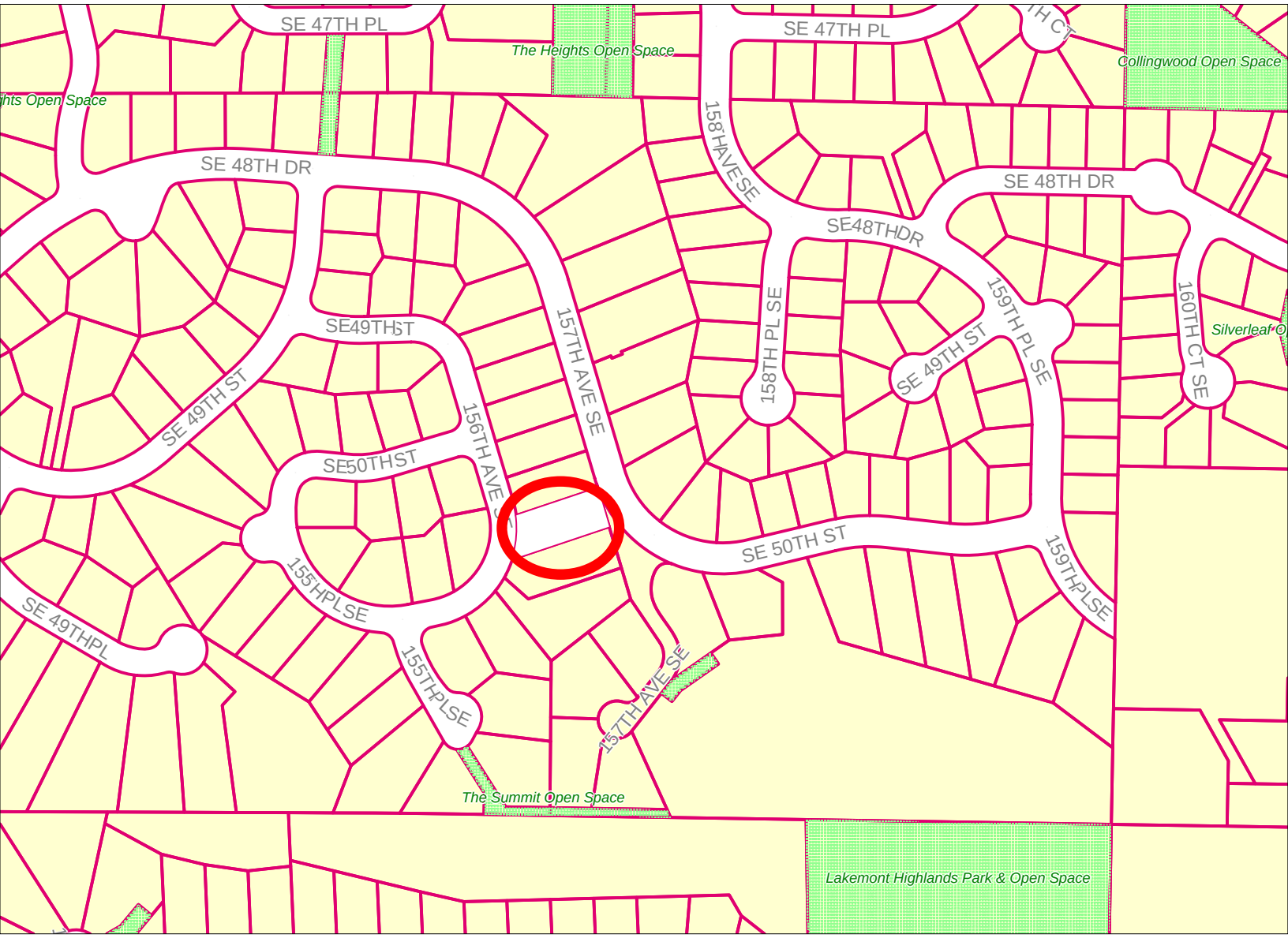
5014 156th Ave SE



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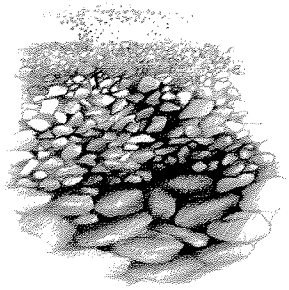

Geotechnical Engineering

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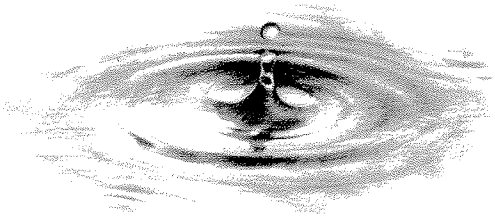
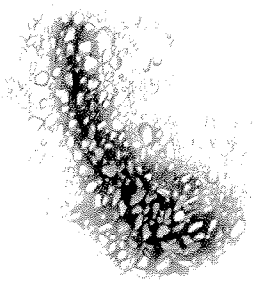


Water Resources

Critical Area Geotechnical Assessment

NAIMUSHIN/GIDIRIMSKI RESIDENCE

Bellevue, Washington



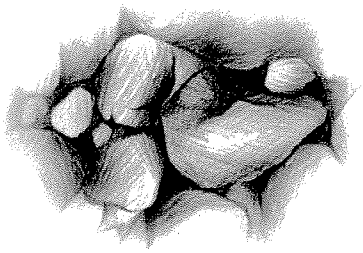
Environmental Assessments and Remediation

Prepared for

Alexei Naimushin and Tatyana Gidirimski

Sustainable Development Services

Project No. KE080750A
March 5, 2009



Geologic Assessments

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March 5, 2009
Project No. KE080750A

Alexei Naimushin and Tatyana Gidirimski
5014 156th Avenue SE
Bellevue, Washington 98006

Subject: Critical Area Geotechnical Assessment
Naimushin/Gidirimski Residence
5014 156th Avenue SE
Bellevue, Washington

Dear Mr. Naimushin and Ms. Gidirimski:

We are pleased to present the enclosed copies of the referenced report. This report summarizes the results of our subsurface exploration and critical area geotechnical assessment and offers recommendations for the design and development of the proposed project.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

J. Scott Kindred, P.E.
Senior Engineer

JSK/ld
KE080750A4
Projects\20080750\KE\WP

Kirkland ▪ Everett ▪ Tacoma
425-827-7701 425-259-0522 253-722-2992
www.aesgeo.com

CRITICAL AREA GEOTECHNICAL ASSESSMENT

NAIMUSHIN/GIDIRIMSKI RESIDENCE

Bellevue, Washington

Prepared for:
Alexei Naimushin and Tatyana Gidirimski
5014 156th Avenue SE
Bellevue, Washington 98006

Prepared by:
Associated Earth Sciences, Inc.
911 5th Avenue, Suite 100
Kirkland, Washington 98033
425-827-7701
Fax: 425-827-5424

March 5, 2009
Project No. KE080750A

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical assessment of the steep slope critical area, and geotechnical engineering study for the proposed landscaping modifications. The site plan and approximate locations of the explorations accomplished for this study are presented on the "Site and Exploration Plan," Figure 1. The locations of the proposed landscaping improvements, including the modular block walls, are shown on Figure 2.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data and geotechnical recommendations to be used in the design of the project. Our study included a review of selected geologic literature, observing exploration pits, and performing geotechnical assessments to address and mitigate risks associated with proximity to the steep slope critical area. Geotechnical engineering studies were completed to formulate our recommendations for site preparation, site grading, modular block wall construction, and erosion control.

1.2 Authorization

Written authorization to proceed with this study was granted by Mr. Alexei Naimushin by means of a signed copy of our scope of work and cost proposal, dated February 11, 2008. This report has been prepared for the exclusive use of Alexei Naimushin and Tatyana Gidirimski and their agents for specific application to this project.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

This report was completed by Associated Earth Sciences, Inc. (AESI) with an understanding of the project based on discussions with Alexei Naimushin and Tatyana Gidirimski and the proposed landscaping plan shown on Figure 2. The site is a residential lot with a single-family home and is surrounded by other single-family homes. As shown on Figure 1, the property is bounded by 156th Avenue SE on the west side and by 157th Avenue SE on the east side. The site slopes to the east. Elevations range from 130 feet above mean sea level (amsl)

at the east side of the house to 110 feet amsl at the eastern property line with an average grade of approximately 25 percent. The slope steepens just west of the east property line with approximately 10 feet of elevation drop over a distance of 12 to 15 feet and a grade of approximately 75 percent. The slope just east of the property line meets the City of Bellevue's steep slope criteria of greater than 40 percent and at least 10 feet of elevation change.

The site includes a partially constructed modular block wall. Vegetation within the eastern portion of the lot includes 10 large trees and a number of shrubs. A sewer easement crosses the property approximately 15 feet east of the house (as shown on Figure 1).

The proposed project, as shown on Figure 2, will include construction of various landscaping features, including walkways, steps, and a modular block wall (MBW). The MBW will generally be less than 3.5 feet high, with the exception of a semi-circular area on the east side of the wall. The semi-circular area will reach a maximum height of approximately 5.5 feet.

3.0 SUBSURFACE EXPLORATION

Our field study included the three hand-dug exploration pits to gain subsurface information about the site. The exploration pits were excavated by the MBW contractor and ranged in depth from 3.5 to 4.5 feet. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineer from our firm. All exploration pits were backfilled immediately after examination and logging. In our opinion, the three explorations provide suitable site coverage for this assessment.

The various types of sediments, as well as the depths where characteristics of the sediments changed, are identified in the exploration logs provided in Appendix A and discussed in Section 4.0. The depths where conditions changed may represent gradational variations between sediment types.

The conclusions and recommendations presented in this report are based primarily on the exploration pits completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected geologic literature.

4.1 Geologic Setting

The site and surrounding community are located near the top of hill overlooking the southern end of Lake Sammamish. Topographic features in the vicinity of the site were formed by glacial and post-glacial processes. Elongate, northwest-southeast trending hills and swales parallel the flow direction of an ice sheet that occupied the Puget Lowland about 15,000 years ago.

4.2 Stratigraphy

The exploration logs are provided in Appendix A. Two stratigraphic units have been identified and delineated for this study: topsoil and Vashon lodgement till. The stratigraphic units were determined with regard to the following parameters: 1) stratigraphic position, 2) composition, and 3) importance of the unit in terms of the presence of ground water. The interpreted subsurface stratigraphy of the site and uplands plateau area are in general agreement with that presented in the *Geologic Map of King County, Washington* (Booth and Wisher, 2006). The stratigraphic units are described below.

Topsoil

Loose, moist, dark brown, silty sand containing abundant organic material and roots. The forest duff or grass and topsoil layer ranged from 0.5 feet to 1 foot thick in the three explorations. Due to their high organic content, these materials are not considered suitable for foundation, roadway, or slab-on-grade floor support, or for use in a structural fill.

Vashon Lodgement Till

Lodgement till was encountered below the topsoil in all three explorations. The upper 2 to 2.5 feet was a weathered zone consisting of moist, reddish brown, loose to medium dense silty sand with gravel and abundant roots. The unweathered lodgement till was moist to wet, olive brown, very dense, silty sand with gravel and occasional cobbles.

The lodgement till sediments were deposited at the base of an active continental glacier and were subsequently overrun and compacted by about 3,000 feet of glacial ice in the project area during the Vashon Stade of the Fraser Glaciation approximately 15,000 years ago. Lodgement till typically possesses high-strength and low-compressibility attributes that are favorable for support of retaining walls. Lodgement till is silty and moisture-sensitive. In the presence of

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and shallow ground water conditions as observed and discussed herein.

5.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur in the Puget Lowland with great regularity. Most of these events are small and are usually not felt by humans. However, large earthquakes do occur, as evidenced by the 2001, 6.8-magnitude event; the 1965, 6.5-magnitude event; and the 1949, 7.2-magnitude event. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

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 hazards to adversely impact the proposed project is discussed below.

5.1 Surficial Ground Rupture

Generally, the largest earthquakes that have occurred in the Puget Sound area are sub-crustal events with epicenters ranging from 50 to 70 kilometers in depth. For this reason, no surficial faulting or earth rupture as a result of deep, seismic activity has been documented to date in the area of the subject site. Therefore, it is our opinion, based on existing geologic data, that the risk of surface rupture impacting the proposed project is low.

5.2 Seismically Induced Landslides

It is our opinion that the risk of damage to the proposed improvements by seismically induced landsliding is low due to gentle slope inclinations and the presence of medium dense to very dense soils observed beneath sloping areas of the site.

5.3 Liquefaction

Liquefaction is a temporary loss in soil shear strength that can occur when loose granular soils below the ground water table are exposed to cyclic accelerations, such as those that occur during earthquakes. The observed site soils were generally medium dense to very dense and

are not prone to liquefaction. A detailed liquefaction analysis was not completed as a part of this study, and none is warranted, in our opinion.

5.4 Ground Motion

Based on the site stratigraphy and visual reconnaissance of the site, it is our opinion that any earthquake damage to the proposed improvements, when founded on a suitable bearing stratum, would be caused by the intensity and acceleration associated with the event and not any of the above-discussed impacts. Based on the site plan for the proposed improvements, failure of the MBW due to ground motion is unlikely to cause any damage to buildings, roads, utilities, or other structures.

6.0 EROSION HAZARDS

The erosion hazard of the site soils is high due to the moderate grades and loose nature of the surficial soil. Without mitigation, dispersed sheet runoff can cause erosion of exposed non-vegetated soil during extreme storm events. Concentrated runoff can pose a greater risk of erosion due to increased water volume and velocity and should be avoided when feasible. Currently, there is no evidence of concentrated runoff or erosion at the site.

It is our opinion that with the proper implementation of the erosion control measures described below (Section 12.0) and by field-adjusting these measures during construction, the potential adverse impacts from erosion hazards on the project may be mitigated.

7.0 LANDSLIDE HAZARDS AND MITIGATIONS

The project site is characterized by moderate slopes within the property and a short steep slope just east of the property. In our opinion, the observed slope inclinations do not present a significant landslide risk given the very dense lodgement till underlying the site. If recommendations contained in this report are incorporated into project design and construction, no detailed landslide hazard analysis is warranted, in our opinion.

III. DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our exploration indicates that, from a geotechnical standpoint, the proposed landscaping improvements are feasible provided the recommendations contained herein are properly followed.

9.0 SITE PREPARATION

Preparation of the MBW area should include removal of all grass, trees, brush, debris, existing fill/peat, and any other deleterious materials from beneath the planned MBW. All soils disturbed by stripping and grubbing operations should be recompacted, as described below for structural fill.

9.1 Temporary and Permanent Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, temporary unsupported cut slopes can be planned at 1H:1V (Horizontal:Vertical) or flatter in the dense lodgement till, and 1.5H:1V in the upper weathered zone with loose soils.

Permanent cut or fill slopes should not be steeper than 2H:1V.

These slope angles are for areas where ground water seepage is not encountered, and assume that surface water is not allowed to flow across the temporary slope faces. If ground or surface water is present when the temporary excavation slopes are exposed, flatter slope angles or other excavation stabilization techniques will be required. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

9.2 Site Disturbance

Most of the on-site soils contain substantial fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils in the area of the MBW are not softened. If disturbance occurs beneath the MBW, the softened soils should be removed and the area brought to grade with structural fill.

9.3 Winter Construction

Due to the high in-situ moisture content of most of the site soils, it may be necessary to dry some of the site soils during favorable dry weather conditions to allow reuse in structural fill applications. If construction takes place in winter, drying is not expected to be feasible, and we anticipate that most of the on-site soils will be unsuitable for structural fill applications.

It may be feasible to use site soils as structural fill in the summer. However, it is possible that significant effort may be needed to scarify, aerate, and dry site soils that are above optimum moisture content to reduce moisture content prior to compaction in structural fill applications. Care should be taken to seal all earthwork areas during grading at the end of each workday by grading all surfaces to drain and sealing them with a compactor. Stockpiled soils that will be reused in structural fill applications should be covered with plastic sheeting whenever rain is possible.

If winter construction is expected, crushed rock fill could be used to provide construction-staging areas. The stripped subgrade should be observed by the geotechnical engineer and should then be covered with a geotextile fabric, such as Mirafi 500X or equivalent. Once the fabric is placed, we recommend using a crushed rock fill layer at least 10 inches thick in areas where construction equipment will be used.

10.0 STRUCTURAL FILL

Structural fill will be necessary to backfill the reinforced section of the MBW. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

After stripping, planned excavation, and any required overexcavation have been performed to the satisfaction of the geotechnical engineer/engineering geologist, the upper 12 inches of exposed ground should be recompacted to 90 percent of *American Society for Testing and Materials* (ASTM):D 1557. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to backfill the MBW. Structural fill behind the

MBW should be free-draining (containing less than 5 percent passing the #200 sieve) soil or rock, acceptable to the geotechnical engineer, placed in maximum 6-inch loose lifts, with each lift being compacted to 95 percent of ASTM:D 1557.

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material at least 72 hours in advance to perform a Proctor test and determine its field compaction standard. A Proctor test is not necessary if washed crushed rock is used to backfill the MBW. On-site soils contain more than 5 percent passing the #200 sieve and are not suitable for MBW backfill.

11.0 MODULAR BLOCK WALL (MBW)

Figure 3 provides details for construction of the MBW. The MBW will be constructed of Anchor Diamond straight concrete landscaping blocks with face dimensions of 17.25 inches by 6 inches and a depth of 12 inches (Figure 3). Wall heights less than 2.5 feet may be constructed without geogrid reinforcing. Wall heights greater than 2.5 feet should be constructed with geogrid reinforcing, as shown on Figure 3. Construction details are discussed below.

- The subgrade for the MBW should be 1 foot below final grade for the unreinforced MBW and 1.5 feet below final grade for the reinforced MBW. The MBW should be founded on undisturbed weathered or unweathered lodgement till. If the lodgement till becomes disturbed or loosened, it should be removed and replaced with compacted crushed surfacing base course (CSBC) that meets Washington State Department of Transportation (WSDOT) Standard Specification 9-03.9(3).

- At least 6 inches of CSBC should be placed beneath the MBW and compacted with a vibrating plate compactor, hoe-pack, or jumping jack to a firm unyielding condition. The CSBC should be approximately 24 inches wide and extend at least 6 inches in front of the MBW.

- For wall heights less than 2.5 feet, the MBW blocks may be stacked on the CSBC to the desired height with no geogrid reinforcing, as shown on Figure 3.

- The semi-circle portion of the wall reaches a maximum height of 5.5 feet and geogrid reinforcing should be placed behind the wall to reinforce the backfill, as shown on Figure 3. The number of geogrid layers is shown on Figure 3 for different wall heights. The length of the geogrid behind each section of wall should range from 4.0 feet to 5.0 feet as shown on Figure 3.

- The geogrid should be Mirafi 3XT or equivalent, as approved by AESI. This material can be purchased from numerous suppliers, including H.D. Fowler in Bellevue at 425-746-8400.

- The backfill placed between the geogrid layers should be free-draining soil (containing less than 5 percent passing the #200 sieve) or washed crushed rock to prevent buildup of hydrostatic pressure. The backfill should be placed in 6-inch lifts and compacted with a vibrating plate compactor or hoe-pack to a firm non-yielding condition.

- As illustrated on Figure 3, the geogrid should be cut into 18-inch-wide strips and placed behind every other block around the semi-circle. In order to maintain the soil-geogrid connection, approximately 2 to 3 inches of soil should be placed between overlapping strips of geogrid. The blocks without geogrid should be marked so geogrid can be placed on these blocks after the next tier of blocks is added.

- Care must be taken to make sure the geogrid is properly oriented so the strongest strands are perpendicular to the wall and in accordance with the manufacturer's guidelines.

- The MBW should be provided with a drain behind the base of the wall. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel or other drain rock. The level of the perforations in the pipe should be set at or slightly below the base of the MBW, and the drain collectors should be constructed with sufficient gradient to allow gravity discharge away from the wall. In addition, the MBW should be lined with a minimum 12-inch-thick washed gravel blanket provided to within 1 foot of finish grade that ties into the drain.

- Drainage from behind the MBW should be discharged to a shallow pit backfilled with drainage rock at the approximate location shown on Figure 2. The shallow pit should be at least 3 feet deep and approximately 2 feet in diameter. The drainage rock in the pit may be covered with geotextile fabric and then covered with topsoil.

- It should be noted that the area bounded by lines extending downward at 1H:1V from the MBW must not intersect another MBW or intersect a filled area that has not been compacted to at least 95 percent of ASTM:D 1557. In addition, a 1.5H:1V line extending down and away from the MBW must not daylight because sloughing or raveling may eventually undermine the MBW. Thus, the MBW should not be placed near the edge of steps or cuts in the bearing soils.

- No buildings or parking surcharges should be allowed within 5 feet of the top of the MBW.

- AESI must observe construction of the wall to verify that it is built in accordance with our specifications.

Stability modeling of the MBW is provided in Appendix B. Simulations were conducted for a 3.5-foot-high wall with two layers of grid and a 5.5-foot-high wall with four layers of grid. These simulations indicate that the MBW configuration described above will support the anticipated loads with a safety factor of at least 1.5.

12.0 EROSION CONTROL MEASURES

12.1 Temporary Erosion Control Measures

Recommended erosion control measure during construction and before permanent erosion control measures are fully established are described below.

- Exposed soil should not remain uncovered for more than 2 days unless it is actively being worked. Ground-cover measures can include erosion control matting, plastic sheeting, straw mulch, crushed rock or recycled concrete, or mature hydroseed.

- During the wetter months of the year, or when large storm events are predicted during the summer months, each work area should be stabilized and covered at the end of each work day using mulch or plastic.

- Surface runoff and discharge should be controlled during and following construction. Uncontrolled discharge may promote erosion and sediment transport. Under no circumstances should concentrated discharges be allowed to flow across the slope.

- Soils that are to be reused around the site should be stored in such a manner as to reduce erosion from the stockpile. Protective measures may include, but are not limited to, covering with plastic sheeting, the use of low stockpiles in flat areas, or the use of straw bales/silt fences around pile perimeters.

- Construction of the proposed improvements should be conducted to prevent concentration of runoff.

- Temporary erosion control measures should be adjusted and maintained, as necessary.

12.2 Permanent Erosion Control Measures

Recommended permanent erosion control measures are described below.

- The short steep slope east of the property is currently covered with landscaping debris and vegetation, which provide erosion protection. Although the large debris may be removed to improve the appearance of the slope, we do not recommend clearing of the slope and exposing bare soil to rainfall and runoff.

- The moderate slopes on the property and the steep slope just east of the property may be landscaped to establish vegetation and provide additional erosion control. In their *Critical Areas Handbook*, the City of Bellevue has developed a Steep Slope Planting Template with a list of recommended plants. This template is provided in Appendix C. The recommended trees included in the template can grow to 60 or more feet and are not recommended given the small scale of the slope and the close proximity to homes. The shrubs and ground-cover recommendations are likely to be suitable for steep slopes at this site. Other plants may be appropriate based on recommendations from a qualified landscape professional.

- Any areas not immediately covered with vegetation should be covered with a mulch, such as bark or wood chips, to reduce soil erosion.

13.0 CONSTRUCTION MONITORING

We are available to provide additional geotechnical consultation as the project develops and to address any changes in the design. In this way, our recommendations may be properly interpreted and implemented. AESI should be on-site during MBW construction to provide geotechnical engineering and monitoring services. The integrity of the MBW depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of the current scope of work. If these services are desired, please let us know, and we will prepare a cost proposal.

14.0 CLOSURE

We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

BRUCE L. BLYTON
STATE OF WASHINGTON
26890
REGISTERED
PROFESSIONAL ENGINEER
3/5/09

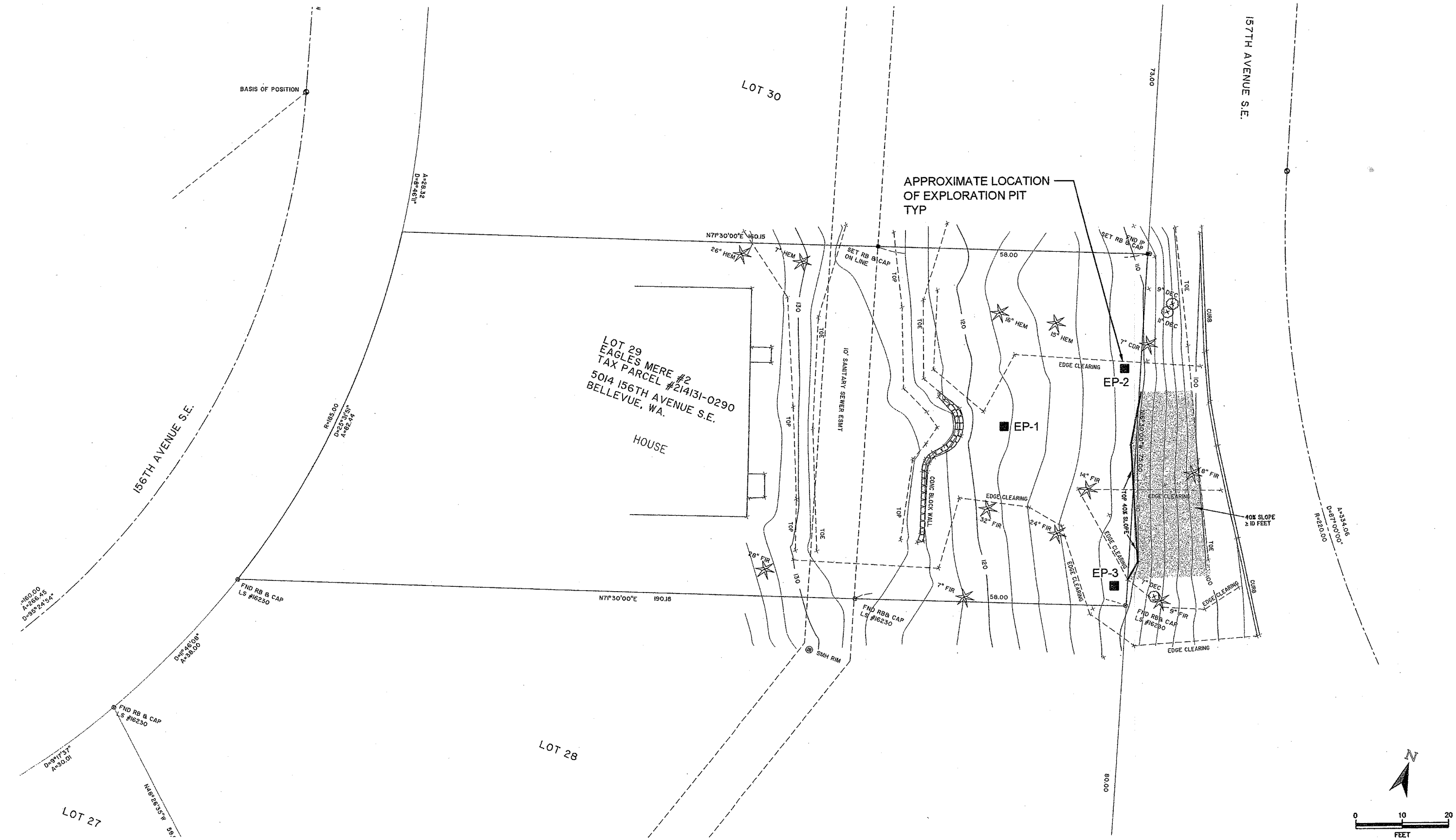
J. Scott Kindred, P.E.
Senior Engineer

Bruce L. Blyton, P.E.
Principal Engineer

Attachments:	Figure 1:	Site and Exploration Plan
	Figure 2:	Landscaping Plan with Location of Modular Block Wall
	Figure 3:	Modular Block Wall Details
	Appendix A:	Exploration Logs
	Appendix B:	Modular Block Wall Stability Modeling
	Appendix C:	Steep Slope Planting Template

IV. REFERENCES

Booth, D.B. and Wisher, A., compilers, 2006, Geologic map of King County, Washington: Pacific Northwest Center for Geologic Mapping Studies, scale 1:100,000.



REFERENCE: GOLDSMITH

Associated Earth Sciences, Inc.

SITE AND EXPLORATION PLAN

NAIMUSHIN - GIDERIMSKI

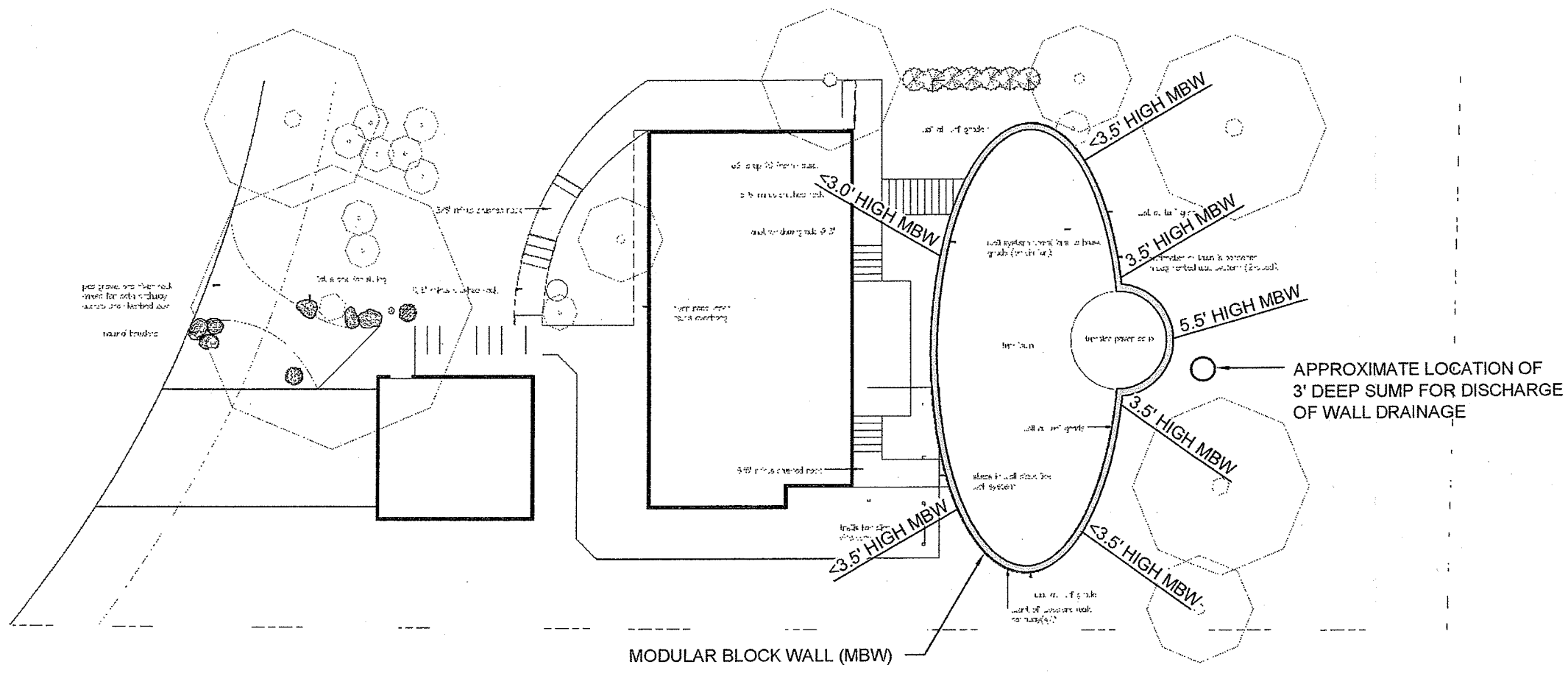
BELLEVUE, WASHINGTON

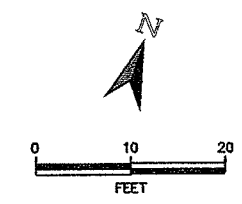
FIGURE 1

DATE 2/09

PROJECT NO. KE080750A

080750 Naimushin-Giderimski \ 080750 Site and Details.dwg LAYOUT: Site and Explr





REFERENCE: NYCE GARDENS

Associated Earth Sciences, Inc.

LANDSCAPE AND WALL PLAN

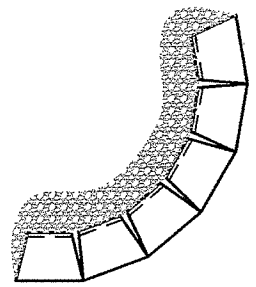
NAIMUSHIN - GIDERIMSKI
BELLEVUE, WASHINGTON

FIGURE 2

DATE 2/09

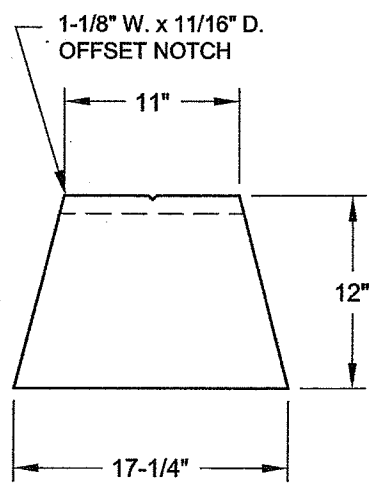
PROJECT NO. KE080750A

080750 Naimushin-Giderimski \ 080750 Site and Details.dwg LAYOUT: Site and Explr

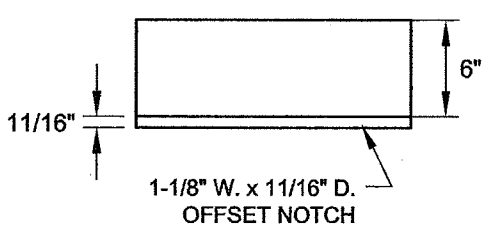


STRAIGHT UNITS

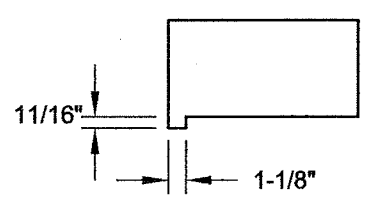
MINIMUM RADIUS: 4 FEET TO FACE



TOP VIEW



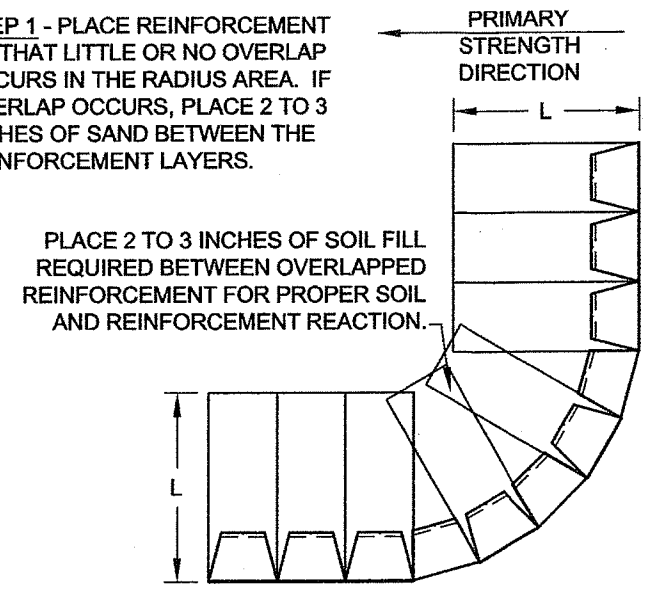
FACE VIEW



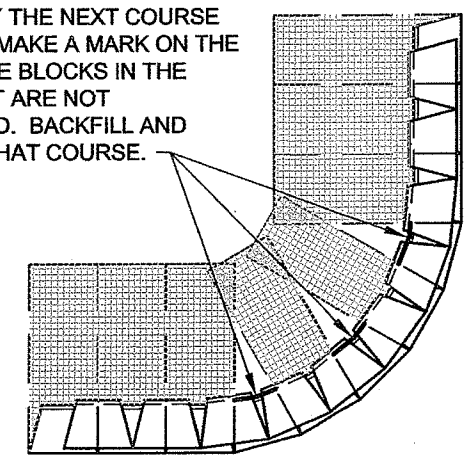
SIDE VIEW

STRAIGHT UNIT

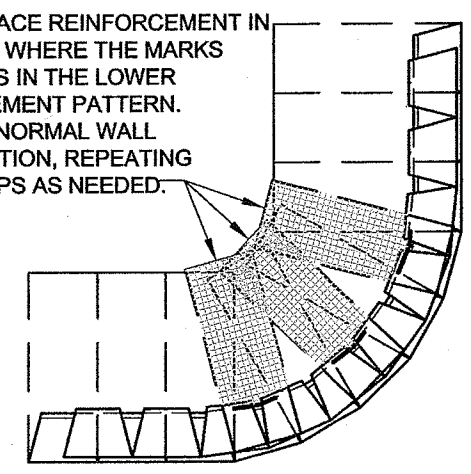
STEP 1 - PLACE REINFORCEMENT SO THAT LITTLE OR NO OVERLAP OCCURS IN THE RADIUS AREA. IF OVERLAP OCCURS, PLACE 2 TO 3 INCHES OF SAND BETWEEN THE REINFORCEMENT LAYERS.



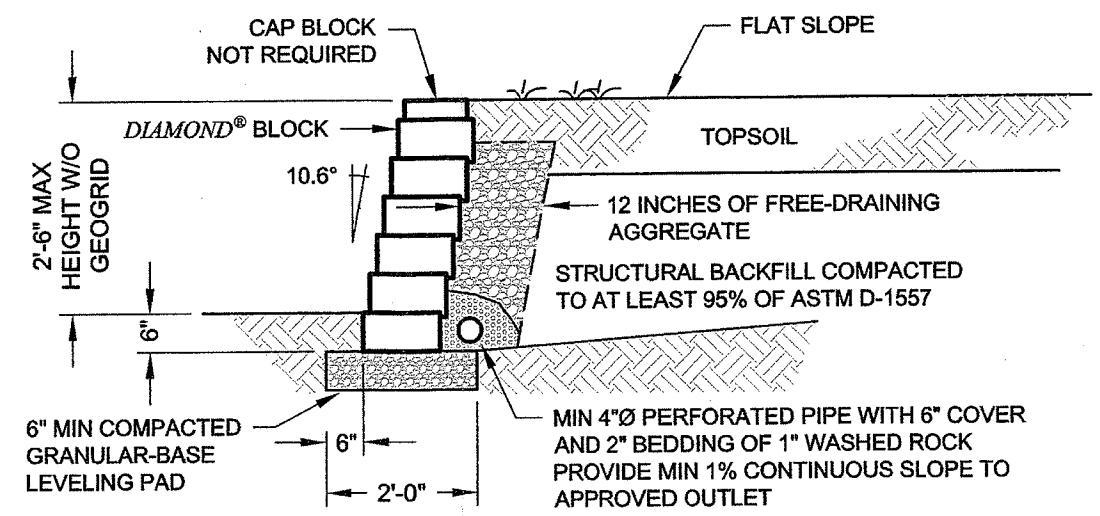
STEP 2 - LAY THE NEXT COURSE OF BLOCK. MAKE A MARK ON THE BACK OF THE BLOCKS IN THE AREAS THAT ARE NOT REINFORCED. BACKFILL AND COMPACT THAT COURSE.



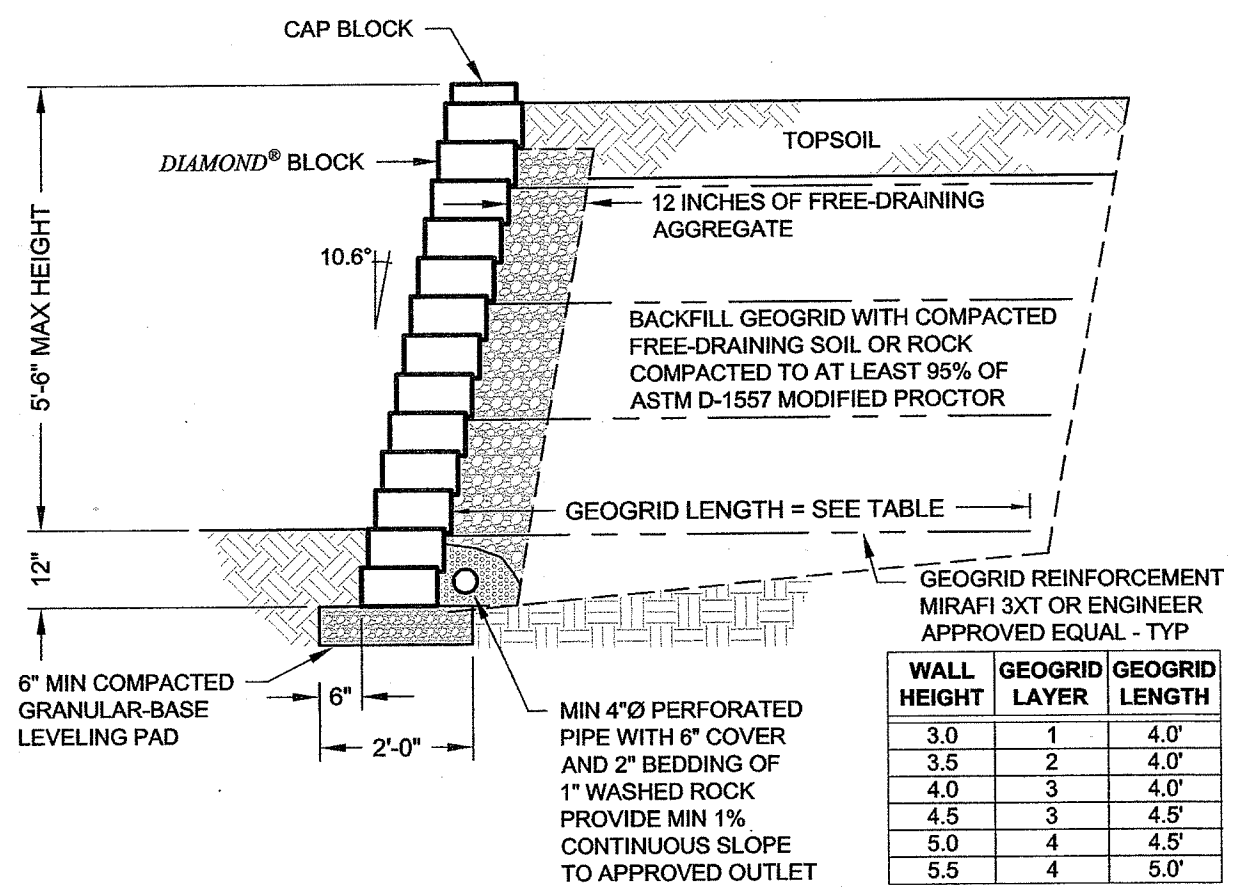
STEP 3 - PLACE REINFORCEMENT IN THE AREAS WHERE THE MARKS SHOW GAPS IN THE LOWER REINFORCEMENT PATTERN. CONTINUE NORMAL WALL CONSTRUCTION, REPEATING THESE STEPS AS NEEDED.



REINFORCEMENT INSTALLATION



TYPICAL NON-REINFORCED MODULAR BLOCK WALL



WALL HEIGHT	GEOGRID LAYER	GEOGRID LENGTH
3.0	1	4.0'
3.5	2	4.0'
4.0	3	4.0'
4.5	3	4.5'
5.0	4	4.5'
5.5	4	5.0'

TYPICAL REINFORCED MODULAR BLOCK WALL

REFERENCE: ANCHOR WALL ENGINEERING, LLC

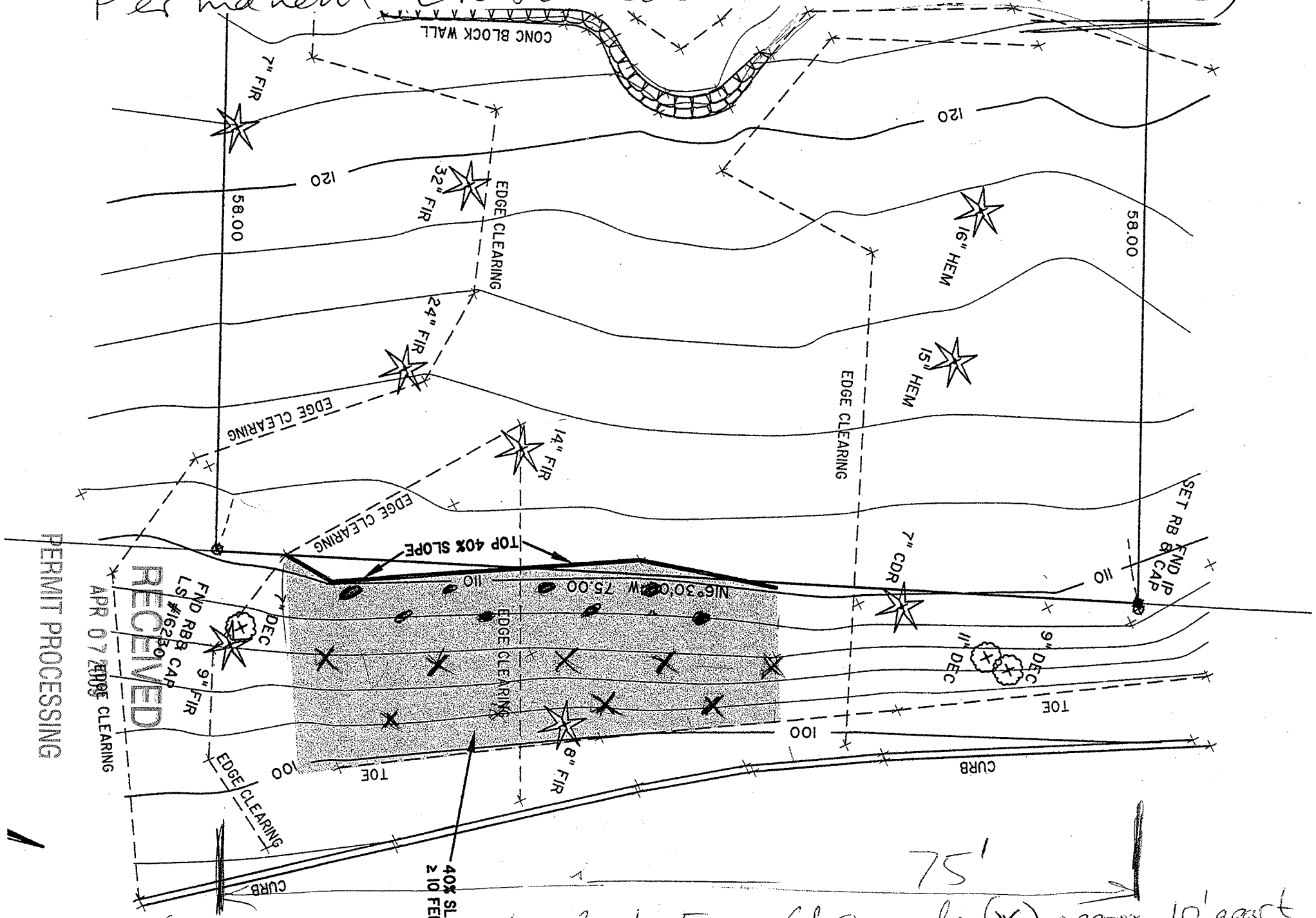
Associated Earth Sciences, Inc.

MODULAR BLOCK WALL DETAILS
NAIMUSHIN - GIDERIMSKI
BELLEVUE, WASHINGTON

FIGURE 3
DATE 2/09
PROJECT NO. KE080750A

080750 Naimushin-Giderimski \ 080750 Site and Details.dwg LAYOUT: Landscape

Permanent Erosion Control Measures (See No. 2.)



We, the owners, propose to plant Emerald Spreader (X) approx 10' apart as groundcover
Also plant English Laurel + Pacific Wax Myrtle (•) at the top of the slope.

RECEIVED
APR 07 2005
PERMIT PROCESSING

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50% [1] Retained on No. 200 Sieve	Gravels - More than 50% [1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines [5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines [5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% [1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines [5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines [5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% [1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT[2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

[3] Estimated Percentage

Component	Percentage by Weight
Trace	<5
Few	5 to 10
Little	15 to 25
With	- Non-primary coarse constituents: ≥ 15% - Fines content between 5% and 15%

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols

Sampler Type
2.0" OD Split-Spoon Sampler (SPT)
Bulk sample
Grab Sample

Blows/6" or portion of 6"

Sampler Type Description
3.0" OD Split-Spoon Sampler
3.25" OD Split-Spoon Ring Sampler
3.0" OD Thin-Wall Tube Sampler (including Shelby tube)
Portion not recovered

Cement grout surface seal
Bentonite seal
Filter pack with blank casing section
Screened casing or Hydrolip with filter pack
End cap

(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
ATD = At time of drilling
Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 15%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

Associated Earth Sciences, Inc.

EXPLORATION LOG KEY

FIGURE A1

blocklog_key.dwg LAYOUT: Layout2

LOG OF EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	Organic rich, loose, moist, dark brown, silty SAND, with roots.
	Weathered Lodgement Till
2	Loose to medium dense, moist, reddish brown, silty SAND, trace gravel, abundant roots.
	Lodgement Till
3	Dense to very dense, moist, olive-brown, silty SAND, with gravel.
4	Bottom of exploration pit at depth 3.5 feet
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Naimushiu/Gidirimski Residence
Bellevue, WA

Associated Earth Sciences, Inc.

Logged by: JSK

Approved by:

Project No. KE080750A

2/12/09

LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	Organic rich, loose, moist, dark brown, silty SAND, with roots.
	Weathered Lodgement Till
2	Loose to medium dense, moist, reddish brown to brown, silty SAND, with gravel and cobbles, roots.
3	Large root at 3'.
	Lodgement Till
4	Dense to very dense, wet, olive-brown, silty SAND, with gravel.
5	Bottom of exploration pit at depth 4.5 feet Slow seepage at 3.5' to 4'.
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Naimushiu/Gidirimski Residence
Bellevue, WA

Associated Earth Sciences, Inc.

Logged by: JSK

Approved by:

Project No. KE080750A

2/12/09

LOG OF EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	Organic rich, loose, moist, dark brown, silty SAND, with roots.
	Weathered Lodgement Till
2	Loose to medium dense, moist, reddish brown, silty SAND, trace gravel, abundant roots.
	Lodgement Till
3	Dense to very dense, moist, olive-brown, silty SAND, with gravel, cobbles.
4	
5	Bottom of exploration pit at depth 4.5 feet
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Naimushiu/Gidirimski Residence
Bellevue, WA

Associated Earth Sciences, Inc.

Logged by: JSK

Approved by:

Project No. KE080750A

2/12/09

KCTP3 080750A.GPJ February 27, 2009

APPENDIX B

Modular Block Wall Stability Modeling

Associated Earth Sciences, Inc.

Celebrating 25 Years of Service

AASHTO DESIGN METHOD
Naimushin - Giderimski

PROJECT IDENTIFICATION

Title: Naimushin - Giderimski
Project Number: KE080750A
Client:
Designer: EJL
Station Number:

Description:

Anchor Diamond Block with Miragrid 3XT. 3.5-ft exposed height wall with min 0.5-ft embedment. Total height is 4-ft.

Company's information:

Name: Associated Earth Sciences, Inc.
Street: 911 Fifth Avenue

Kirkland, WA 98033
Telephone #:
Fax #: 425-827-7701
E-Mail: 425-827-5424

Original file path and name: X:\01Projects\08s\080750 Naimushin - Giderimski\KE08075..... .....750 dia3XT short.BEN

Original date and time of creating this file: 2/26/09

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

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License number MSEW-301043

SOIL DATA

REINFORCED SOIL

Unit weight, γ		135.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	34.0 °

RETAINED SOIL

Unit weight, γ		135.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	34.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$		135.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	34.0 °
Equivalent cohesion, $c_{equiv.}$		0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2169 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 56.70° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.2169 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 42.16 N γ= 41.06

SEISMICITY

Maximum ground acceleration coefficient, α_o = 0.180
Kae (α_o> 0) = 0.3642 Kae (α_o= 0) = 0.2169 Δ Kae = 0.1473 (see eq. 37 in DEMO 82)
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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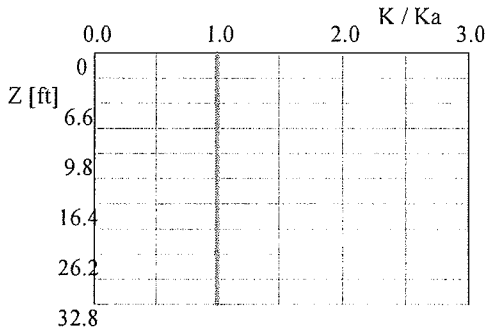
License number MSEW-301043

INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	3000.0				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.10				
Creep reduction factor, RFc	1.60	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	26.60				
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



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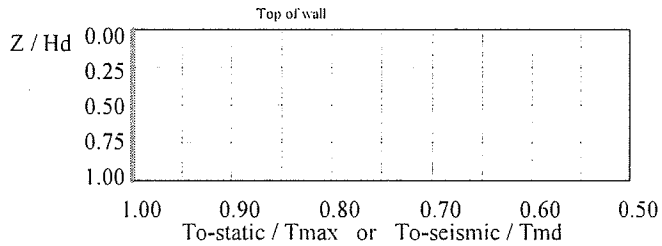
INPUT DATA: Facia and Connection (according to revised Demo 82) (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 1.00/0.50 ft. Horizontal distance to Center of Gravity of block is 0.50 ft.
Average unit weight of block is $\gamma_r = 100.00$ lb/ft ^{3}

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



Geogrid Type #1 σ [1]	CRult [2]	Geogrid Type #2 σ	CRult	Geogrid Type #3 σ	CRult	Geogrid Type #4 σ	CRult	Geogrid Type #5 σ	CRult
0.0	0.07								
824.0	0.42	N/A		N/A		N/A		N/A	

Geogrid Type #1[3] σ	CRcr	Geogrid Type #2 σ	CRcr	Geogrid Type #3 σ	CRcr	Geogrid Type #4 σ	CRcr	Geogrid Type #5 σ	CRcr
0.0	0.06								
836.0	0.41	N/A		N/A		N/A		N/A	

[1] σ = Confining stress in between stacked blocks [lb/ft ^{2}]
[2] CRult = Tc-ult / Tult
[3] CRcr = Tcre / Tult

In seismic analysis, long term strength is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Mirafi 3XT	N/A	N/A	N/A	N/A
Connection strength reduction factor, RFd	1.20	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

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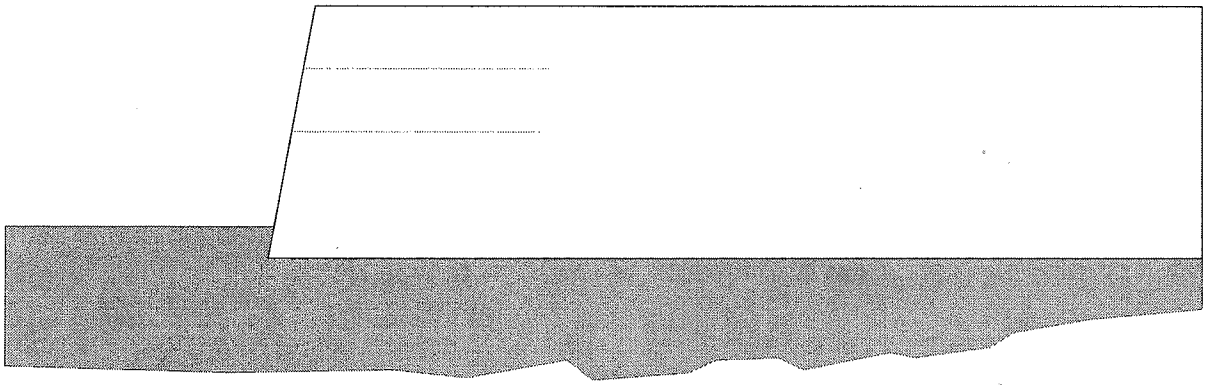
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	4.00	[ft]	{ Embedded depth is E = 0.50 ft, and height above top of finished bottom grade is H = 3.50 ft }
Batter, ω	10.6	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE
Uniformly distributed dead load is 0.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 22.17, Meyerhof stress = 495 lb/ft².
Foundation Interface: Direct sliding, Fs = 5.638, Eccentricity, e/L = -0.0053, Fs-overturning = 13.67

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	4.00	1	1.79	7.70	7.698	4.430	8.804	-0.0135	Mirafi 3XT
2	3.00	4.00	1	7.73	47.04	47.044	11.456	18.039	-0.0093	Mirafi 3XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 17.04, Meyerhof stress = 564 lb/ft².
Foundation Interface: Direct sliding, Fs = 2.567, Eccentricity, e/L = 0.0664, Fs-overturning = 4.89

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	4.00	1	1.11	6.44	6.442	2.701	4.008	0.0035	Mirafi 3XT
2	3.00	4.00	1	2.51	23.42	23.420	3.506	8.213	-0.0051	Mirafi 3XT

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Associated Earth Sciences, Inc.

Celebrating 25 Years of Service

AASHTO DESIGN METHOD
Naimushin - Giderimski

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Project Number: KE080750A
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Description:

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Kirkland, WA 98033
Telephone #:
Fax #: 425-827-7701
E-Mail: 425-827-5424

Original file path and name: X:\01Projects\08s\080750 Naimushin - Giderimski\KE08075..... .....\KE080750 dia3XT.BEN

Original date and time of creating this file: 2/26/09

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

Copyright © 1998-2006 ADAMA Engineering, Inc.
License number MSEW-301043

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	135.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	34.0 °

RETAINED SOIL

Unit weight,	γ	135.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	34.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	135.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	34.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2169 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 56.70° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.2169 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 42.16 N γ= 41.06

SEISMICITY

Maximum ground acceleration coefficient, α_o = 0.180
Kae (α_o> 0) = 0.3642 Kae (α_o= 0) = 0.2169 Δ Kae = 0.1473 (see eq. 37 in DEMO 82)
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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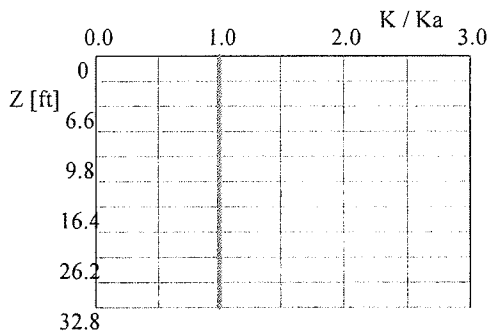
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	3000.0				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.10				
Creep reduction factor, RFc	1.60	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	26.60				
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



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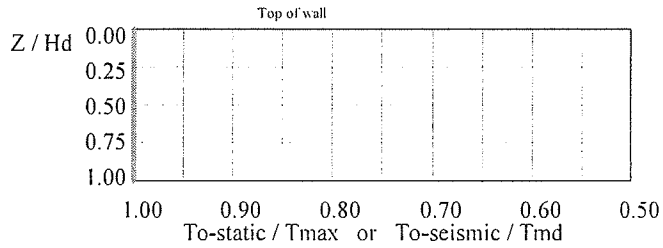
INPUT DATA: Facia and Connection (according to revised Demo 82) (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 1.00/0.50 ft. Horizontal distance to Center of Gravity of block is 0.50 ft.
Average unit weight of block is γ_r = 100.00 lb/ft ^{3}

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



Geogrid Type #1 σ (1)	CRult (2)	Geogrid Type #2 σ	CRult	Geogrid Type #3 σ	CRult	Geogrid Type #4 σ	CRult	Geogrid Type #5 σ	CRult
0.0	0.07								
824.0	0.42	N/A		N/A		N/A		N/A	

Geogrid Type #1 (3) σ	CRcr	Geogrid Type #2 σ	CRcr	Geogrid Type #3 σ	CRcr	Geogrid Type #4 σ	CRcr	Geogrid Type #5 σ	CRcr
0.0	0.06								
836.0	0.41	N/A		N/A		N/A		N/A	

(1) σ = Confining stress in between stacked blocks [lb/ft ^{2}]
(2) CRult = Tc-ult / Tult
(3) CRcr = Tcre / Tult

In seismic analysis, long term strength is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Mirafi 3XT	N/A	N/A	N/A	N/A
Connection strength reduction factor, RFd	1.20	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

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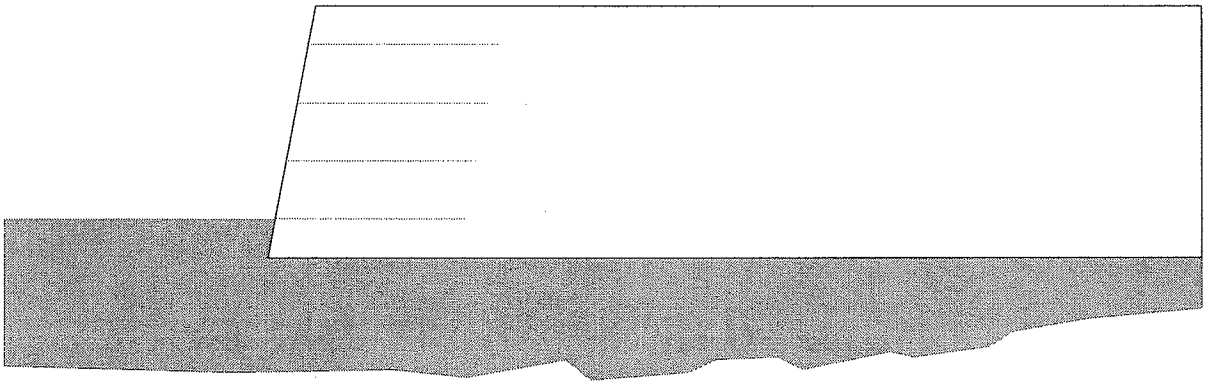
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.50	[ft]	{ Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 5.50 ft }
Batter, ω	10.6	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE
Uniformly distributed dead load is 0.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 17.16, Meyerhof stress = 789 lb/ft².

Foundation Interface: Direct sliding, Fs = 4.203, Eccentricity, e/L = 0.0115, Fs-overturning = 8.02

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	1.00	5.00	1	2.46	5.38	5.376	12.172	3.766	-0.0007	Mirafi 3XT
2	2.50	5.00	1	3.24	8.82	8.821	12.688	5.340	-0.0114	Mirafi 3XT
3	4.00	5.00	1	3.75	14.11	14.113	10.350	8.804	-0.0135	Mirafi 3XT
4	5.50	5.00	1	5.68	34.56	34.563	7.848	22.657	-0.0078	Mirafi 3XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 9.50, Meyerhof stress = 1060 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.914, Eccentricity, e/L = 0.1366, Fs-overturning = 2.87

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	1.00	5.00	1	1.48	4.42	4.419	7.232	1.715	0.0869	Mirafi 3XT
2	2.50	5.00	1	1.78	6.79	6.785	6.859	2.431	0.0335	Mirafi 3XT
3	4.00	5.00	1	1.89	10.14	10.142	5.091	4.008	0.0035	Mirafi 3XT
4	5.50	5.00	1	2.19	19.84	19.835	2.870	10.316	-0.0052	Mirafi 3XT

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APPENDIX C

Steep Slope Planting Template

STREAMS

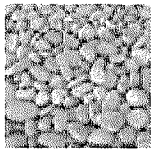
WETLANDS

SHORELINES

GEOLOGICAL HAZARD AREAS

CRITICAL AREAS HANDBOOK

RESTORING, ENHANCING, AND PRESERVING



FOR MORE INFORMATION ABOUT THIS HANBOOK CONTACT:

City of Bellevue
450 110th Ave NE, Bellevue, WA 98004
http://www.bellevuewa.gov

Service First (Reception)	425-452-6800
Land Use Desk	425-452-4188
Environmental Planning Manager	425-452-2739
Stream Team	425-452-5200
Water Conservation, Natural Lawn and Garden Care	425-452-6932

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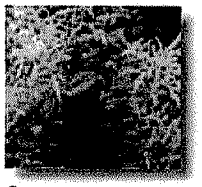
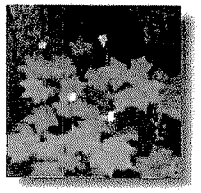
All research, copy, graphics and layout provided by:

THE WATERSHED COMPANY

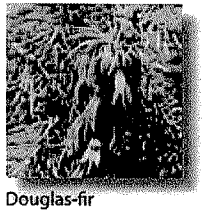
750 Sixth Street South, Kirkland, WA 98033 p 425.822.5242 f 425.827.8136

GEOLOGICAL HAZARDS TEMPLATE


Oceanspray


Thimbleberry

Mock Orange

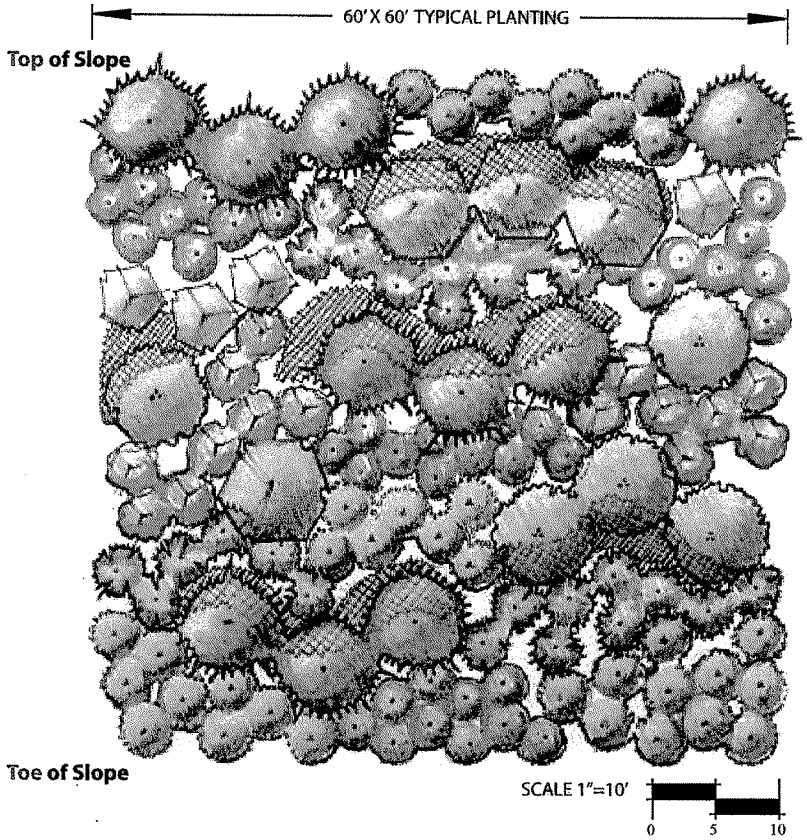

Douglas-fir

Geological Hazards

Steep Slope Planting Template
for ***Sunny*** and ***Shady*** Sites

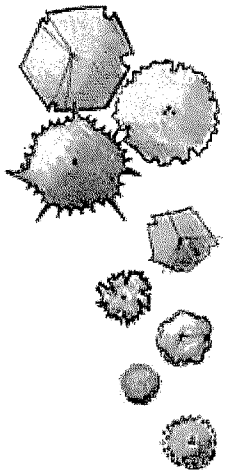
A1

GEOLOGICAL HAZARDS (STEEP SLOPE) PLANTING TEMPLATE

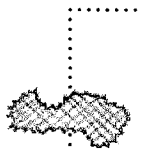


Steep slopes commonly have fragile, erodible soils. Planting can be difficult to establish in these areas as gravity, wind, and rain have a tendency to pull nutrient-rich soil down the slope. In addition, sunny sites require drought-tolerant plants, while both sunny and shady sites require plants with strong, root systems to keep soil intact. On the next two pages you will find one legend designed for sunny, steep sites and one designed for shady, steep sites. The plants chosen for these templates are known for drought tolerance and soil-binding characteristics. With the successful establishment of plants on steep slopes, the potential for erosion decreases. For additional information on Steep Slopes, refer to the section on *Geological Hazard Areas* in *Chapter One* and the City's Critical Areas Ordinance. Note, these templates are to be used for stable and undisturbed sloping sites. If your site has experienced a landslide or substantial erosion, do not use this template; consult a professional.

PLANT LEGEND FOR SUNNY SITES



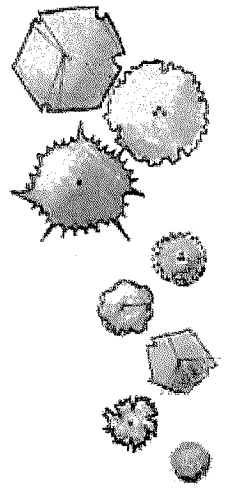
LATIN NAME/ COMMON NAME	TYPICAL SPACING/ AVERAGE HEIGHT	CHARACTERISTICS
TREES		
Acer macrophyllum/ Big-leaf maple	9 feet on center/ 75 feet	Yellow fall color, provides understory shade, largest leaf of all maples
Alnus rubra/ Red alder	9 feet on center/ 60 feet	Vigorous grower, provides cover quickly for other plants
Pseudotsuga menziesii/ Douglas-fir	9 feet on center/ 100 feet	Highly adaptable, fast grower
SHRUBS		
Corylus cornuta/ Beaked hazelnut	6 feet on center/ 11 feet	Edible acorn, wildlife food. Small understory tree, yellowish fall color
Holodiscus discolor/ Oceanspray	4.5 feet on center/ 7 feet	Spectacular blossom; attracts hummingbirds and butterflies
Philadelphus lewisii/ Mock orange	4.5 feet on center/ 8 feet	Fragrant white blossom
Rubus parviflorus/ Thimbleberry	4 feet on center/ 8 feet	Delicious edible berries, fast grower, likes sun
Symphoricarpos albus/ Snowberry	4.5 feet on center/ 5 feet	White berries, proven performer in tough conditions
GROUNDCOVERS & PERENNIALS		
Arctostaphylos uva-ursi/ Kinnikinnick	*24 in. on center/ 6-8 in.	Evergreen groundcover, great for rockeries and full sun areas
Fragaria chiloensis/ Coastal strawberry	*24 in. on center/ 4-6 in.	Tough, highly adaptable groundcover w/ red stems and edible berries
Festuca idahoensis/ Idaho fescue	*24 in. on center/ 2.5 feet	Bluish leaves, clumping
Polystichum munitum/ Sword fern	*24 in. on center/ 5 feet once mature	Semi-evergreen fern, highly adaptable
Epilobium angustifolium/ Fireweed	*24 in. on center/ 1.5-2 feet	Big purple flowers on a tall stem



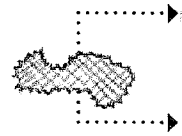
** Indicates plants are to be triangularly spaced for the area shown. See page 23 for triangular spacing.*

A1-Sun

PLANT LEGEND FOR SHADY SITES



LATIN NAME/ COMMON NAME	TYPICAL SPACING/ AVERAGE HEIGHT	CHARACTERISTICS
TREES		
Acer macrophyllum/ Big-leaf maple	9 feet on center/ 75 feet	Yellow fall color, provides understory shade, largest leaf of all maples
Alnus rubra/ Red alder	9 feet on center/ 60 feet	Vigorous grower, provides cover quickly for other plants
Thuja plicata/ Western red cedar	9 feet on center/ 150 feet	Fragrant, adaptable to many sites
SHRUBS		
Acer circinatum/ Vine maple	4.5 feet on center/ 20 feet	Bright red fall color, small understory tree, grows well in shade
Amelanchier alnifolia/ Western serviceberry	4.5 feet on center/ 20 feet	Fragrant flowers, edible red to purple berries
Corylus cornuta/ Beaked hazelnut	6 feet on center/ 11 feet	Edible acorn, wildlife food, small understory tree, yellowish fall color
Oemleria cerasiformis/ Osoberry	4.5 feet on center/ 10 feet	Berries attract birds, first shrub to leaf out in spring
Sambucus racemosa/ Red elderberry	4 feet on center/ 15 feet	Edible berries, fast grower, graceful form with age
GROUNDCOVERS & PERENNIALS		
Arctostaphylos uva-ursi/ Kinnikinnick	*24 in. on center/ 6-8 in.	Evergreen groundcover, great for rockeries and full sun areas
Asarum caudatum/ Wild ginger	*24 in. on center/ 6-8 in.	Tough groundcover, great for planting under shrubs and trees
Polystichum munitum/ Sword fern	*24 in. on center/ 5 feet once mature	Semi-evergreen fern, highly adaptable



** Indicates plants are to be triangularly spaced for the area shown. See page 23 for triangular spacing.*

A1-Shade