-001
Figure 2
SHANNON & WILSON, INC.
Legend
0
100
200
400
Feet

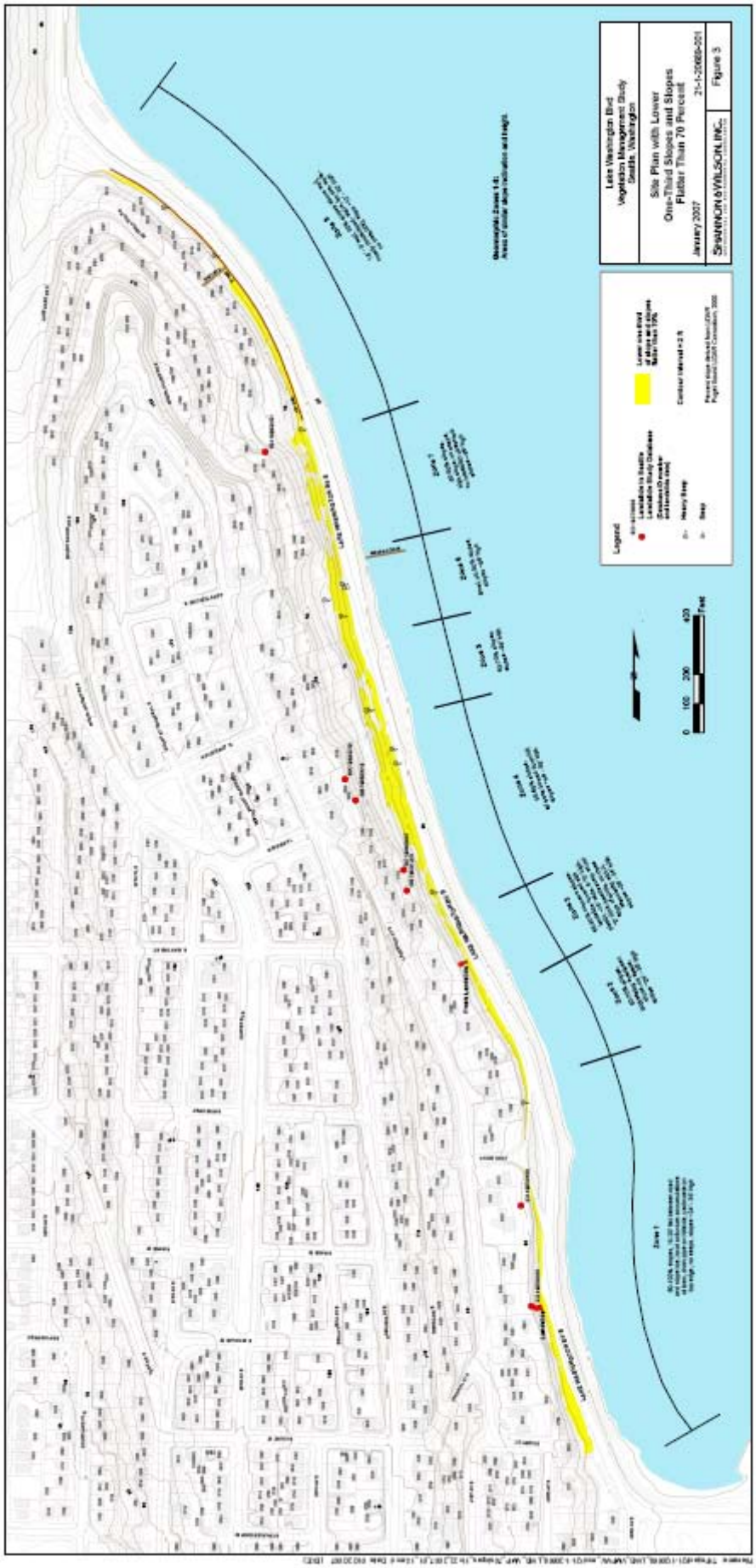

Lake Washington Blvd
Vegetation Management Study
Seattle, Washington
Site Plan with Lower
One-Third Slopes and Slopes
Flatter Than 70 Percent
January 2007
21-1-20669-001
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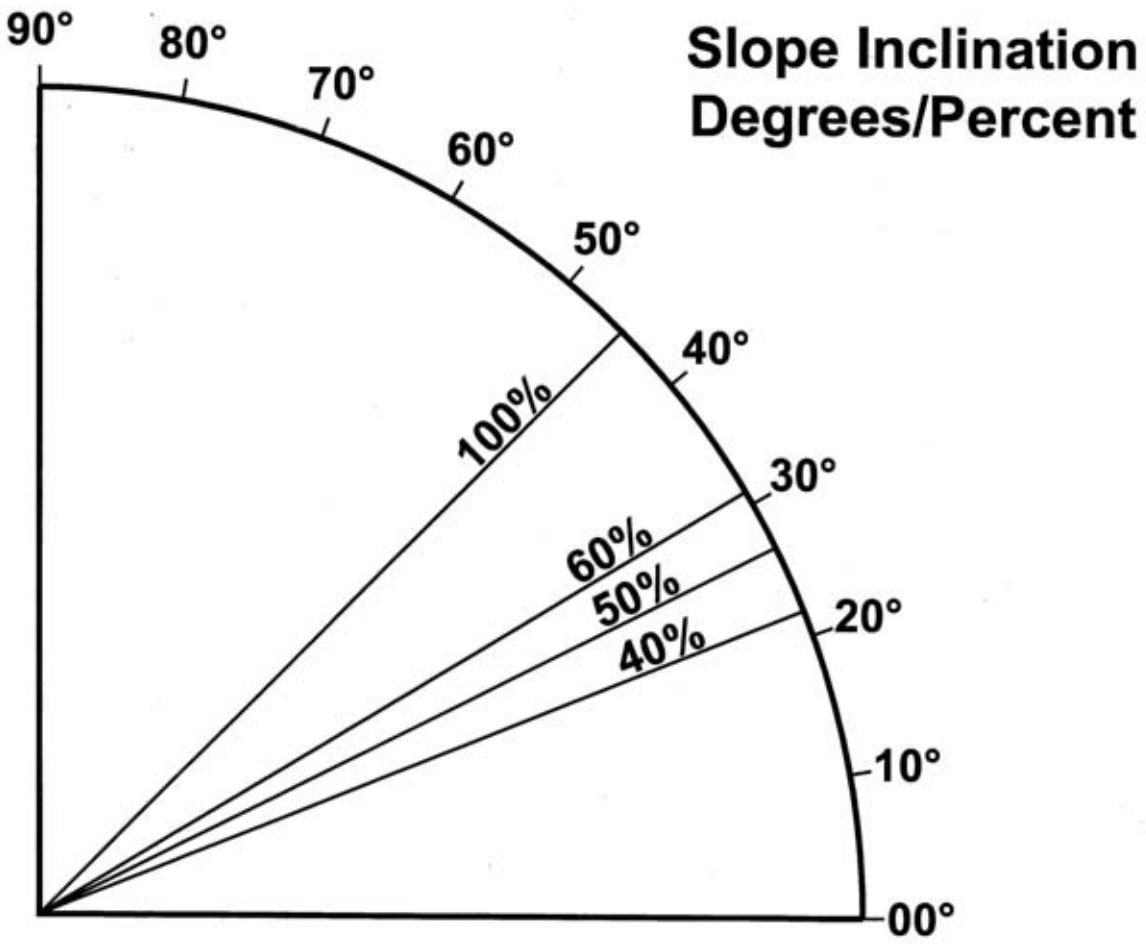
Figure 3
Legend
Lower one-third of slopes flatter than 70%
Center Interval = 2 ft
0 100 200 400 Feet

Appendix 10 – Glossary of Terms and Acronyms

Glossary of Terms/Acronyms

AVG: Average
BMP: Best Management Practices
DBH: Diameter at Breast Height (46")
DON: Department of Neighborhoods
LWB: Lake Washington Boulevard
MU: Management Unit
OC: On Center
OHW: Ordinary High Water
PIP: Public Involvement Process
PNW: Pacific Northwest
ROW: Right of Way
SDOT: Seattle Department of Transportation
SPU: Seattle Public Utilities
UW: University of Washington
VMP: Vegetation Management Plan

Appendix 11 – Slope Inclination Graphic


Slope Inclination
Degrees/Percent
90°
80°
70°
60°
50°
40°
30°
20°
10°
00°
100%
60%
50%
40%