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August 23, 2006

Better World Acquisitions, LLC.
Columbia Gorge Land Development
PO Box 444
Cascade Locks, OR 97014

Attn: Mimi Morissette

cc: Gary Peterson, Shannon & Wilson, City's Geotechnical Consultant- 1 copy
Frank Childs, Pioneer Surveying & Engineering, Inc. – 1 copy
John Morgan, AICP, City Planner, City of Cascade Locks – 1 copy

Re: Harmony Heaven- A Planned Unit Development, Cascade Locks, Oregon
GNN Job #: 206-623-1

Subject: Supplemental Geotechnical Engineering Report

I. PURPOSE AND SCOPE OF STUDY

This supplemental geotechnical report is prepared in response to a Memorandum from Mr. John Morgan dated July 26, 2006 and presents additional geological information and slope stability analyses results including the suggested changes described in an email dated August 21, 2006, from Mr. Gary Peterson of Shannon & Wilson for the referenced project in the City of Cascade Locks, Oregon. This report is a supplement to out initial geotechnical report dated July 14, 2006 prepared for the referenced project.

We have provided additional information regarding "the area of concern-area along the southern portion of the site" noted in a memorandum dated July 26, 2006, from Mr. John Morgan, City Planner, regarding the above referenced project in Cascade Locks Oregon. The additional information compiled in this phase of our study specifically addresses the contents of item # 3 of the above noted memorandum. The additional information is based on data research and review of published geological information, findings of initial subsurface exploration consisting of exploratory borings and additional subsurface exploration consist of deep test pits, and slope stability analyses. Based on the findings of the slope stability analyses, geotechnical recommendations are presented for mitigated slope stability measures and the construction of the proposed slopes.

II. FIELD EXPLORATION

On August 7, 2006 three deep test pits were excavated within and near the "the area of concern-area along the southern portion of the site" using a backhoe operated by Crestline Construction. Test pit

(TP) 1 was excavated to a depth of 15 feet below existing ground surface (bgs), TP- 2 was excavated to a depth of 14 feet bgs and TP-3 was excavated to a depth of 15.5 feet bgs. Logs of the test pits are attached to this report. Refer to Exhibit E for test pit locations.

III. GEOLOGICAL INFORMATION

Cascade Locks Regional Geology

The Columbia Gorge has been formed by fluvial, glacial, mass wasting and volcanic processes. These processes have included catastrophic events that altered the course of the river and dramatically changed the shape of the Gorge. Additionally, continual weathering and erosion throughout the Gorges geologic history has added to the change. The role of any process in forming the Gorge only points toward the significance of the other processes.

The area of Cascade Locks, within the Gorge is thought to be underlain by Eocene volcanic rocks that are composed of andesitic flows, tuffs, mudflows and other volcanic rocks (Suchanek, 1974 – The Ore Bin Volume 36, No. 12). These rocks have formed a bedrock layer that is less permeable due to the abundance of saprolite. These Eocene volcanic formations slope to the south from the Washington side to the Oregon side of the Gorge. This southerly sloping unit and slippery saprolitic layer have been key factors in the large landslides that have occurred on the Washington side of the Columbia River. Although this unit is not exposed at Cascade Locks, the southerly slope is inferred and is thought to lower the potential and presence for similar large scale slides on the Oregon side of the River (Beaulieu, 1977 and Yang, 2004).

The Eagle Creek Formation was deposited in the early Miocene above the Eocene volcanics and at Cascade Locks consists of sedimentary rocks and mudflows. Beaulieu states that the Eagle Creek Formation at Cascade Locks is composed of boulder conglomerate, sandstone, shale, tuff breccia and debris flows or slurry deposits. These rocks are carbonate and clay cemented in sandstones and conglomerates, while the debris flows remain less consolidated. These units are discontinuous due to the disruption by a moderate to large scale landslide south of Cascade Locks (Beaulieu, 1977).

The Columbia River Basalt overlie the Eagle Creek Formation and are observable in the ridges lying south of Cascade Locks. The basalts are moderately to highly fractured giving low to high permeability to the unit. The basalt originated to the east from fissures and flowed westward covering a large expanse including the Cascade Locks area. The thickness of individual flows averages 80 feet while the total thickness reaches 2000 feet in some areas of the Gorge.

Overlying the Columbia River Basalt are both localized and more regional alluvial deposits and volcanic rocks of Pliocene and Pleistocene age. These units have not been mapped in the immediate vicinity of Cascade Locks.

Quaternary older alluvium was deposited by the Columbia River. This unit appears to cover much of the developed portion of Cascade Locks based on the geologic map of the area (Beaulieu, 1977). The alluvium consists primarily of unconsolidated gravel, sand, and minor silt.

The attached geologic map (Exhibit C) identifies the distribution of deposits in the vicinity of Cascade Locks. The Harmony Heaven site lies near the mapped boundary of the Eagle Creek Formation and Quaternary older alluvium ((Exhibit C). The juxtaposition of these units indicates that the Quaternary unit overlies the Eagle Creek Formation unconformably or that mass wasting has deposited the Eagle Creek Formation over portions of the Quaternary deposits. Beaulieu has interpreted the alluvium deposits to unconformably overlie the Eagle Creek Formation.

Historic Landslides

The Cascade Locks appears to be a zone where landslides from the north side of the Columbia River converged with those to the south. On the north shore, the large scale Bonneville Landslide slid south damming the river. This likely caused the river course to move south towards the present course. The river undercut the south wall creating instability, and was a major factor contributing to the Cascade Locks landslide. The Cascade Locks slide may have occurred in mid-Pleistocene following earlier movement along the Bonneville slide. The Bonneville slide has continued to move as recently as 700 years ago when the river was blocked. The Cascade Locks slide is identified as no longer active by Beaulieu, 1977.

The Cascade Locks slide is located between Cascade Locks and Herman Creek. A basalt shear zone is located approximately 200 feet above the river and primarily involved the failure of the Eagle Creek formation (Beaulieu, 1977). This unit became oversaturated as water infiltrated permeable zones in the overlying basalts and flowed into the more permeable zones within the Eagle Creek. The less permeable saprolitic layer of the underlying Eocene volcanic unit prevented further downward movement of water. High pore pressures were developed decreasing the shear strength of the Eagle Creek Formation before failure.

More recent instability shifted further west along the south shore to the current position of the Ruckel slide. The Ruckel slide is located between Cascade Locks and Ruckel Creek. The movement of the Ruckel slide has been greatly alleviated by drainage tunnels installed in the 1930's.

The attached geologic map and cross section (Exhibit C) shows the interpreted distribution of the Cascade Lock landslide mass. The Harmony Heaven site appears to be located within the mapped extent of this failure, but also near the older Quaternary alluvium deposits.

Site Conditions

The Harmony Heaven site appears to be located at the distal end of the Cascade Locks landslide. The terrain suggests the toe of the failure may be beyond the northern property boundary.

Our assessment is focused on specific hazards associated with the site and nearby site conditions or from the modification of the site based on the proposed development.

The site varies in relief from nearly level along the northern and eastern property boundaries to moderately sloping through the center of the site. The site generally slopes to southwest toward the intermittent stream located along the southern property boundary. The site becomes gently sloping across the southwestern corner. A moderate slope exists along the northwestern property boundary that falls toward Interstate 84.

The level terrain continues beyond the site to the east before ascending toward some small hills and then relief increases near steep cliffs faces approximately ½ miles away. To the north and west lie developed properties that are located on the more gently sloping ground that falls toward the Columbia River to the northwest.

Adjacent to the intermittent stream and at the more gently sloping ground at the southwest corner of the site are moist soil conditions and some standing water. Other wet areas were not observed in the proposed developed areas of the site.

Based on the current topography and the moist conditions, the City's geotechnical consultant has inferred a youthful landslide mass on the Harmony Heaven site. Further discussion of this feature will be presented in our description of site geologic hazards. The area identified by the City's geotechnical consultant does appear to be a very low relief ravine near the top of the hill based on the site topographic map. This low relief ravine is not continuous down slope and gradually changes to a more consistent grade down slope. Our field reconnaissance of the site and the topographic map of the site do not support the conclusion of this being a landslide mass.

There is no scarp above the proposed youthful landslide area and there are no apparent cracks noted on the ground surface. Based on the lack of these conditions, the type of motion for the proposed landslide would have to be a flow of some type. The V shaped upper head of the inferred slide area would indicate a debris flow rather than an earth flow (Schuster & Krizek, 1978). However, debris flows typically occur in long narrow valleys. The body of flows consists of large blocks in a finer matrix and the flow spreads laterally in lobes near the toe. Based upon the topographic expressions, there appears to be little support for a flow.

Subsurface Conditions

The site appears to be underlain by unconsolidated to semi-consolidated sediments derived from the Cascade Locks landslide. These soils are primarily a combination of sandy silt and silty sand with varying moisture content. Some interbedded layers of gravel with cobbles and boulders are also present. Based on the consistency and the soil type we interpret the soil to be associated with the Eagle Creek Formation. The horizontal continuity to some of the gravel layers suggest that these unit would have moved down slope as an intact mass, however, the generally unconsolidated nature of the soil seem to support the interpretation as the deposits being part of a debris flow as described by Beaulieu (1977).

Recently completed test pits logs are attached which provide details on the subsurface conditions encountered at the site. Exploratory boring logs were submitted with our original geotechnical report dated July 13, 2006. The subsurface profile encountered within the borings generally consists of alternating layers of sandy silt and silty clay. Some zones of silty sand were encountered in BH-2A and BH-3A. Gravel layers were present at the base of BH-2A and at a depth between 15 and 20 feet in BH-3A.

The fine grain silt and clay were generally hard with a slightly weaker consistency of stiff silty clay in BH-3A where wet to saturated soil was encountered. The fine grain soil varied in color from light brown to dark gray with some mottling. The soil generally showed slight plasticity.

The silty sand and gravel were dense to very dense, and slightly moist to moist. The silty sand was brown in color, while the gravel was brown in BH-3A and black in BH-2A.

Three deep test pits were completed at the site on August 7, 2006. Two test pits were completed within the vicinity of the City's geotechnical consultant interpreted youthful landslide. Test pit 2 was located at the top of the ridge (cul-de-sac area) and test pit 1 was located at the toe. A topsoil layer was encountered above silty sand layer in each test pit. The silty sand in the test pit (TP-2) at the top of the slope was light brown to brown, slightly moist, and medium dense. This zone extended to a depth of 7 feet where a layer of slightly plastic sandy silt was encountered. Occasional boulders and a harder consistency were encountered in the sandy silt below 12 feet.

The sandy silt/silty sand layer began at three feet depth in test pit 1 near the suspected toe of youthful landslide and extended to the full depth explored. The silt/sand was slightly plastic and perched groundwater was located above the interface at 3 feet. The less permeable sandy silt appears may have pounded the standing water located in this area. The underlying sandy silt/silty sand was very moist to wet. Sloughing of the excavation began at a depth of 10 feet. An increase in gravel and cobbles were encountered at a depth of 12 feet below the ground surface.

The third test pit (TP-3) was located on the ridge (at a higher elevation than any other area) to the west of the proposed youthful slide area, and the soils encountered were not similar to those encountered at other locations around the site. The soil was highly oxidized throughout and consisted of semi-consolidated silty sand and conglomerates. The conglomerates were weak to moderately strong. The gravel appeared to be rounded to subrounded. The soil became light brown to tan below 12 feet with a slight increase in silt and little gravel.

Geologic Hazards

The site lies within a landslide prone area and appears to be located on Cascade Locks landslide deposits. These deposits consist primarily of disturbed Eagle Creek Formation. An aerial photograph of the Cascade Locks vicinity shows the scarp to the south and hummocky ground surface that is likely associated with the Cascade Locks slide (Exhibit A). Some risk of reactivation of this large scale feature is present (Beaulieu, 1977), and the City of Cascade Locks should be monitoring the dormant Cascade Locks slide areas for changes in groundwater conditions, cracks in the upper reaches of the landslide or major undercutting by the Columbia river. The scope of stability analyses of the dormant Cascade Locks landslide area is beyond the scope of GN Northern's services.

This slide has left unconsolidated to semi-consolidated silty sand, sandy silt with zones of gravel, cobbles and boulders as the primary units within the depths explored. The soil is slightly plastic and contains some clay. The soil consistency allows for a moist condition in the silty zones. Additionally, the silty zones with some clay have created a less permeable layer where water is perched and stands on the surface in the lower flat areas at the southwest corner of the site.

Some risk of reactivation of the Cascade Locks slide may exist in the future as the river undercuts the south bank. A catastrophic failure of this magnitude may require ground shaking from a large seismic or volcanic event to trigger the reactivation. Such an event may create liquefaction and greater risk for instability.

Since much of the Northwestern United States and specifically the entire Columbia Gorge is subject to geologic hazards, i.e. volcanoes, floods, earthquake, mass wasting, all developments will have some inherent risks from major catastrophes. Our assessment is focused on specific hazards associated with the site and nearby site conditions or from the modification of the site with the proposed development.

The boulders and soils at the site appear to be indicative of debris flow deposits and are extensive immediately to the southwest of the site. We believe debris flow hazard exists at the site; mitigation measures may include identification and delineation of areas where existing landslide hazard exist, instrumentation monitoring of fills, adequate subdrainage measures incorporated in site development design and construction.

The area is moderately to gently sloping across the site with an intermittent stream flowing south of the site. The upslope areas offsite are located to the southeast and the slopes are generally moderate nearby. A youthful landslide does not appear to have occurred on the site. This interpretation is based on the following criteria:

- Topography does not support a youthful landslide with the presence of scarps or upslope features that suggest failure. Additionally, there is not topographic evidence that suggest the body, foot or toe that would be associated with a slide or flow (i.e. distal lobes, mounding, hummocky surfaces, raised flanks, etc).
- Standing water at the base of the slope appears to be related to less permeable soil conditions prevalent throughout the site rather than localized at the toe. The water present at the corner of the site appears to occur due to the proximity to the intermittent stream, the change in topography, and the less permeable substratum at 3 feet.
- Soil conditions at the top and base of the slope show topsoil layer and recent alluvium to a depth of three feet in the toe test pit (TP-1). The presence of a thick topsoil horizon and underlying gravel layer does not appear to indicate the presence of a recent flow. The underlying silts are not consistent with the soil at the source area which is sandy material. Organic debris was not incorporated in the silty zone in the test pit (TP-1) at the base of the slope which would be expected with a debris flows.

IV. SLOPE STABILITY ANALYSES

The proposed moderate slopes, moisture content of the on-site soil, and the fine grain consistency may create some potential problems with site grading if the proper procedures for developing the site are not followed. The following sections describe the stability analyses; risks associated with the existing and original proposed slopes and mitigated slope measures.

We performed the slope stability analyses for the following conditions:

1. Existing slope between the detention pond and upper lots (lot 9).
Results of slope analyses (rotational and translational) for the existing slope between the detention basin and upper lots are attached.

Since no slide plane was identified during deep trenching exploration, none was included in the model. It appears that rotational failure would be the likely critical failure mechanism. Based on the result of our analyses, we believe the existing slope appears relatively stable at the current gradient and poses no apparent risk of slope instability.

2. Original proposed slopes at Cul-de-sac shown on PSE's drawings dated January 5& 12, 2006, Rev. April 14, 2006 (Non-mitigated slope).
Results of slope analyses (rotational and translational) for the existing slope are attached. Note that they fall below the acceptable minimum safety factors even with the higher strength imported fill material (#3). The proposed fill slope becomes a challenge even at a 2H:1V configuration due to the height of the slope coupled with high groundwater and relatively weaker material. A key problem appears to be the geometry of the proposed slope, it is very high. Based on our review of PSE's site and grading plans we believe a proposed change in the configuration of Lots 13 & 14 may partially help to remediate the problems of slope instability. The southwest corner of Lot 13 appears to be the primary problem. I have attached a PDF of a sketch of one idea to allow the slope to lay back at a slightly shallower grade. In doing so the developer may even be able to add an extra lot the way we have sketched it.

3. Mitigated Reconfigured Slope and Reconfigured/Buttressed Slope
Results of our slope analyses (rotational) for the reconfigured slope are attached.

If the upper lots are reconfigured, especially the southwest corner of #13, the slope can be laid back at a shallower gradient and becomes more stable. We performed a slope stability analysis based on the assumption that top of the slope may be pushed back about 30 feet. Using this new gradient we ran the analysis with imported fill over the native and also with a shallow (5 feet deep) buttress using only the onsite native compacted materials. In our analysis we also lowered the piezometric surface slightly with the assumption that the sub-drains will lower the surface slightly.

Results of our analyses indicate that on the reconfigured slope, it can be made stable with either: native compacted fill and a 5 feet deep buttress at the toe, or placement of less of the imported material over the native. We believe that the reconfigured lot layout and the resulting shallower slope may be the least expensive option available.

4. Mitigated Buttressed Slope A
Results of our slope analyses (rotational) for the mitigated buttressed slope A are attached.

We performed an analysis of a graded buttressed slope about 10 feet deep at the toe using compacted native fill material. In our analysis we also lowered the piezometric surface slightly with the assumption that the sub-drains will lower the surface slightly.

Results of our analyses indicate that the buttressed slope made with compacted native fill material appears to be stable.

5. Mitigated Reconfigured 3:1 Slope (Preferred Alternative)
Upon evaluation of the mitigated slope options presented in our Draft Geotechnical Information and Analysis Report dated August 14, 2005, the owner and the project civil engineer, Pioneer Surveying and Engineering, chose Reconfigured Slope (Option 2) considering site development feasibility.

The project civil engineer provided us a revised grading plan laying the slope back as we recommended. The slope transitions from a 2:1 at the trail to a 3:1 opposite to the pond. Using this revised slope configuration we ran a slope stability analysis as a 3:1 slope including a shallow groundwater table and conservative design parameters for static and dynamic loading conditions. The results of our analysis indicate stable slope conditions. Static Factor of Safety (FS) is 1.77 and dynamic is 1.12. Results of the analyses are attached to this report.

V. SUPPLEMENTAL GEOTECHNICAL RECOMMENDATIONS

The following geotechnical recommendations shall be adhered to for fill placement, slope construction and protection, subdrainage measures, and field monitoring and quality control testing. Recommendations are also presented for a post-construction fill monitoring program.

The selected design includes a reconfigured 3:1 slope made of native soil structural fill material. Construction of the slope includes overexcavation and removal of soft and wet to saturated native soils and placement of quarry spalls rock fill at the toe of the slope to allow drainage. Refer to cross section detail "SECTION THROUGH FILL AREA" and "GRADING AND DRAINAGE PLAN" Sheet 2/12 attached to this report depicting details of a 3:1 reconfigured slope.

Prior to new fill placement, the native soft and wet to saturated soils along the toe of the new slope shall be overexcavated and replaced with imported granular fill to create a stable foundation for the new fill. At least 36 inches of the native soils shall be removed and replaced with 4-6 inches quarry spalls to provide a stable subgrade and minimize built-up of hydrostatic pressure from groundwater seepage. The quarry spalls shall be placed on a geotextile separation fabric such as Mirafi 600X or equivalent. Sides of excavation shall be wrapped with a filter fabric to prevent the migration of fines. A subdrain pipe(s) shall be hydraulically connected to the quarry spalls to carry and dispose water by gravity flow to a stormwater drain system. Design of underdrain system shall prevent back flow.

The fill slope shall be constructed with engineered fill material consisting of compacted native soil that has been properly moisture conditioned and compacted as recommended in the initial geotechnical report. Fill slopes shall be overfilled and trimmed back to uniformly compacted material. The final slope surface shall be track-walked or grid rolled to improve the slope's resistance to erosion.

The fill shall be keyed and benched into firm natural soil. From the top of the interior back-cut of the over-excavation, the slope of the re-graded surface shall extend at a minimum 3:1 until it daylights at an elevation of approximately 298. This surface must be benched. As shown on the cross-section detail, the benches should be maximum 10 feet wide with a maximum 3 feet high back-cut. Before fill is placed, the key shall be observed by a representative of GN Northern to observe compliance with the above recommendations and evaluate the need for subdrains, if required.

It is recommended that a representative of our geotechnical engineer be present during the fill construction to observe compliance with the above recommendations.

Erosion control measures are required on all graded slopes. A project civil engineer or landscape architect should provide recommendations for slope planting. As the site soils are susceptible to erosion, it is strongly recommended that erosion control measures, such as planting, erosion control blankets or fabrics, sprayed tackifiers, or some combination of these, be utilized on all slopes within this project. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability.

A protective berm shall be constructed and maintained at the top of fill slopes to divert any runoff away from the slope face.

It is critical to provide periodic maintenance and repair of all slopes and drainage structures. Drainage inlets and outlets should be periodically inspected and cleaned of soils and debris. Leaks in the irrigation system should be fixed without delay. All slopes should be periodically inspected for evidence of cracking, erosion, and rodent infestation. Any problems should be repaired immediately.

Fill Monitoring Program

For the upcoming winter season, we recommend a fill monitoring program to avoid unacceptable ground movements resulting from the placement of major fills and to ensure that the constructed earthwork is performed adequately. The monitoring program shall include the installation of a series of reference survey hubs as directed by the geotechnical engineer; measurements shall be taken periodically, at survey accuracy, in three dimensions. Baseline data shall be collected immediately upon fill placements. Subsequent survey measurements shall be taken for a six month period at minimum 30-day intervals, data shall be submitted to the geotechnical engineer for evaluation. The duration of the fill monitoring program may be extended based on the results of the monitoring.

If you any questions regarding this report, please contact us.

Sincerely,

Imran Magsi, PE
Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER 17677 OREGON MARCH 14, 1995 IMRAN G. MAGSI
8-23-06
Expires: 12/31/2006

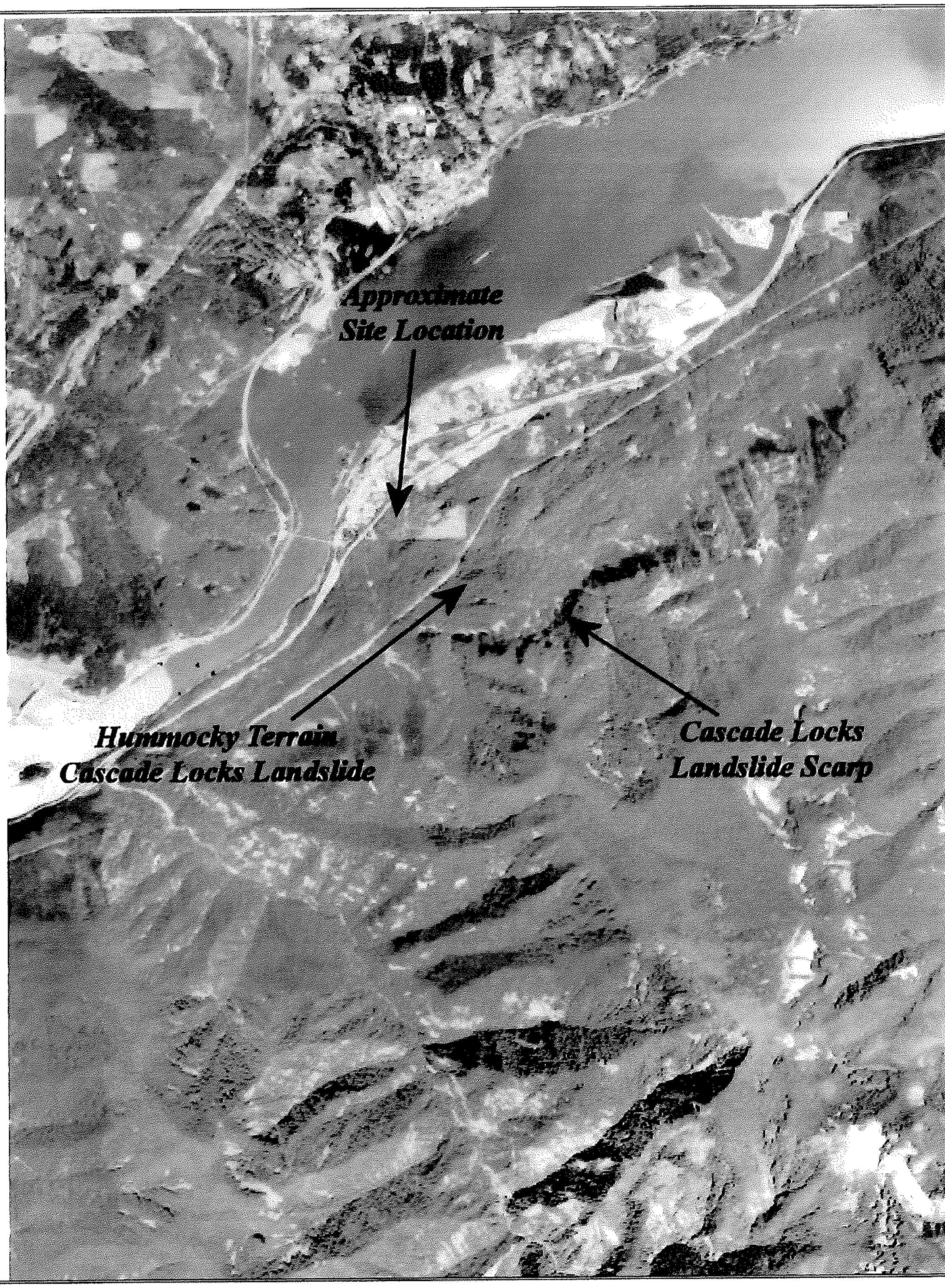
Gerald Harper for
Senior Project Geologist

Attachments

- Exhibits A through E
- Test Pit Logs
- Detail Showing "Section Through Fill Area" and PSE's "Grading and Drainage Plan" Sheet 2/12
- Slope Stability Analysis Existing Slope with Static and Dynamic Loading conditions
- Slope Stability Analysis Originally Proposed Slope with Static and Dynamic Loading conditions (non-mitigated slope)
- Slope Stability Analysis Reconfigured Slope with Static and Dynamic Loading conditions
- Slope Stability Analysis Reconfigured/Buttressed Slope with Static and Dynamic Loading conditions
- Slope Stability Analysis Buttressed Slope A with Static and Dynamic Loading conditions
- Slope Stability Analysis Reconfigured 3:1 Slope (Preferred Alternative) with Static and Dynamic Loading conditions

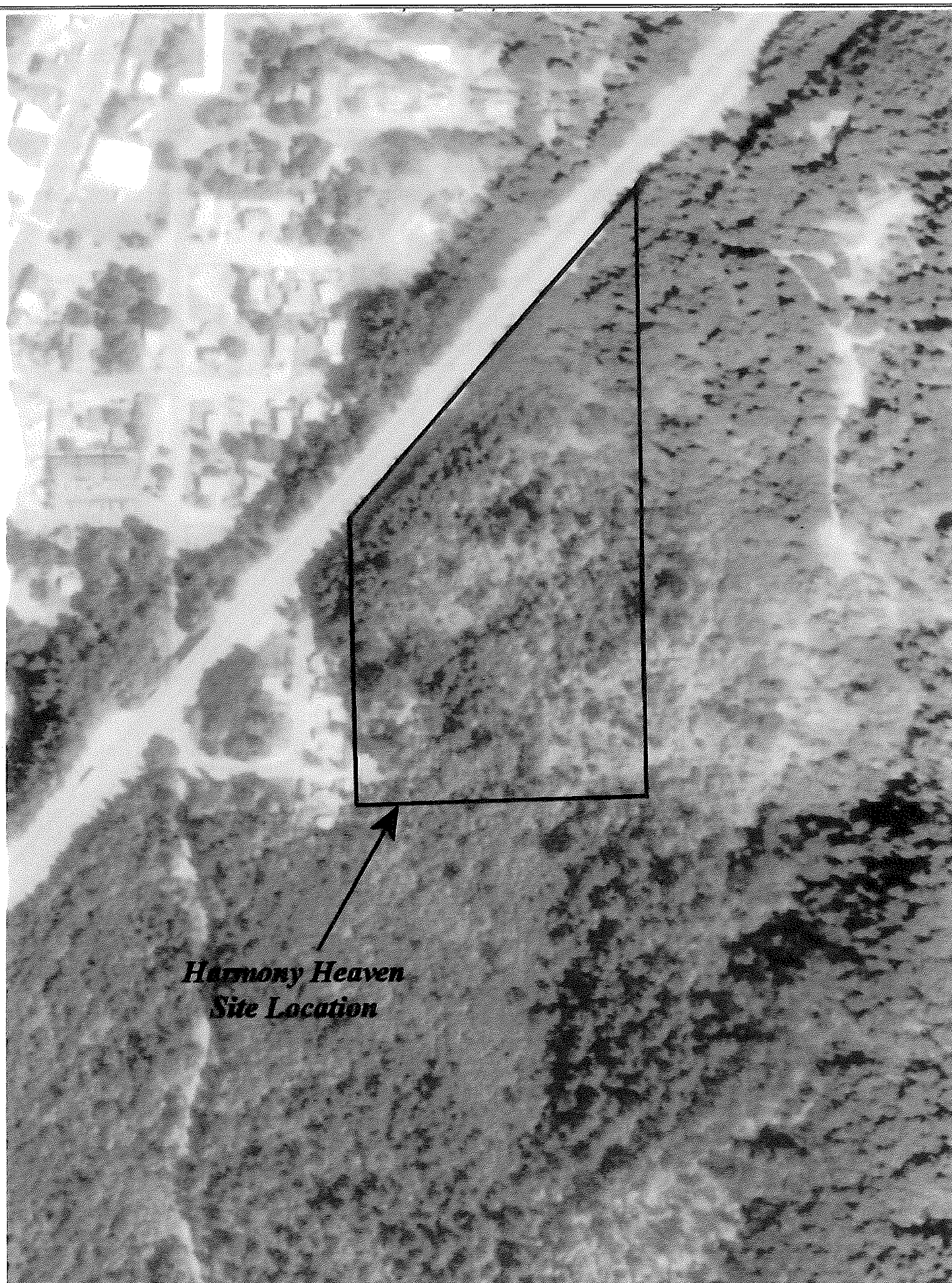
ATTACHMENTS

EXHIBIT A



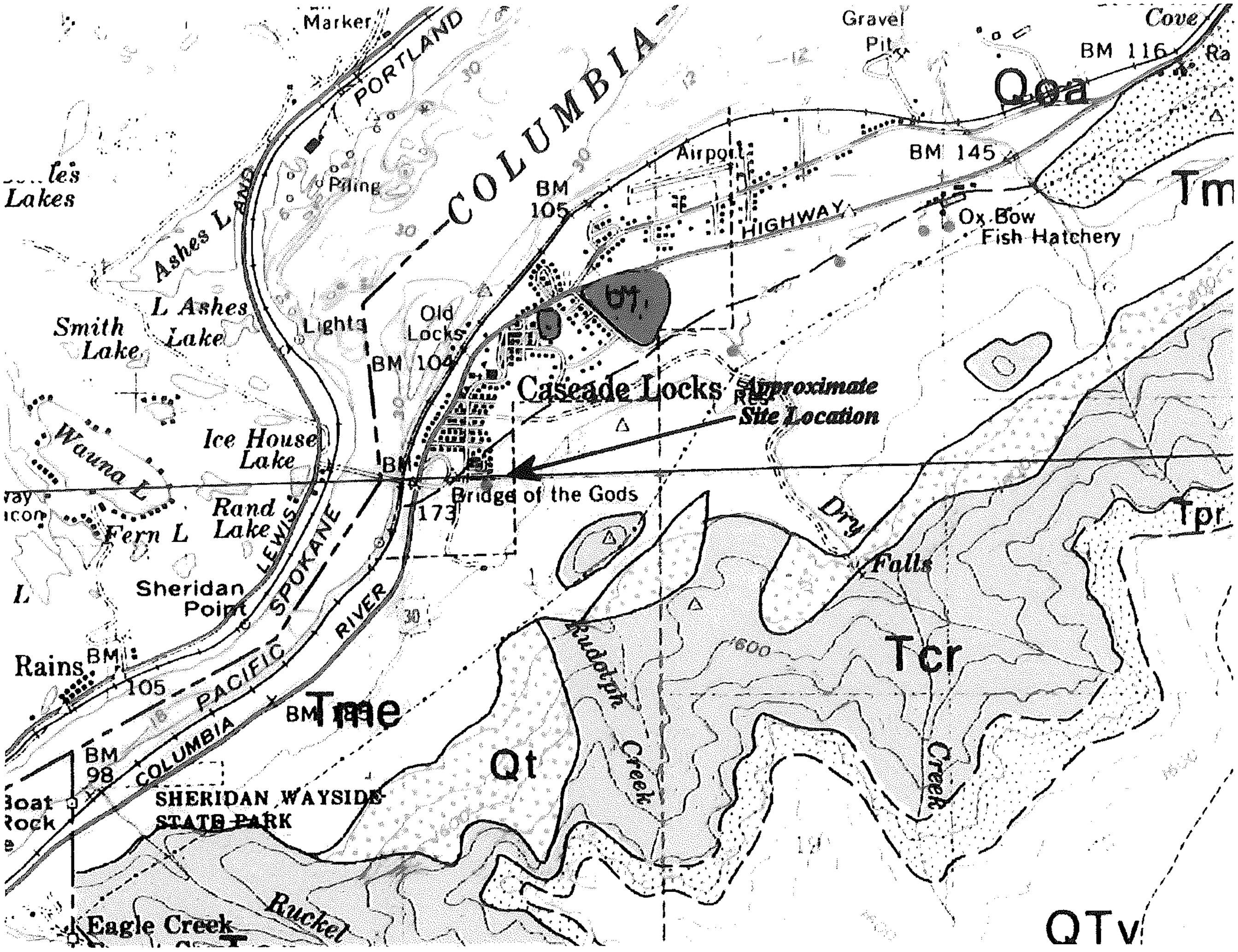
GN Northern, Inc. **Job No.: 206-623-1**	Aerial Photograph Cascade Locks Vicinity U.S. Geologic Survey 1993			
	Date 08-06	Mounted By: ST	Reviewed By: GH	Exhibit A

EXHIBIT B

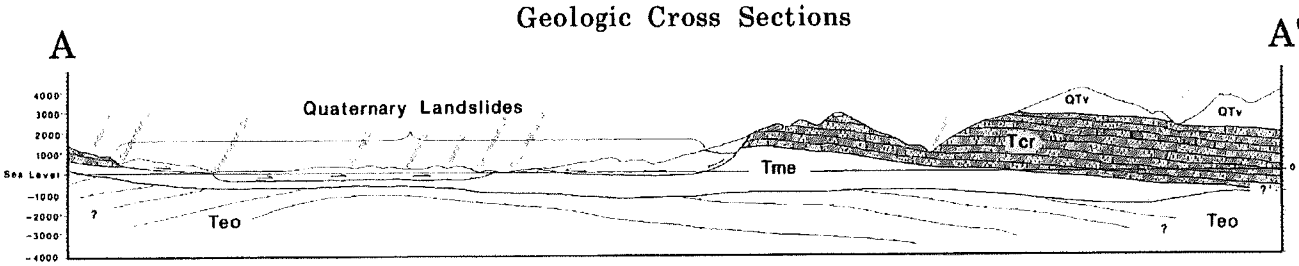


GN Northern, Inc. **Job No.: 206-623-1**	Aerial Photograph Cascade Locks Vicinity U.S. Geologic Survey 2000			
	Date 08-06	Mounted By: ST	Reviewed By: GH	Exhibit B

EXHIBIT C & C1



Geologic Cross Sections



Cross Section of Cascade Locks Vicinity

GN Northern, Inc. **Job No.: 206-623-1**	Geologic Map Cascade Locks Vicinity Oregon Division of Geology Bulletin 91 (Beaulieu, 1977)			
	Date 08-06	Mounted By: ST	Reviewed By: GH	Exhibit C

Surficial Geologic Units

Stream deposits:

Qoa — Quaternary older alluvium: *Unconsolidated gravel, sand, silt, and clay located above floodplains of major streams and as valley fill of smaller stream valleys; equivalent to Qoa and part of Qya of Newcomb (1969); includes several terrace levels of varying ages; generally not subject to flooding except in smaller drainages where scale precludes separate mapping of Qal.*

Qt — Quaternary thick talus: *Uniformly sloping unconsolidated rock and soil debris accumulating at base of cliffs primarily by rockfall and rock slide; estimated thickness generally greater than 50 feet; numerous associated hazards.*

High Cascades volcanic rock:

QTv (Qba, Qvw 2, Qvw 1, Qvu, Qvp, Qdf) — Cascades Formation: *Basaltic and andesitic flow rock, agglomerate, tuff breccia, and debris flows of High Cascades volcanic peaks; includes relatively young vents and intracanyon flows in Mount Defiance area and Hood River Valley (Qba), Wind River (Qvw1, Qvw2), Underwood (Qvu), and Parkdale (Qvp) areas; also includes debris flows in Hood River Valley (Qdf) and intracanyon flows (now ridge crests) south and east of The Dalles (QTv); engineering properties and hazards variable. An older Qba unit (Qba1) and a younger unit (Qba2) are mapped near Odell.*

Tpr — Rhododendron Formation: *Tuff breccia, agglomerate, and ash of local extent, forming benches between Tcr and Qtv in cliffs of Columbia River Gorge; deeply weathered; local mass movement.*

Pliocene Columbia River deposits *(excluding those mapped as part of Dalles Formation):*

Miocene flood basalts:

Tcr — Columbia River Basalt: *Extensive flows of dense, dark-gray basaltic lava of upper and middle Yakima Basalt; pillowed lavas, tuffs, and thin interbeds locally; average flow thickness 80 feet; extensive scabland topography at lower elevations; deep, fault-controlled bedrock failures on steep valley sides.*

Early Miocene volcaniclastic rock:

Tme — Eagle Creek Formation: *Hard, stream-deposited sandstone and conglomerate, and semi-consolidated debris flows and tuff breccias derived from scattered volcanic centers north of Columbia River; exposed in uplifted core of Cascade Range; a variety of extensive deep bedrock slumps; stable in places.*

Eocene volcanic rock:

Teo — Ohanapecosh Formation *(not exposed in study area): Impermeable clay altered and zeolite-cemented volcanic and volcaniclastic rocks and related saprolitic clays; inferred in shallow sub-surface of study area on basis of scattered Ohanapecosh-like material in massive bedrock slumps and nearby exposures on north side of Columbia River; instrumental in generation of massive bedrock slumps in Cascade Locks area.*

Intrusive igneous rock:

QTi — Quaternary and Pliocene intrusive rock: *Wide variety of basaltic and dioritic intrusive rocks which fed QTv vents throughout Quaternary and Pliocene; dense and coarsely jointed in places; includes Shellrock Mountain and quarry rocks east of Cascade Locks; no local vents for Tcr are recognized.*

GEOLOGIC SYMBOLS

Contacts
- Definite contact
- Approximate contact

Faults
- Definite fault
- Approximate fault
- Inferred fault
- Concealed fault
- Normal fault *(ball and bar on downthrown side)*

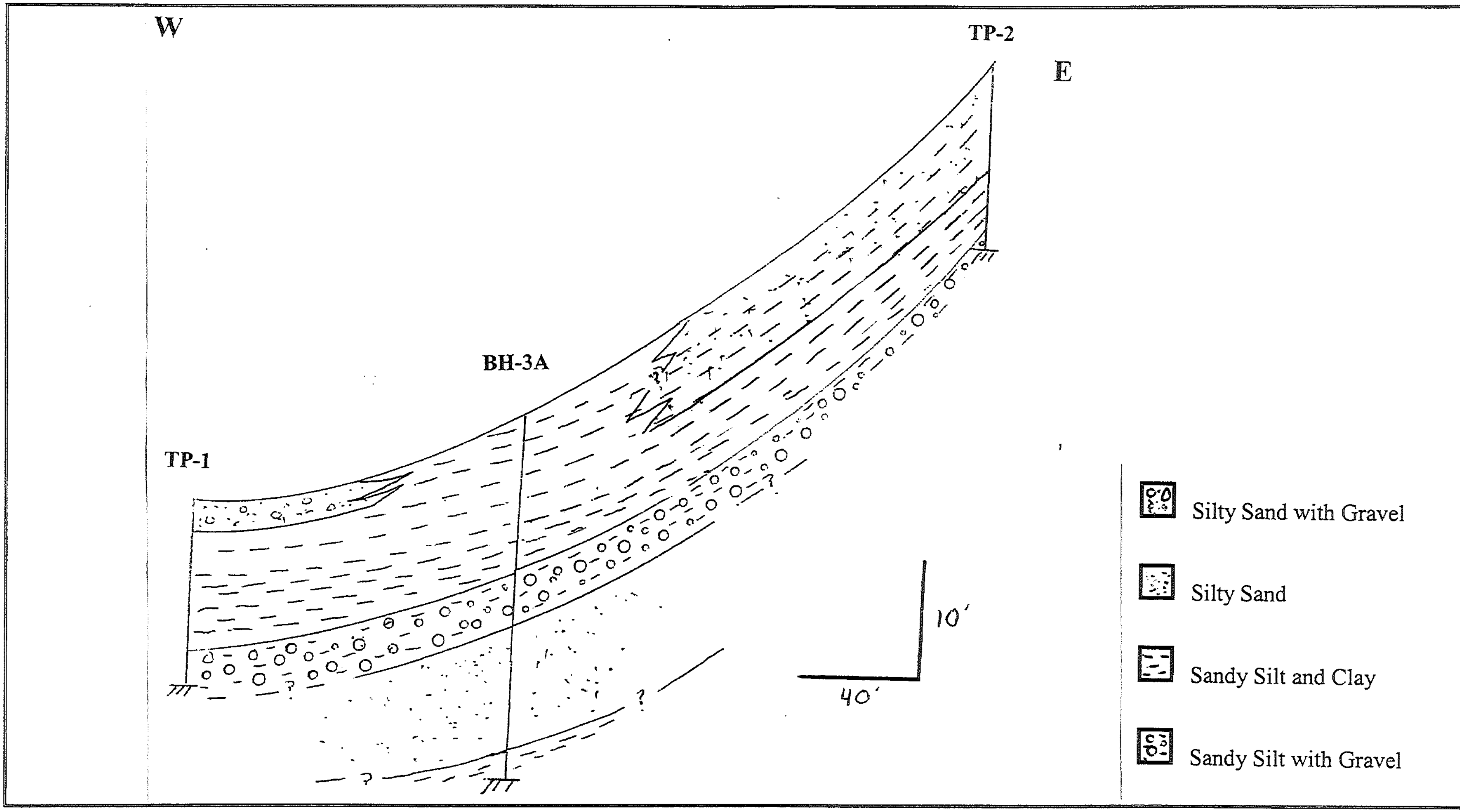
Folds
- Definite anticline
- Definite syncline
- Approximate anticline
- Approximate syncline
- Inferred anticline
- Inferred syncline
- Concealed anticline
- Concealed syncline

Bedding
- Strike and dip of bed
- Strike of vertical bed
- ⊕ Horizontal bed

Spring

GN Northern, Inc.	**Geologic Map Legend**			
Job No. : 206-623-1	Date 08-06	Mounted By: ST	Reviewed By: GH	Figure C1

EXHIBIT D



GN Northern, Inc.

Job No.: 206-623-1

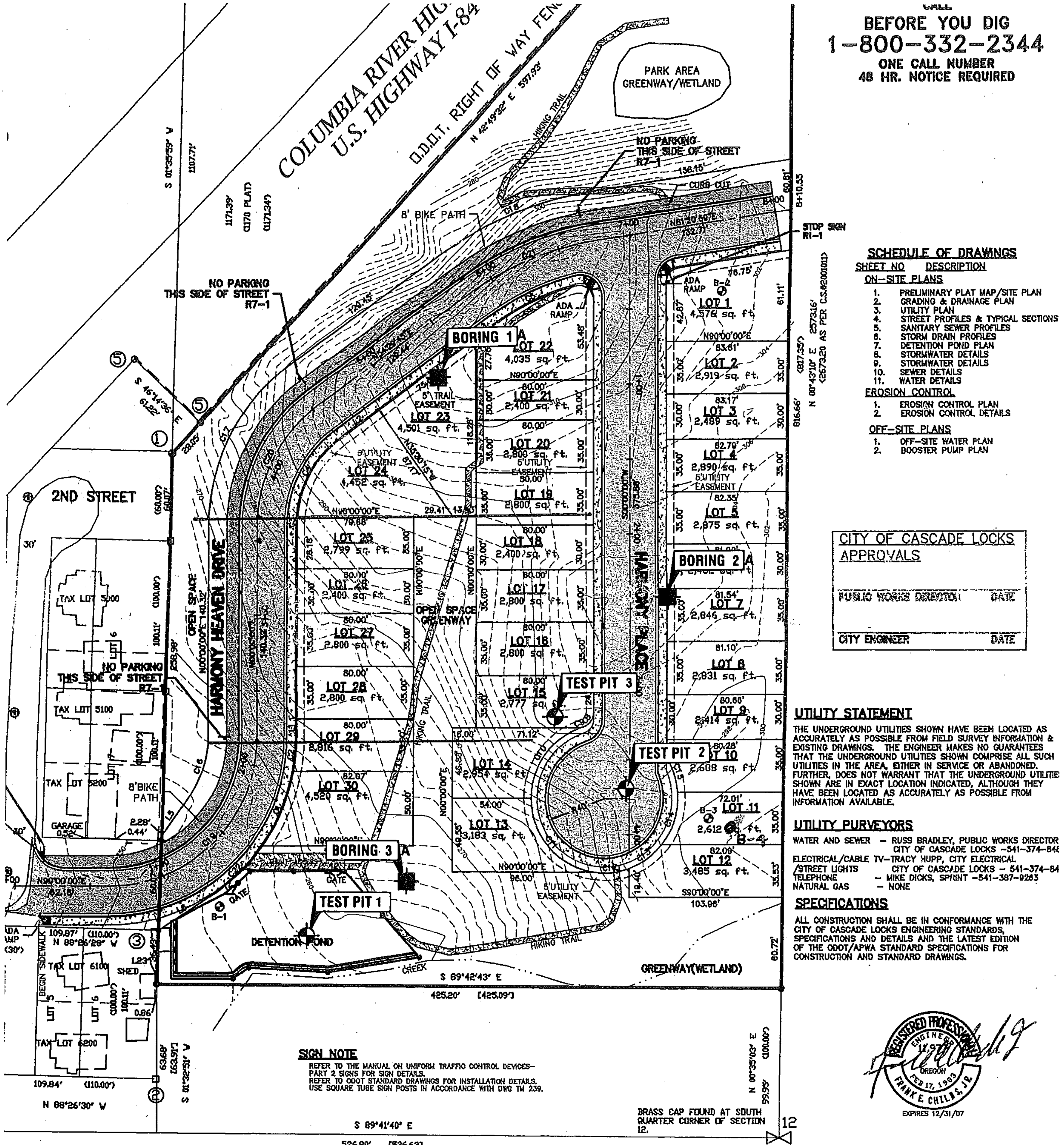
East – West Profile

Harmony Heaven Development

Cascade Locks

Date	Mounted By:	Reviewed By:	Exhibit
8-06	GH	GH	D

EXHIBIT E



GN Northern, Inc. **Job No. 206-623-1**	**Approximate Test Pit & Boring Location Plan** **Harmony Heaven Development** **Cascade Locks Oregon**

Date:	Prepared By:	Reviewed By:	Exhibit:
8-06	RL	IM	E

TEST PIT LOGS

TEST PIT TP-1

Project: Harmony Heaven Development
Project No: 206-623-1
Client: Harmony Heaven Development

[illegible]
Exc. Depth: 15'
Water Level: 2.5'
Location: South End of Detention Pond

Description	Soil Type	Depth (ft)	Water	Samples	Remarks
Topsoil	TP	0			
Sandy Silt with gravel, brown, moist to wet, stiff, non-plastic	ML	1	2.5		
Silty Sand with occassional gravel and cobbles, light brown mottled gray/oxidation, moist, medium dense to dense, and slightly plastic.	SM	3			
Caving Sidewalls	SM	10			
Increasing Gravel and Cobbles	SM	12			
		14			

Northern, Inc.

TEST PIT TP-1

Project: Harmony Heaven Development
Project No: 206-623-1
Client: Harmony Heaven Development

[illegible]
Exc. Depth: 15' **Water Level: 2.5'**
Location: South End of Detention Pond

Description	Soil Type	Graphic Log	Depth	Water	Samples	Remarks
			14			
Increasing Gravel and Cobbles	SM					
Test pit completed at depth of 15 feet BGS						
			16			
			18			
			20			
			22			
			24			
			26			
			28			

TEST PIT TP-2

Project: Harmony Heaven Development
Project No: 206-623-1
Client: Harmony Heaven Development

Exc. Depth: 14'
Location: 10 ' South of Cul-de-sac Center

Water Level: ND

Description	Soil Type	Graphic Log	Depth	Water	Samples	Remarks
Topsoil	TP		0	GWT not encountered		
Silty Sand, light brown to brown, slightly moist, medium dense to dense.	SM		2, 4, 6			
Silty Sand, light brown with mottling of gray/oxidation, moist, medium dense, and slightly plastic.	SM		8, 10			
Becoming dense with cobbles and boulders to 3 feet diameter subrounded to rounded.	SM		12			
Test pit completed at depth of 14 feet BGS			14			

TEST PIT TP-3

Project: Harmony Heaven Development
Project No: 206-623-1
Client: Harmony Heaven Development

Exc. Depth: 16'
Location: Lot 15

Water Level: ND

Description	Soil Type	Graphic Log	Depth	Water	Samples	Remarks
Topsoil	TP		0	GWT not encountered		
Silty Sand, reddish brown (rust), slightly moist, dense, and slightly cemented.	SM		2 4			
Conglomerate, reddish brown, weak to moderately strong, highly to moderately weathered.	BR		6			
Sandstone with occasionaly gravel and cobbles, reddish brown, weak to moderately strong, and moderately weathered.	BR		8 10			
Becoming light brown to tan	BR		12 14			

TEST PIT TP-3

Project: Harmony Heaven Development
Project No: 206-623-1
Client: Harmony Heaven Development

Exc. Date: August 7, 2006
Exc. Depth: 16'
Location: Lot 15

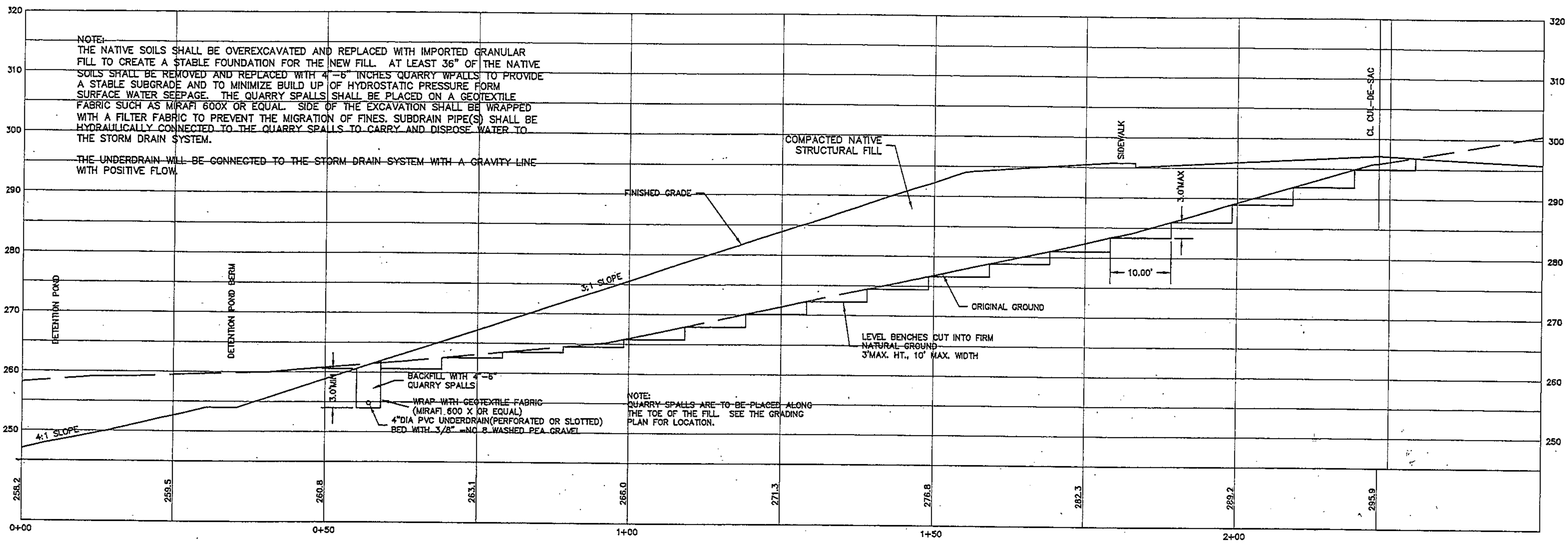
Logged By: GH
Water Level: ND

Description	Soil Type	Graphic Log	Depth	Water	Samples	Remarks
Becoming light brown to tan	BR		14			
Test pit completed at depth of 15.5 feet BGS			16			
			18			
			20			
			22			
			24			
			26			
			28			

DETAIL SHOWING "SECTION THROUGH FILL AREA"

&

PSE'S "GRADING AND DRAINAGE PLAN" SHEET 2 of 12

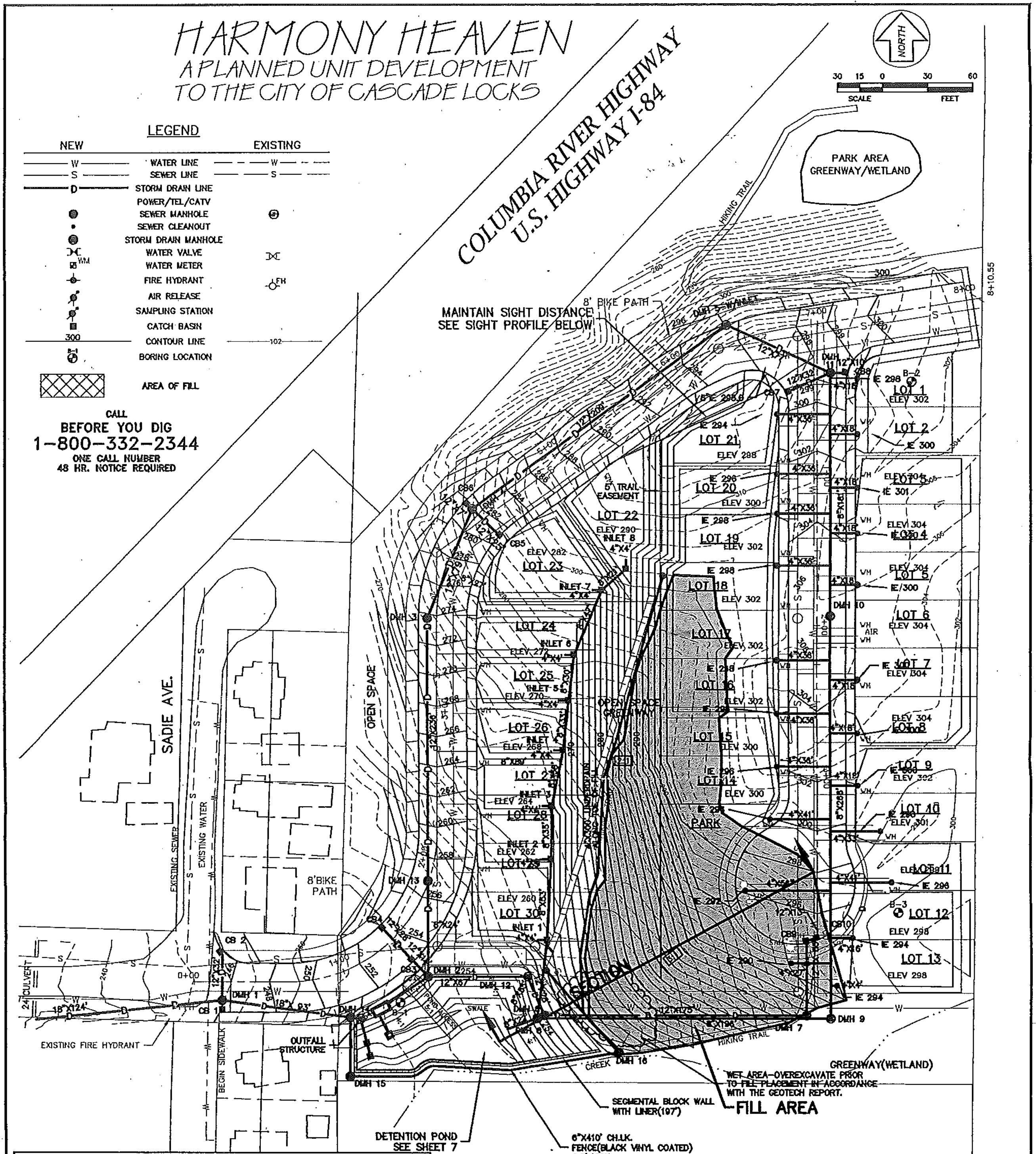


HARMONY HEAVEN SUBDIVISION

CITY OF CASCADE LOCKS

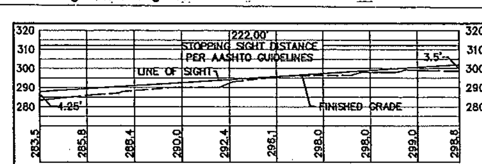
SECTION THROUGH FILL AREA

HARMONY HEAVEN
A PLANNED UNIT DEVELOPMENT TO THE CITY OF CASCADE LOCKS



Site Volume Table: Unadjusted

Site	Stratum	Surf1	Surf2	Cut cuyds	Fill cuyds	Net cuyds	Method
VOLUME	volume	revised-og	finished grade	32568	8946	23622 (C)	Grid



35MPH SIGHT PROFILE HARMONY PLACE INTERSECTION

NOTE:
SEE PROFILES FOR RIM, GRATE AND INVERT ELEVATIONS

GRADING NOTES

1. QUANTITIES SHOWN FOR EXCAVATION AND EMBANKMENT ARE APPROXIMATE ONLY. THE CONTRACTOR IS RESPONSIBLE FOR CALCULATIONS OF QUANTITIES TO BE USED IN THEIR BID.

2. CITY AND COUNTY STREETS AND ROADS ARE TO BE PROTECTED FROM DAMAGE OR BEING FOULED WITH OBJECTIONABLE MATERIALS. REPAIR OR REPLACEMENT OF DAMAGED AREAS IS AT THE CONTRACTORS EXPENSE.

3. NOTIFY THE ENGINEER WHEN UNSUITABLE MATERIAL IS ENCOUNTERED.

4. PROTECT COMPLETED OR PARTIALLY COMPLETED WORK FROM EXCAVATION, HAULING OR PLACEMENT OF MATERIAL ON THE PROJECT. REPAIR OR REPLACEMENT OF DAMAGED AREAS IS AT THE CONTRACTORS EXPENSE.

5. ALL FILL ON THIS PROJECT IS CONSIDERED "ENGINEERED FILL" AND SHALL BE PLACED IN MAXIMUM 8" LIFTS AND BE COMPACTED TO 95% OF MAXIMUM DENSITY.

6. ALL WORK SHALL CONFORM TO THE REPORT OF GEOTECHNICAL RECOMMENDATIONS PREPARED BY G.N. NORTHERN, INC

7. SLOPES, SWALES, BERMS, DETENTION PONDS AND OTHER DISTURBED AREAS SHALL BE HYDROSEEDED WITH THE FOLLOWING SEED MIX. SEEDING SHALL CONFORM TO ODOT/APWA SPECIFICATIONS. ALTERNATE SEED SPECIFICATIONS RECOMMENDED BY THE LOCAL NCRS OFFICE MAY BE USED.

	% WEIGHT	% PURITY	% GERMINATION
TALL OR MEADOW FESCUE	75-80	98	90
SEASIDE/CREEPING BENTGRASS	10-15	92	85
REDTOP BENTGRASS	5-10	90	80
SEED MIX RATE	120#/ACRE		
FERTILIZER(22-16-8)	400#/ACRE		
MULCH	2000#/ACRE(SLOPES 2:1 OR LESS) 3000#/ACRE(SLOPES STEEPER THAN 2:1)		

STORM SEWER NOTES

1. STORM SEWERS SHALL BE CORRUGATED POLYETHELENE CONFORMING TO AASHTO M294, TYPE S OR AS AN ALTERNATIVE IPEX ULTRA RIB PVC PIPE MAY BE USED. EXPOSED PIPE ENDS SHALL BE BEVELED TO FIT THE SLOPE. THE 4" AND 8" DRAIN LINES FOR ROOF DRAINAGE MAY ALSO BE ASTM D3034, SDR 35 AND SHALL BE MARKED "STORM DRAIN" IF USED.

2. STORM MANHOLES SHALL COMPLY WITH ODOT STANDARD DRAWING ERD 336 OR ERD 342. POLLUTION CONTROL MANHOLES SHALL CONFORM TO STD DWG ERD 340.

3. CATCH BASINS SHALL BE ADS NYLOPLAST OR EQUAL AS DETAILED. ALL CATCH BASINS SHALL HAVE A POLLUTION CONTROL OUTLET PIPE AS SHOWN ON STD PLAN RD 374. FRAMES AND GRATES SHALL CONFORM TO CITY REQUIREMENTS AND SHALL BE BICYCLE SAFE

4. TRENCHING AND BEDDING FOR STORM SEWERS SHALL COMPLY WITH TYPICAL SEWER DETAILS S-1.1, 1.2 & 1.3.

5. THE 4" AND 8" STORM SEWERS FOR ROOF DRAINAGE AND DRIVEWAY DRAINAGE, INCLUDING INLETS, AND CLEANOUTS ARE PRIVATE AND WILL BE MAINTAINED BY THE HOMEOWNERS. ADJUST GRADES FOR ROOF DRAINAGE LINES AS NECESSARY TO KEEP LINES ABOVE SEWER SIDE SERVICES AND BELOW WATER SERVICES. STUBOUTS INTO LOTS SHALL BE HAVE APPROXIMATELY 3.0' OF COVER AT THEIR TERMINATION. STUBOUTS AND TEES SHALL BE MARKED WITH A PAINTED 2X4. ALL HOUSES SHALL BE CONNECTED TO THE STORM SYSTEM EXCEPT AS NOTED.

REGISTERED PROFESSIONAL ENGINEER 11,977 OREGON FEB 17, 1983 FRANK E. CHILDS, JR.
EXPIRES 12/31/07

REVISIONS
3. INCLUDED GN NORTHERN COMMENTS
2. INCLUDED CITY COMMENTS 8-4-06
1. LOT DRAINAGE/OVEREXCAVATION 6/30/06

DWN: FEC DATE: 5-1-06

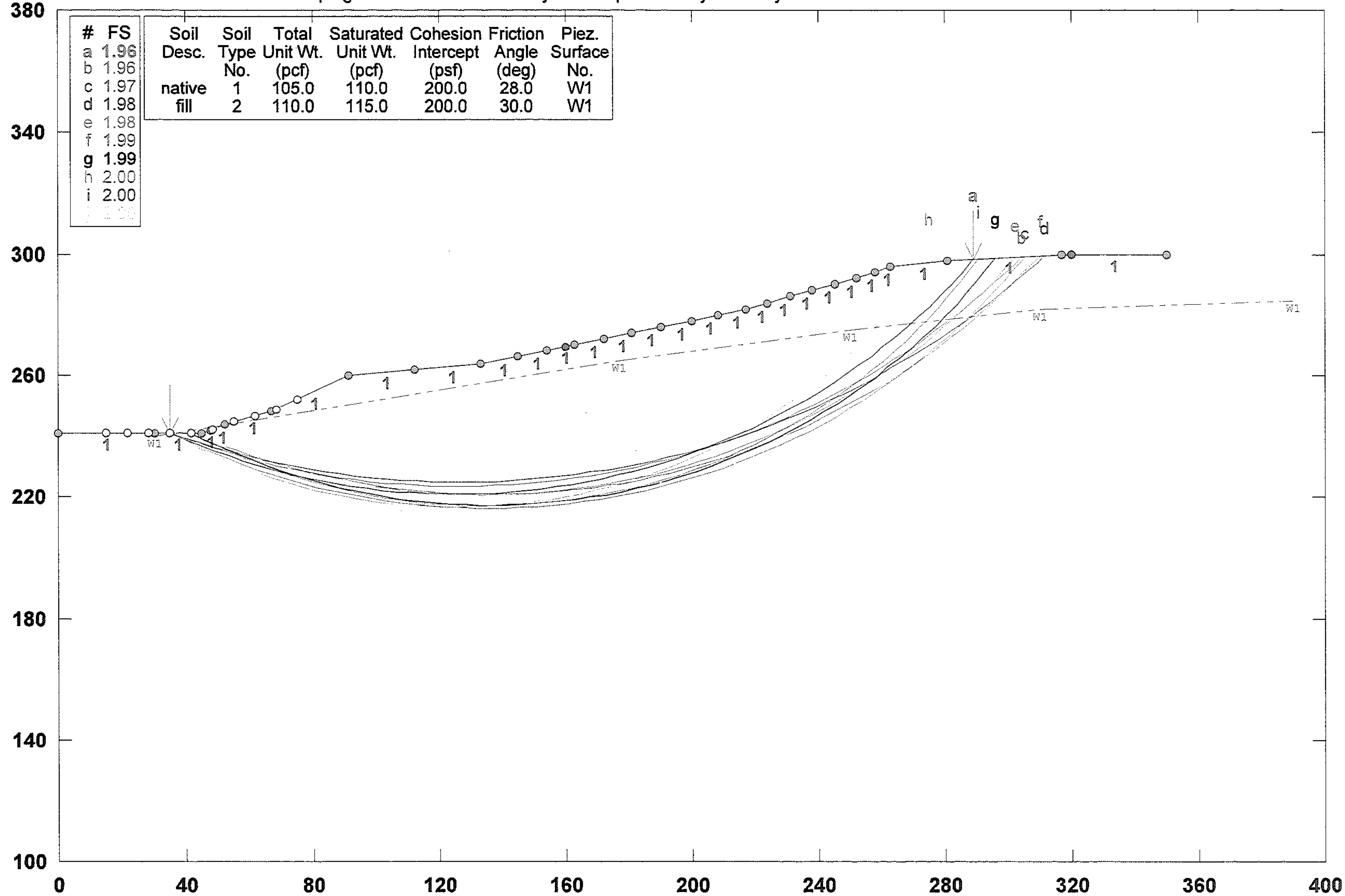
PSE Pioneer Surveying & Engineering, Inc.
Civil Engineering and Land Planning

GRADING & DRAINAGE PLAN
CITY OF CASCADE LOCKS
HOOD RIVER COUNTY, OREGON

SLOPE STABILITY ANALYSIS EXISTING SLOPE STATIC AND DYNAMIC LOADING CONDITIONS

Harmony Heaven - Exisitng Slope - Pond to Lot 9 - Static-Rotational

c:\program files\stedwin\harmony\aaex21.pl2 Run By: Earth Systems Northwest 8/11/2006 10:18AM



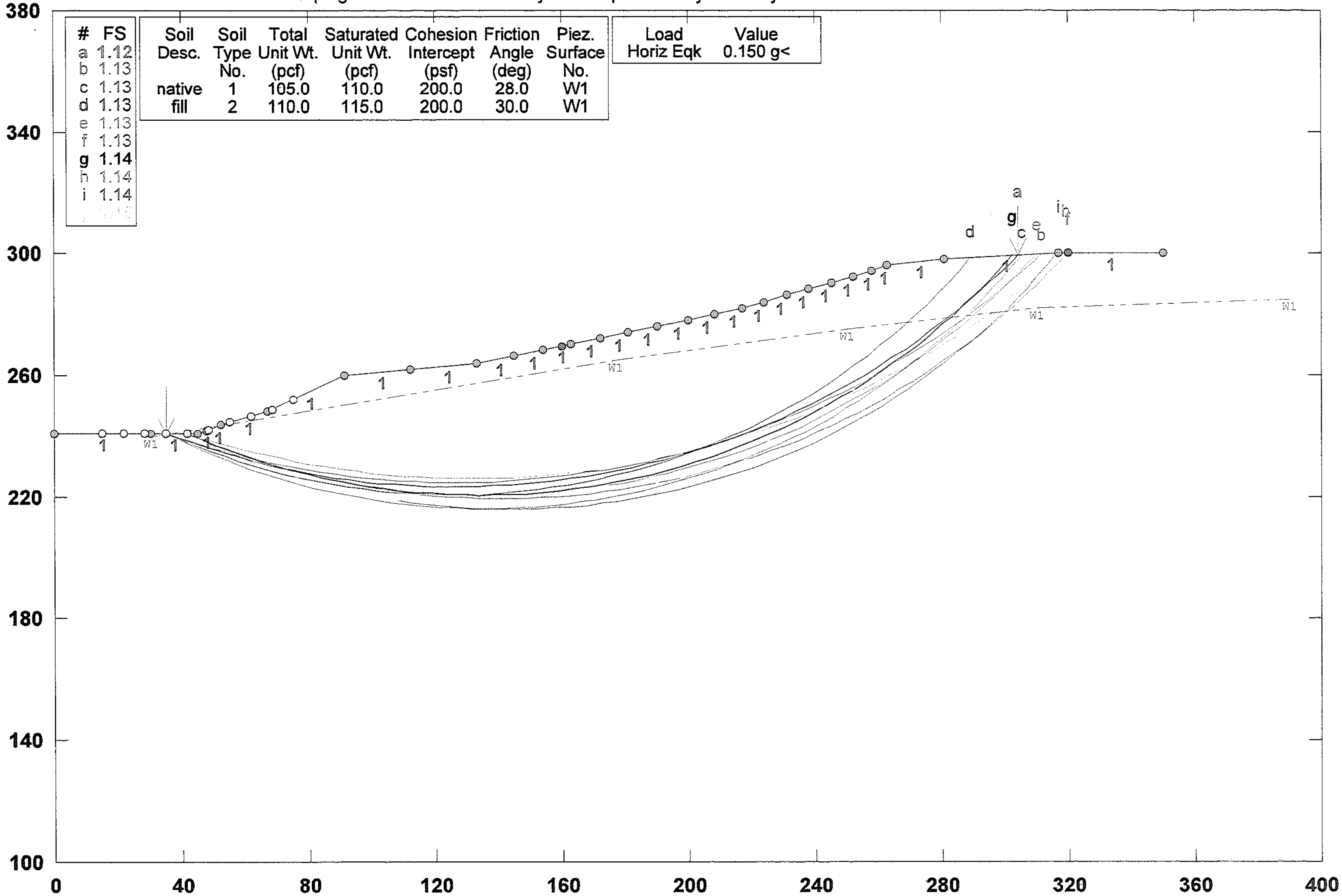
STABL6H FSmin=1.96

Safety Factors Are Calculated By The Modified Bishop Method

STED

Harmony Heaven - Exisitng Slope - Pond to Lot 9 - Dynamic-Rotational

c:\program files\stedwin\harmony\aaex20.pl2 Run By: Earth Systems Northwest 8/15/2006 12:52PM



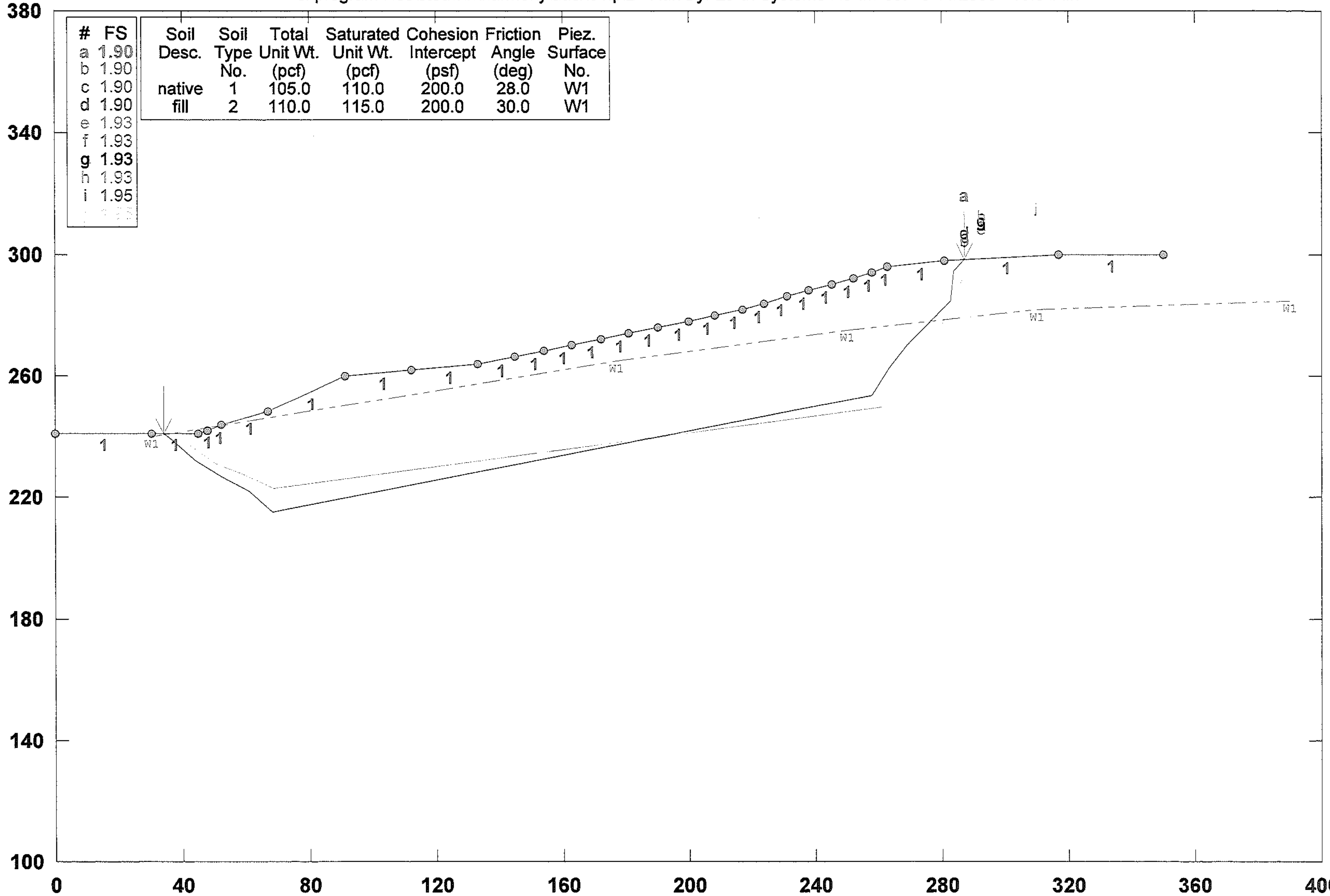
STABL6H FSmin=1.12

Safety Factors Are Calculated By The Modified Bishop Method

STED

Harmony Heaven - Exisitng Slope - Pond to Lot 9 - Static-Translational

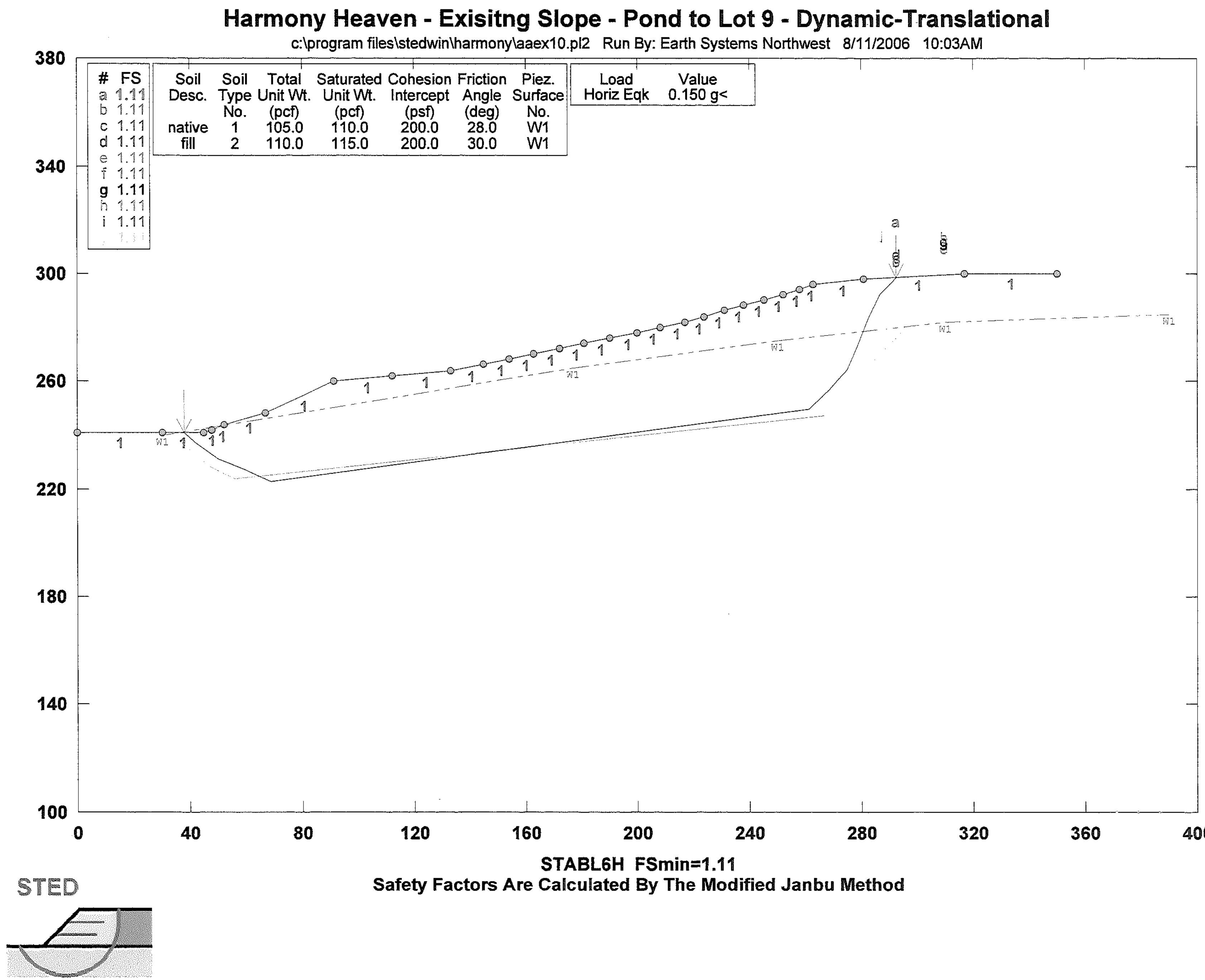
c:\program files\stedwin\harmony\aaex01.pl2 Run By: Earth Systems Northwest 8/11/2006 10:04AM



STABL6H FSmin=1.90

Safety Factors Are Calculated By The Modified Janbu Method

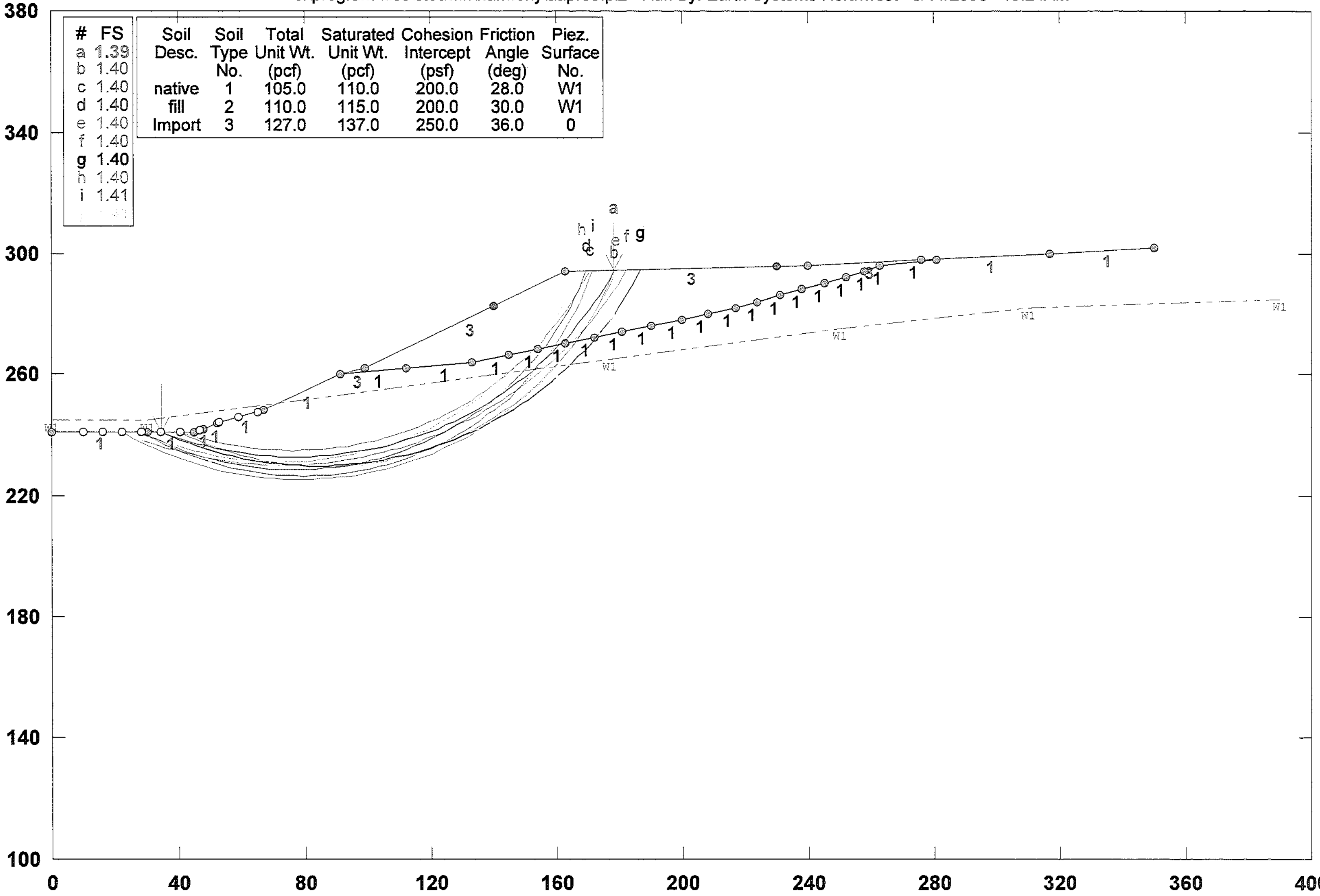
STED


Harmony Heaven - Exisitng Slope - Pond to Lot 9 - Dynamic-Translational
c:\program files\stedwin\harmony\aaex10.pl2 Run By: Earth Systems Northwest 8/11/2006 10:03AM
FS
a 1.11
b 1.11
c 1.11
d 1.11
e 1.11
f 1.11
g 1.11
h 1.11
i 1.11
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
native 1 105.0 110.0 200.0 28.0 W1
fill 2 110.0 115.0 200.0 30.0 W1
Load Value
Horiz Eqk 0.150 g<
380
340
300
260
220
180
140
100
0
40
80
120
160
200
240
280
320
360
400
W1
STABL6H FSmin=1.11
Safety Factors Are Calculated By The Modified Janbu Method
STED

SLOPE STABILITY ANALYSIS ORIGINALLY PROPOSED SLOPE STATIC AND DYNAMIC LOADING CONDITIONS (NON-MITIGATED SLOPE)

Harmony Heaven - Proposed Slope - Pond to Lot 9 - Static-Rotational

c:\program files\stedwin\harmony\aapr03.pl2 Run By: Earth Systems Northwest 8/11/2006 10:24AM



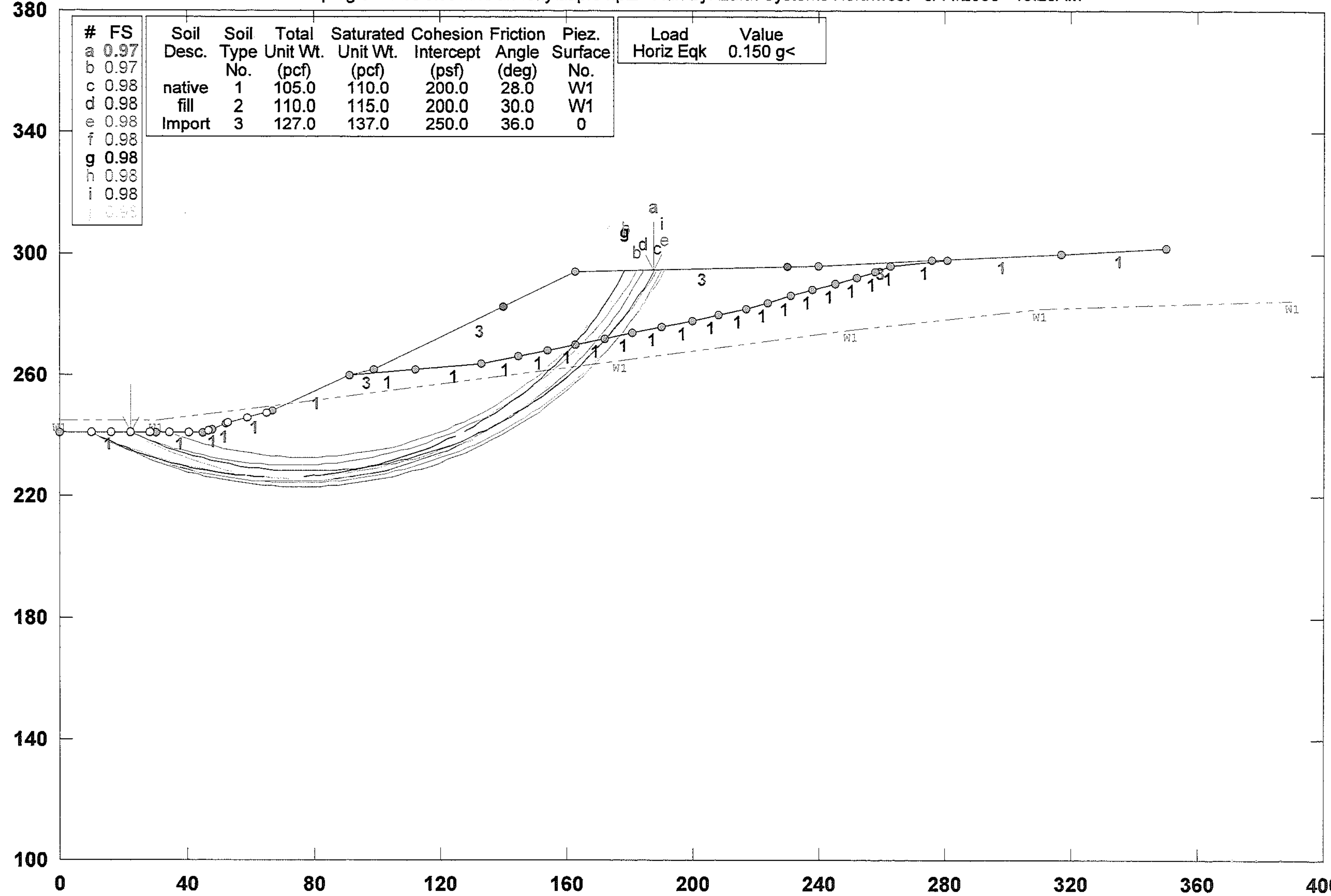
STABL6H FSmin=1.39

Safety Factors Are Calculated By The Modified Bishop Method

STED

Harmony Heaven - Proposed Slope - Pond to Lot 9 - Dynamic-Rotational

c:\program files\stedwin\harmony\aapr04.pl2 Run By: Earth Systems Northwest 8/11/2006 10:26AM



STABL6H FSmin=0.97

Safety Factors Are Calculated By The Modified Bishop Method

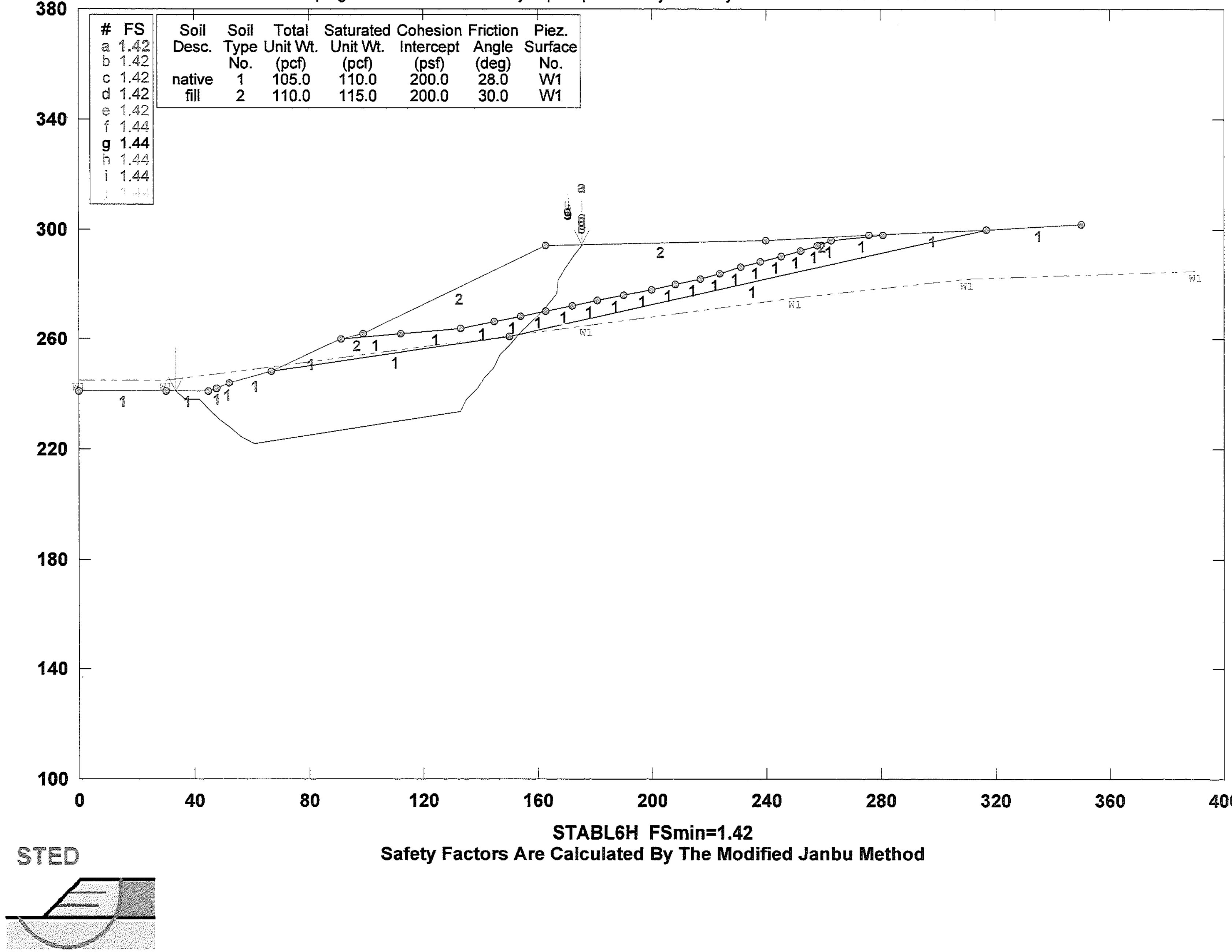
STED

Harmony Heaven - Proposed Slope - Pond to Lot 9 - Static- Translational

c:\program files\stedwin\harmony\aapr30.pl2 Run By: Earth Systems Northwest 8/11/2006 10:00AM

#	FS
a	1.42
b	1.42
c	1.42
d	1.42
e	1.42
f	1.44
g	1.44
h	1.44
i	1.44
j	1.44

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
native	1	105.0	110.0	200.0	28.0	W1
fill	2	110.0	115.0	200.0	30.0	W1

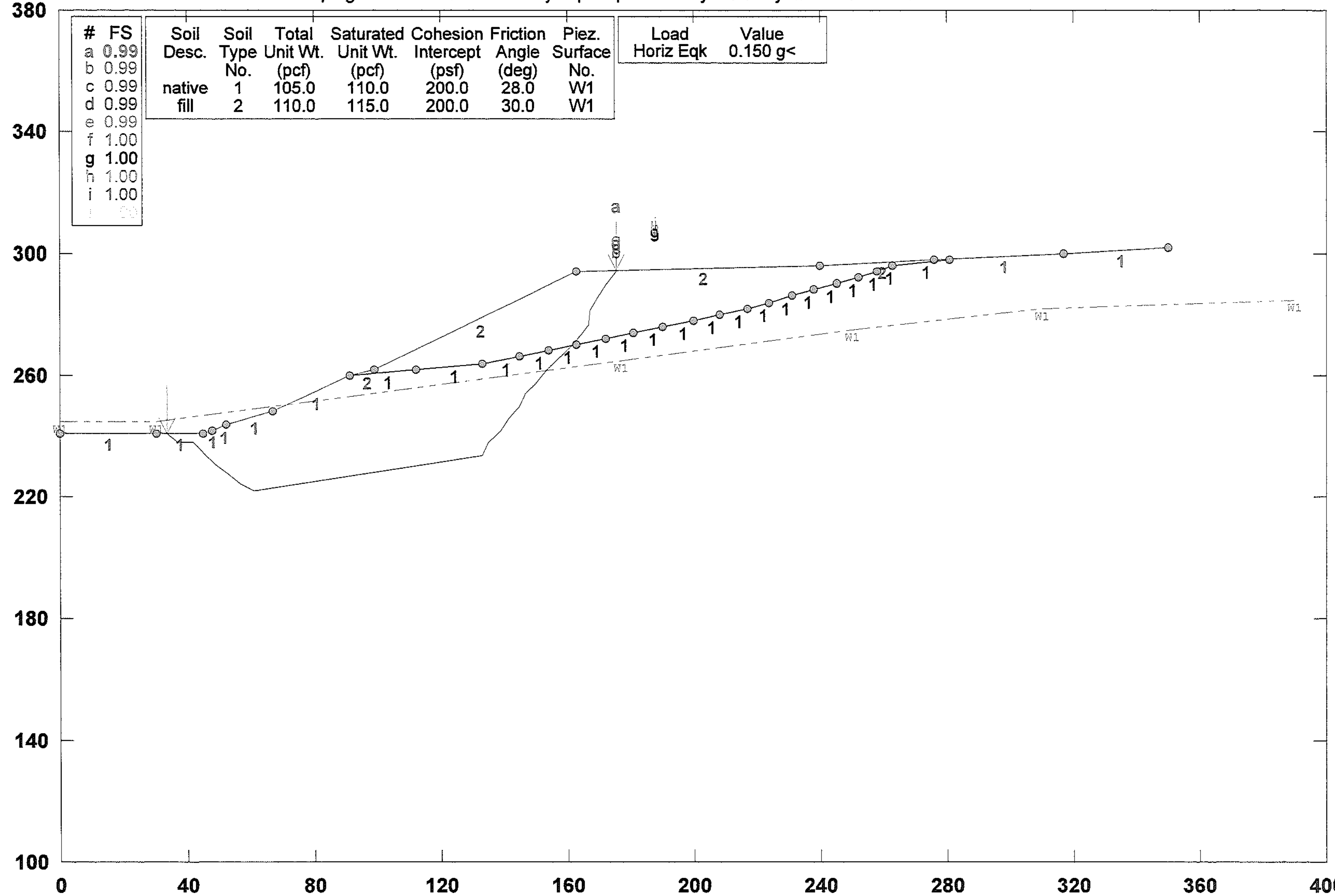


STABL6H FSmin=1.42

Safety Factors Are Calculated By The Modified Janbu Method

Harmony Heaven - Proposed Slope - Pond to Lot 9 - Dynamic-Translational

c:\program files\stedwin\harmony\aapr31.pl2 Run By: Earth Systems Northwest 8/11/2006 10:17AM



STABL6H FSmin=0.99

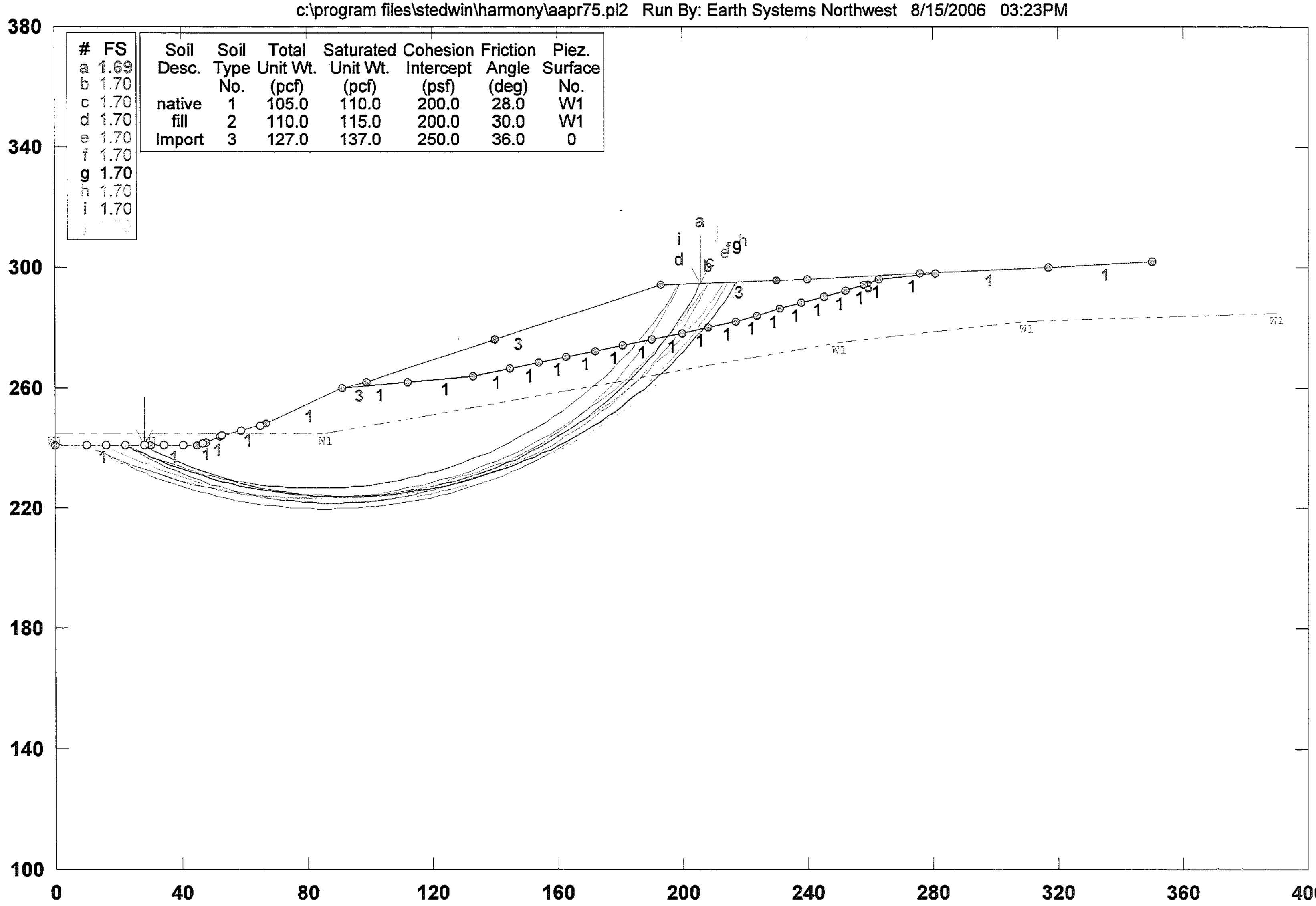
Safety Factors Are Calculated By The Modified Janbu Method

STED

SLOPE STABILITY ANALYSIS RECONFIGURED SLOPE STATIC AND DYNAMIC LOADING CONDITIONS

Harmony Heaven - Reconfigured Slope - Pond to Lot 9 - Static-Rotational

c:\program files\stedwin\harmony\aapr75.pl2 Run By: Earth Systems Northwest 8/15/2006 03:23PM



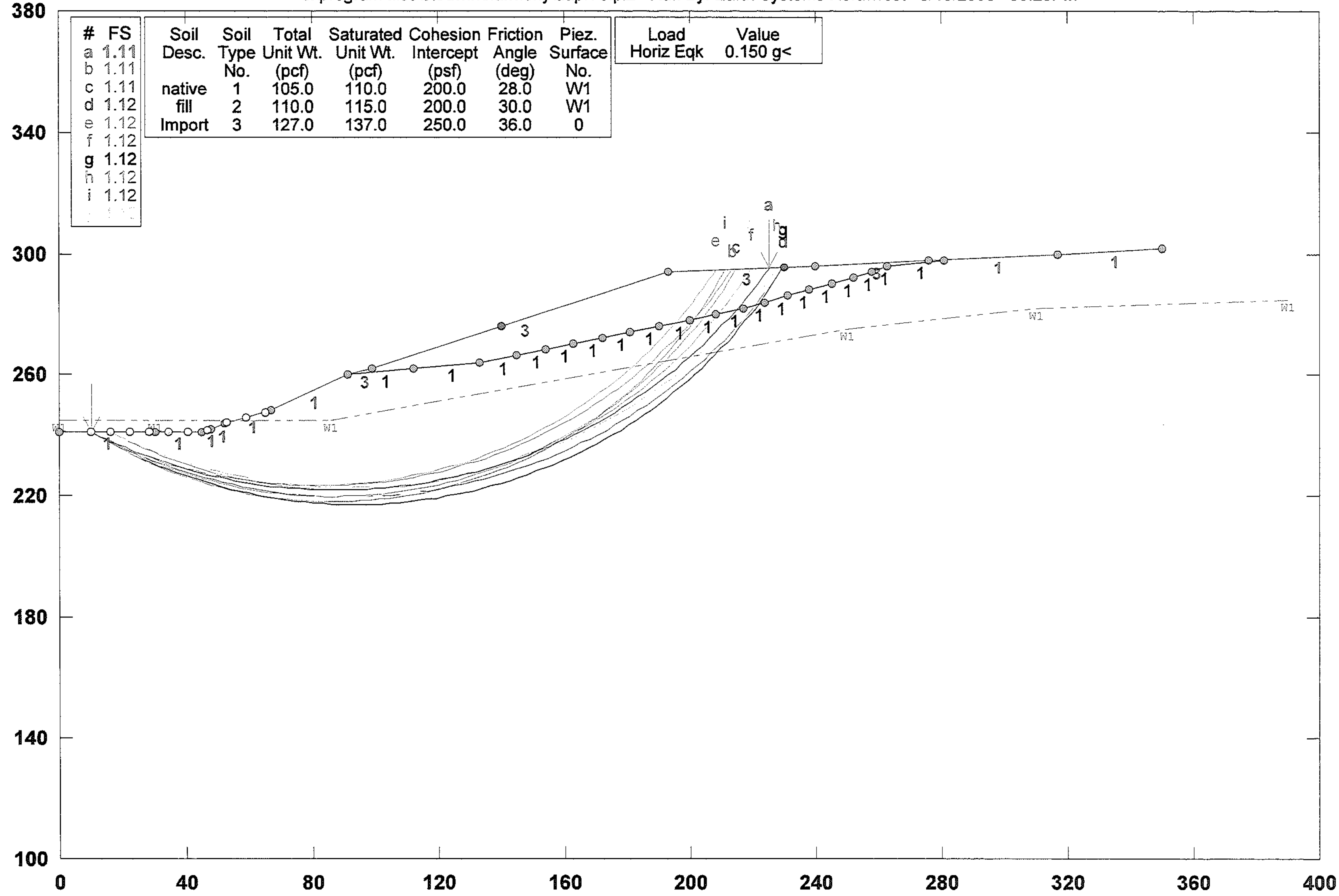
STABL6H FSmin=1.69

Safety Factors Are Calculated By The Modified Bishop Method

STED

Harmony Heaven - Reconfigured Slope - Pond to Lot 9 - Dynamic-Rotational

c:\program files\stedwin\harmony\aapr76.pl2 Run By: Earth Systems Northwest 8/15/2006 03:25PM



STABL6H FSmin=1.11

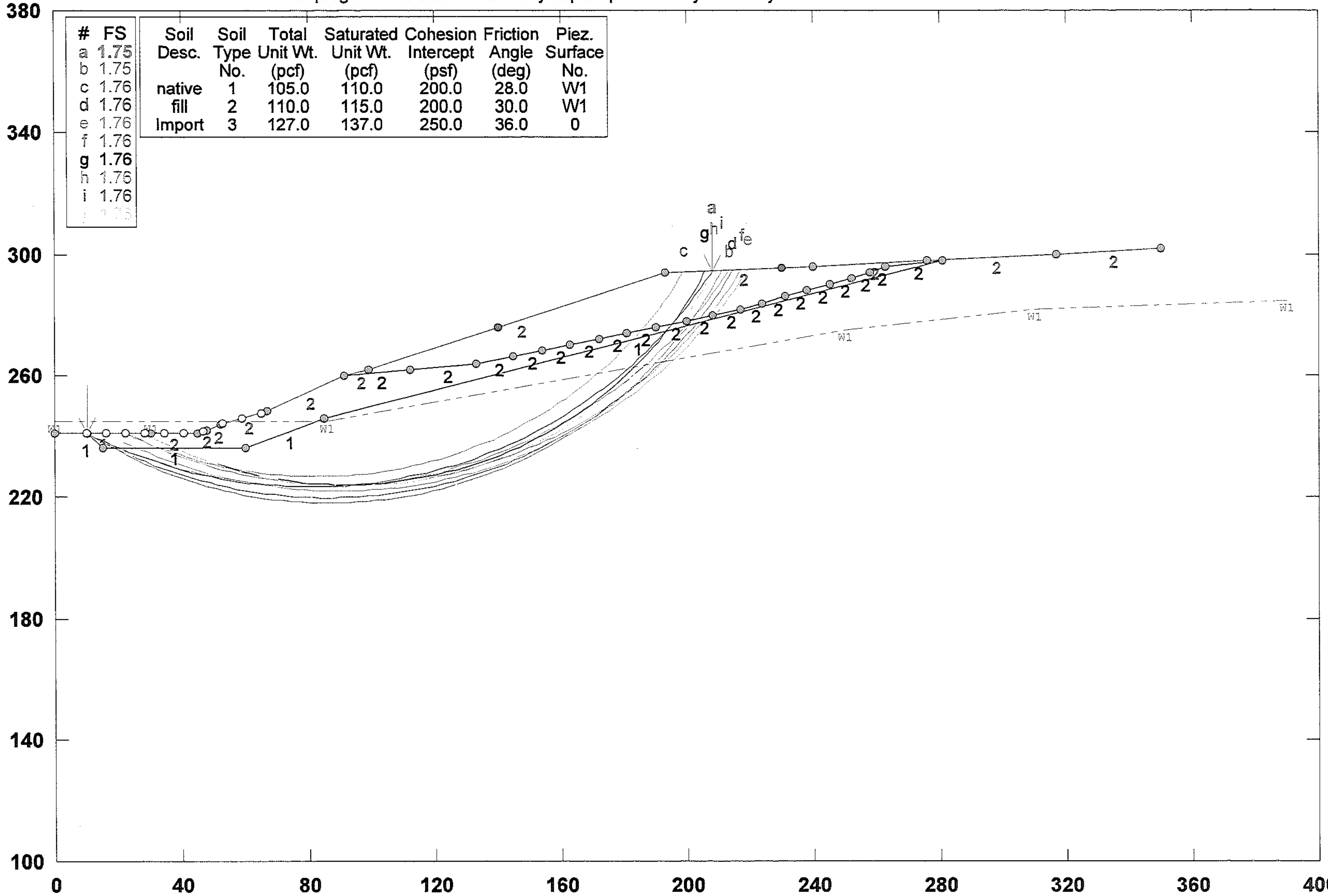
Safety Factors Are Calculated By The Modified Bishop Method

STED

SLOPE STABILITY ANALYSIS RECONFIGURED/BUTTRESSED SLOPE- STATIC AND DYNAMIC LOADING CONDITIONS

Harmony Heaven - Reconfigured/Buttressed- Pond to Lot 9 - Static-Rotational

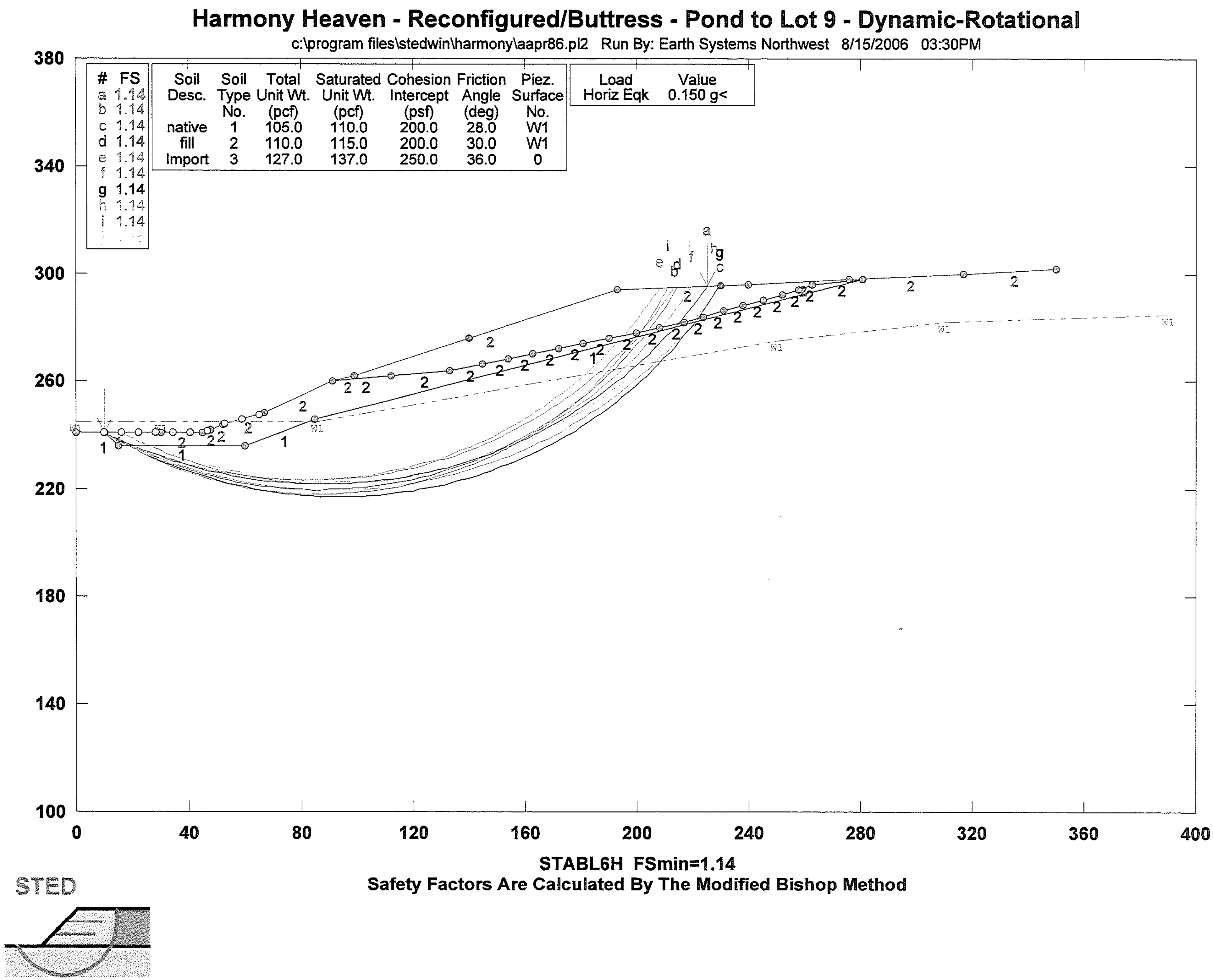
c:\program files\stedwin\harmony\aapr85.pl2 Run By: Earth Systems Northwest 8/15/2006 03:28PM



STABL6H FSmin=1.75

Safety Factors Are Calculated By The Modified Bishop Method

STED

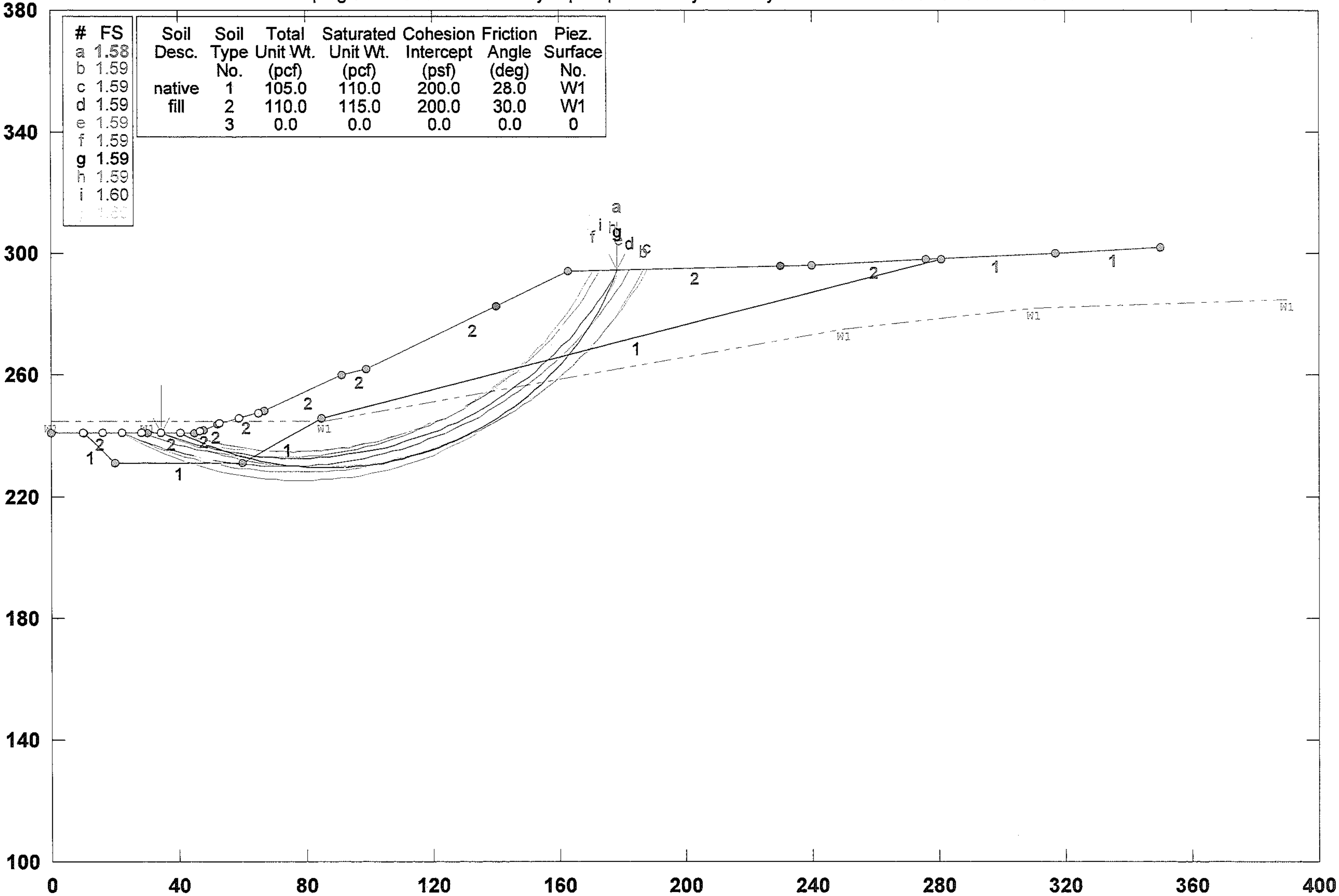


Harmony Heaven - Reconfigured/Buttress - Pond to Lot 9 - Dynamic-Rotational
c:\program files\stedwin\harmony\aapr86.pl2 Run By: Earth Systems Northwest 8/15/2006 03:30PM
FS
a 1.14
b 1.14
c 1.14
d 1.14
e 1.14
f 1.14
g 1.14
h 1.14
i 1.14
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
native 1 105.0 110.0 200.0 28.0 W1
fill 2 110.0 115.0 200.0 30.0 W1
Import 3 127.0 137.0 250.0 36.0 0
Load Value
Horiz Eqk 0.150 g<
380
340
300
260
220
180
140
100
0
40
80
120
160
200
240
280
320
360
400
STABL6H FSmin=1.14
Safety Factors Are Calculated By The Modified Bishop Method
STED

SLOPE STABILITY ANALYSIS BUTTRESSED SLOPE STATIC AND DYNAMIC LOADING CONDITIONS

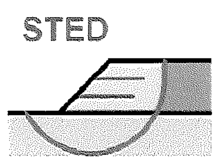
Harmony Heaven - Buttressed Slope A - Pond to Lot 9 - Static-Rotational

c:\program files\stedwin\harmony\aapr51.pl2   Run By: Earth Systems Northwest   8/15/2006   04:35PM



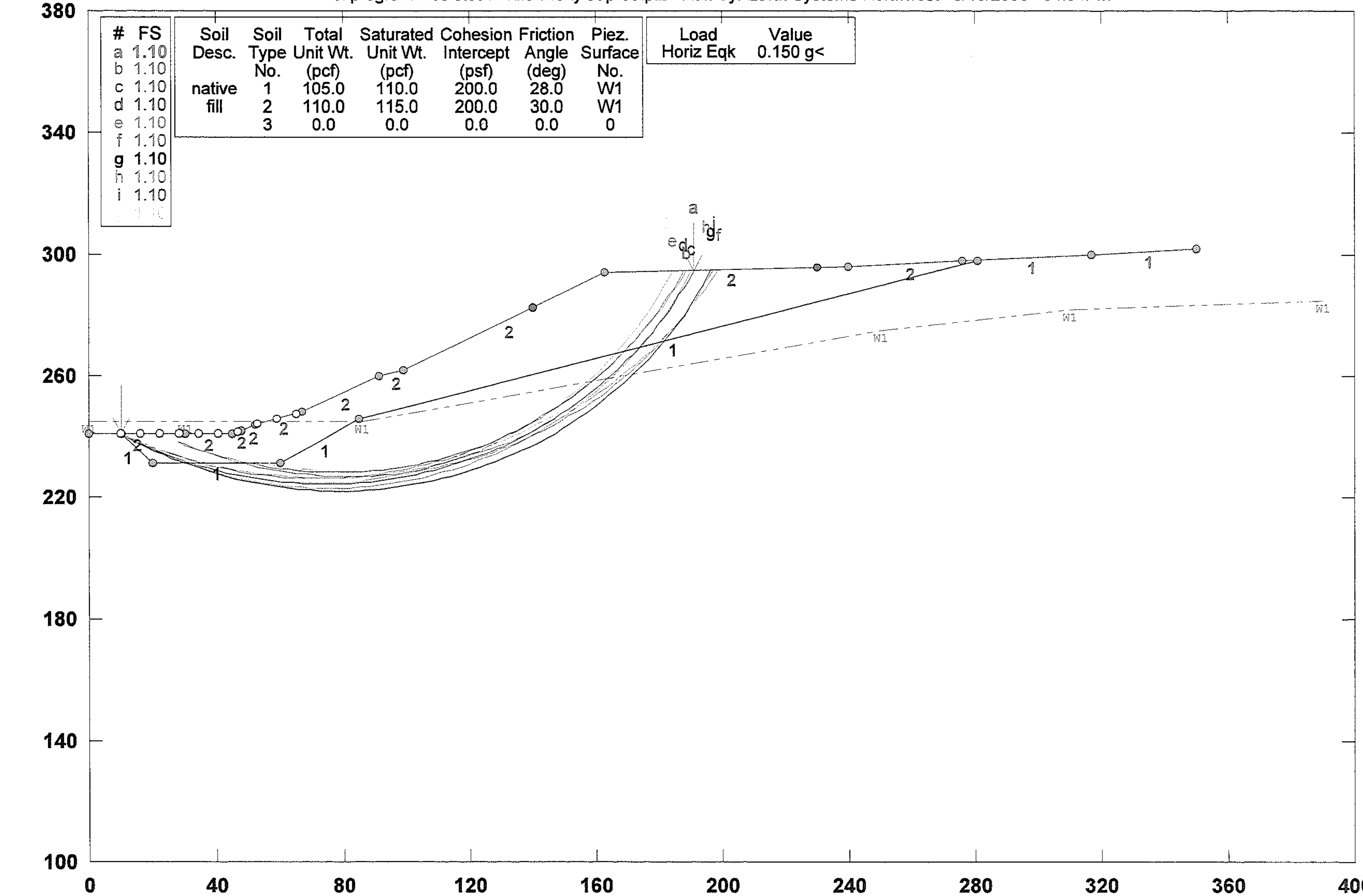
STABL6H FSmin=1.58

Safety Factors Are Calculated By The Modified Bishop Method



Harmony Heaven - Buttressed Slope A - Pond to Lot 9 - Dynamic-Rotational

c:\program files\stedwin\harmony\aapr50.pl2 Run By: Earth Systems Northwest 8/15/2006 04:34PM



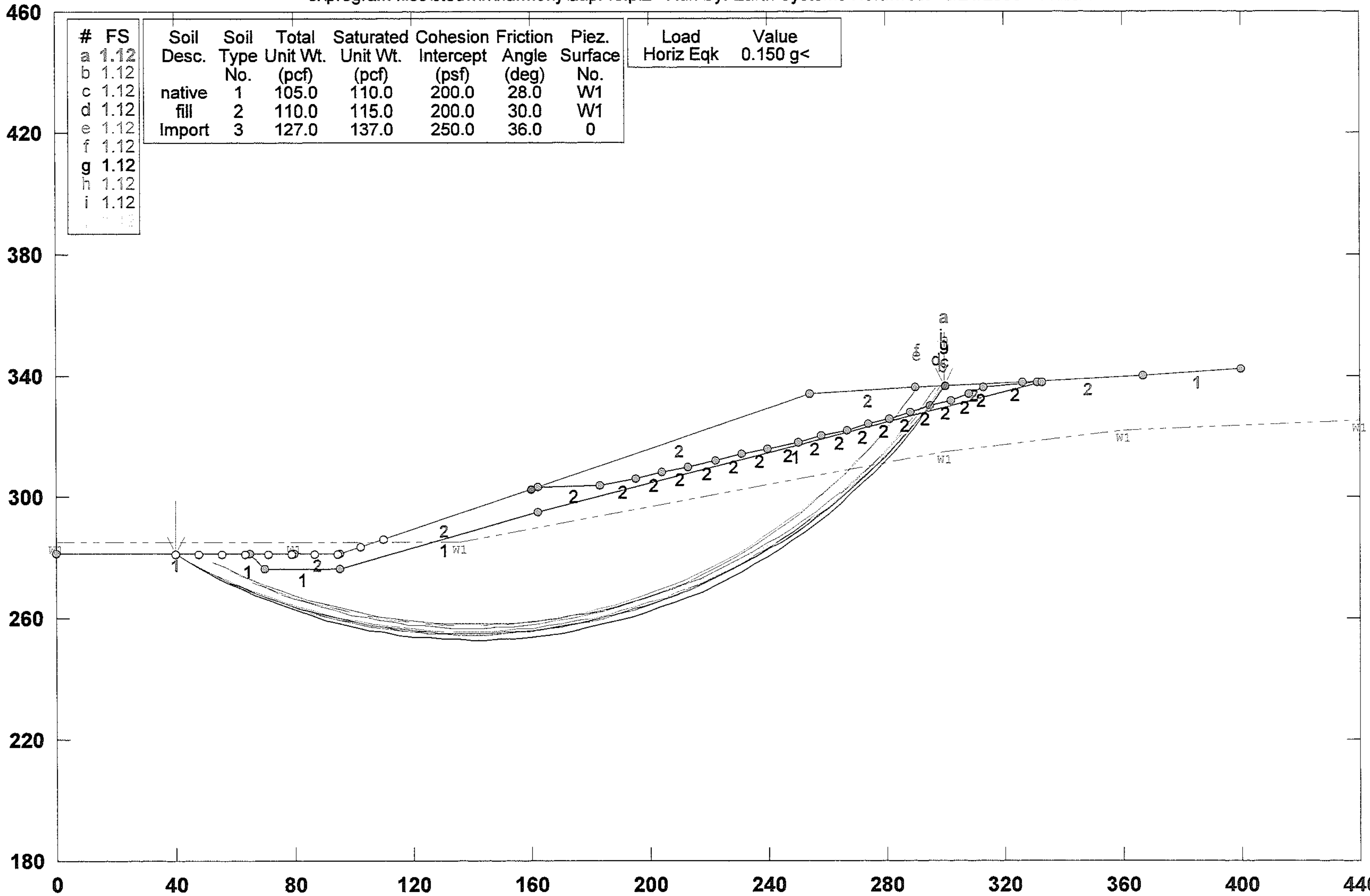
STABL6H FSmin=1.10

Safety Factors Are Calculated By The Modified Bishop Method

SLOPE STABILITY ANALYSIS RECONFIGURED 3:1 SLOPE STATIC AND DYNAMIC LOADING CONDITIONS (PREFERRED ALTERNATIVE)

Harmony Heaven - Reconfigured 3:1 Slope - Pond to Lot 9 - Dynanic-Rotational

c:\program files\stedwin\harmony\aapr40.pl2 Run By: Earth Systems Northwest 8/21/2006 11:26AM



STABL6H FSmin=1.12

Safety Factors Are Calculated By The Modified Bishop Method

STED