E3RA

GEOTECHNICAL ENGINEERING REPORT

EAGLE HILL ROAD IMPROVEMENTS AND LANDSLIDE MITIGATION TOKELAND, WASHINGTON

Submitted to:

Red Plains Professional, Inc.
230 North 1680 East, Suite J-2
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Attention: Elisabeth Whitlock

Submitted by:

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August 5, 2010

T10065

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E3RA

August 5, 2010
T10065

Red Plains Professional, Inc.
230 North 1680 East, Suite J-2
St. George, Utah 84790

Attention: Elisabeth Whitlock, PE, VP Western Region

Subject: **Geotechnical Engineering Report**
Eagle Hill Road Improvements and Landslide Mitigation
Tokeland, Washington

Dear Ms. Whitlock:

E3RA is pleased to submit this report describing the results of our geotechnical engineering evaluation for improvements to Eagle Hill Road on the Shoalwater Bay Indian Reservation. Eagle Hill Road is located on the north side of SR 105 approximately one half mile west of the intersection of Tokeland Road and SR 10 in Tokeland, Washington.

This report has been prepared for the exclusive use of the Shoalwater Bay Tribe, Red Plains Professional, Inc., and their consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The project site is an existing 12 foot wide graveled roadway that extends north from SR 105 about 0.6 miles. The roadway continues beyond 0.6 miles, where it is periodically used as part of an extensive logging road system. The general location of Eagle Hill Road is shown on the enclosed Topographic and Location Map (Figure 1).

The roadway is currently used as an access road for a water reservoir that is located midway along the 0.6 mile roadway alignment. It is also used to access a single family residence located near the north terminus of the alignment and for logging operations, when they occur, farther to the north.

Landslides periodically occur on the lower reaches of the east side of the roadway, where a steep ridge rises to elevations of up to 150 feet.

Plans call for widening the roadway to 22 feet and paving it. Plans also call for stabilization of the landslide area on the lower reach of the roadway.

Preliminary plans indicate that the improved roadway alignment will follow the existing roadway alignment except for a short length in the vicinity of the water reservoir, where a sharp “meander” in the road will be made less sharp by cutting out the outside “meander” edge.

After the roadway is widened and paved, and slope stability is achieved in the landslide area, it will be used, when necessary, as a Tsunami escape route for the nearby lowland area.

Eventually, a multi-purpose building is planned for a swale on the east side of the roadway, at a location somewhat south of the water reservoir and adjacent to and north of the ridge where landslides occur. We understand that preliminary plans call for filling the swale to an elevation of 88 feet (approximately 25 to 30 feet above the swale floor) with, possibly, fill generated by grading down the landslide-prone ridge and with fill generated during road grading activities.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on June 29, 2010 and July 21, 2010. Our exploration and evaluation program comprised the following elements:

- Surface reconnaissance of the roadway alignment and the landslide prone ridge;
- Nine test pits (designated TP-1 through TP-9), conducted along the edge of the roadway alignment;
- Three test holes excavated through the existing roadway surface;
- Two grain-size analyses, one Proctor Analysis, and five moisture determinations performed on samples collected from our test pit explorations and from the face of a landslide scarp;
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate functional locations and termination depths of our subsurface explorations, and Figure 2 depicts their approximate relative locations. The following sections describe the procedures used for excavation of test pits.

TABLE 1
APPROXIMATE LOCATIONS, ELEVATIONS AND DEPTHS OF EXPLORATIONS

Exploration	Functional Location	Approximate Elevation (feet)	Termination Depth (feet)
TP-1	West edge roadway, edge of bog,125 feet from SR105	10	10
TP-2	5 to 7 feet above east edge roadway, within toe of slope	30-40	10
TP-3	20 feet from east side roadway, in landslide deposit	60-70	7
TP-4	West, “fill” side of existing roadway	60-70	7
TP-5	Floor of swale east of roadway	60	11
TP-6	West side roadway in old grading cut, north of water tower	150	10
TP-7	East, “fill” side of roadway	150	11
TP-8	East, “fill” side of roadway	220	7
TP-9	West, “cut” side of roadway	250-260	5
TH-1	Road surface	260	1½
TH-2	Road surface	240	1½
TH-3	Road surface	160	1
Elevation information: From site plan provided by Red Plains Professional			

The specific number and locations of our explorations were selected in relation to the existing site features, under the constraints of surface access, underground utility conflicts, and budget considerations.

It should be realized that the explorations performed and utilized for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

2.1 Test Pit Procedures

Our exploratory test pits were excavated with a steel-tracked excavator by an employee of Shawn Maben Construction under subcontract to E3RA. An engineering geologist from our firm observed the test pit excavations and logged the subsurface conditions.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in each test pit, based on our field classifications. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of the in-situ soils by means of the excavation characteristics and the stability of the test pit sidewalls. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 through A-10.

2.2 Test Hole Procedures

Our exploratory test holes were advanced with a shovel, mattock/pickaxe, and a heavy iron digging bar.

The enclosed Test Hole Logs describe the vertical sequence of soils and materials encountered in our test hole, based on our field classification. Where a soil contact was observed to be gradational or undulating, our log indicates the average contact depth. Our log also indicates the approximate depth of any sidewall caving or groundwater seepage observed in the hole. Summary logs of the explorations are included as Figures A-11 through A-13.

3.0 SITE CONDITIONS

The following sections present our observations, measurements, findings, and interpretations regarding, surface, soil, groundwater, seismic, and liquefaction conditions.

3.1 Surface Conditions

The southernmost 250 feet or so of Eagle Hill road alignment, from its inception at SR 105, traverses a low, wetland bog. North of the bog, the roadway alignment ascends, to an elevation of about 80 feet, the south flank of a 150 foot high, east-west oriented ridge. At an elevation of 80 feet or so, the roadway traverses a swale at the base of the north flank of the above-described ridge. North of the swale, the roadway ascends moderately steep to steep terrain to the terminus of the planned roadway improvement area, approximately 0.6 miles from SR 105, at an elevation of about 265 feet. A water reservoir is located on the east side of the middle part of the roadway, at an elevation of about 120 feet.

The existing roadway appears to have been constructed by cutting the uphill side of the alignment and filling on the downhill side of the alignment. Judging by the size of trees growing from cut and fill areas, the roadway was originally built around 50 years ago. Generally, at elevations below the swale described in the preceding paragraph, cuts were made on the east side of the roadway alignment and fills were made on the west side of the alignment. Above the swale, cuts and fills are reversed so that cuts are to the west and fills to the east of the alignment.

Landslides have occurred along the upper part of the south flank of the east-west trending ridge, where the roadway first ascends from the bog area along SR 105. Scarps associate with these landslides, which have exposed bare soils, are visible on the upper third or quarter of the ridge. These scarps, which are 10 to 20 feet or so in height and intermittent over a horizontal distance of 200 feet or so, are nearly vertical. Small (on the order of 20 cubic yards or so), recent, landslide deposits were observed just below the scarps. Generally, slopes below the scarps and below most of the recent landslide deposits, which descend down to the roadway, measure 60 percent or so, but steeper areas are present.

We also observed a small, shallow, detached landslide block (perhaps 300 square feet in area), 50 to 100 feet north of the water tower. It is likely that the detached landslide block occurred in fill placed during the original construction of the road. We also observed an over-steepened area on the fill side of the roadway, where the roadbed lies between an elevation of 170 and 200 feet that might indicate that surficial sliding occurred there not long after original road construction.

Vegetation in the bog area that lies along the southernmost part of the roadway, where it begins at SR 105, consists of high grass, brush, and isolated smaller spruce trees. Vegetation along the alignment north of the bog, where the roadway climbs to the north through steep terrain, consists of second growth forest comprised mostly of hemlock and alder. Many of the trees growing along the grading cuts and fills have sweeping trunks, or “pistol butts”, indicating that shallow soil creep may be occurring where looser soils mantle the surface of steep slopes.

No springs or seeps were observed near the roadway alignment, but a trickle of water was flowing in a ditch that parallels the upper (north) half of the alignment. It is reported that springs and seeps are common on similar hillside terrain in the Tokeland area.

Standing water was observed in the bog along the south part of the alignment and wet, saturated soil was observed on the floor of the swale where the multi-purpose building is planned. It appears that standing water accumulates on the swale floor during the wet season and during periods of moderate to heavy rainfall.

3.2 Soil Conditions

Our onsite exploration in the bog area next to the southernmost part of the roadway, test pit TP-1, indicates that soils there consist of 7 feet of peat and chunks of wood, including logs, overlying, to the termination of the exploration at a depth of 10 feet, very loose, saturated beach sand, comprised of fine to medium sand with trace silt.

Our explorations along the edge of the roadway on the upland part of the alignment, north of the bog area, indicates that the soil composition is relatively uniform. Generally, native, in situ soil and fill soils used during original roadway construction consist of silty fine sand. In situ soils contain no organics at depths greater than a few feet; while fill soils at all depths usually contain small, scattered pockets of organic material that were mixed into the soil during original site grading.

In test pits TP-2 and TP-3, excavated in landslide deposits and colluvium that have accumulated below the landslide area next to the east side of the road, we observed loose, silty fine sand with small, scattered pockets of organics. The colluvium and land slide deposit material is basically indistinguishable in geotechnical properties from the loose fill described in the preceding paragraph.

Our test pit excavated in the floor of the swale, TP-5, where the multi-purpose building will be built, and where excess soil accumulated during planned and possible grading activities will be placed, indicate that the 5½ feet of saturated peat and chunks of wood overlie 3 feet of very soft, wet, silt. Underlying the silt, and extending to the termination of our exploration at a depth of 11 feet, we encountered very loose, moist, silty fine sand.

We also observed soils exposed in the landslide scarps within the landslide area. Soils exposed in the scarps are comprised of densely consolidated silty fine sand that contains laminations of silt.

A slight variation in the general, upland soil stratigraphy was observed in TP-6, located on the cut side of the roadway somewhat north (uphill) from the water reservoir, in the area where a “meander in the roadway alignment will be modified. There we observed a mantle of forest duff overlying, to a depth of 4 feet, colluvium or weathered in situ soil comprised of loose, silty fine sand. Underlying the weathered/colluvial layer, we observed 3 feet of in situ, relatively unweathered soil, comprised of medium dense, silty fine sand. At a depth of 7 feet, and extending to the termination of the exploration at a depth of 10 feet, we encountered stiff fine sandy silt.

Surface soils within the roadway appear well compacted. We noted that the heavy large excavator that was used for test pit exploration caused no deflection within the surface of the roadway on margins of the roadway.

Our explorations within the road surface (TH-1 through TH-3) indicate that generally 14 or 15 inches of densely compacted 3 or 4 inch minus crushed basalt has been placed over medium dense subgrades comprised of native silty sand or fill derived from native silty sand. Our explorations also indicate that the gravel surface is somewhat thinner in spots. It is likely that the gravel surface is occasionally thicker in areas as well.

The enclosed exploration logs (Appendix A) provide a detailed description of the soil strata encountered in our subsurface explorations.

3.3 Laboratory Testing

An independent laboratory conducted soil testing, using AASHTO criteria, on samples collected from our test pit explorations and from a sample extracted from the face of a landslide scarp within the landslide area.

The results of our soils analyses are presented in Table 2, and the attached Soil Gradation Graphs, Proctor Analysis, moisture content determinations (Appendix B) graphically display these results. Sample locations, except in the case of sample G-1, which was hand-excavated from the face of a landslide scarp, are described in terms of their position on the “fill” edge or “cut” edge of the existing roadway.

TABLE 2
LABORATORY TEST RESULTS FOR NON-ORGANIC ONSITE SOILS

Soil Sample, Depth, Location	Moisture Content	Optimum Moisture Content	Maximum Dry Density	% Medium Sand	% Fine Sand	% Fines
G-1, at scarp face, in landslide area	15.3	19	108 pcf	4	69	27
TP-2, S-1, 4 feet, in fill part of roadway	22.1	N/A	N/A	N/A	N/A	N/A
TP-6, S-1, 5 feet, in proposed road cut	34.7	N/A	N/A	2	64	34
TP-8, S-1, 5 feet, in fill part of road	20.3	N/A	N/A	N/A	N/A	N/A
TP-9, S-1. 4 feet, in cur part of road	31.0	N/A	N/A	N/A	N/A	N/A

We performed a Proctor and a Grain Size Analysis of soils taken from a landslide scarp located within the landslide area. We assumed that mass grading would occur within the landslide area, in order to reduce the potential for slope instability, and that spoils obtained from grading activities there would be used as a source of fill. Our analysis indicates that the maximum dry density of in situ soils within the landslide area is 108 pounds per cubic foot (pcf); that the optimum moisture content of the soil is 19 percent and the “native moisture content is 15.3 percent, and that the soil is comprised of 4 percent medium sand, 69 percent fine sand, and 27 percent fines.

Mass grading may also occur on the west side of the existing roadway, just north of the water reservoir, where a sharp “meander” in the roadway alignment will be straightened somewhat, where we excavated test pit TP-6. For comparative purposes, we performed a grain size analysis of this soil and found that it is very similar in composition to the soil within the scarp, and contains 2 percent medium sand, 64 percent fine sand, and 34 percent fines. Based on our grain size analysis, the maximum dry density of this soil sample is similar to the dry density determined for soils from the landslide scarp, approximately 108 pcf. However, the “natural” moisture content (34.7 percent) is much higher than soils from the landslide scarp (15. 3 percent), and would need to be dried, or amended, before reuse as structural fill.

Our field classification of soils from elsewhere along the roadway alignment also indicate that they consist of silty fine sand are similar in composition to soils from the landslide area and from the area where the roadway would be straightened. The moisture content varies considerably, however, and ranges from near optimum (about 20 to 22 percent) to very wet of optimum (31 percent).

3.4 Groundwater Conditions

At the time of our reconnaissance and subsurface explorations (June 29, 2010), we observed groundwater at the surface elevation of the bog in test pit TP-1, which was located on the edge of the roadway about 125 feet from SR 10. We also observed shallow, slowly seeping groundwater in test pit TP-5, located on the floor of the swale, where groundwater is perched in the 5½ foot thick peat layer that mantles the swale floor.

We did not observe groundwater within any of our exploration conducted on the edge of the roadway on the sloped part of the site.

3.5 Seismic Conditions

Based on our analysis of our subsurface exploration logs and our review of published geologic maps, we interpret the soil conditions on the east end of the alignment, where the roadway traverses a bog, to correspond with site class F, as defined by Table 1613.5.2 of the 2009 *International Building Code (IBC)*. Soils on the sloped part of the site correspond with site class D of the 2006 *International Building Code (IBC)*.

3.6 Liquefaction Potential

Liquefaction is a sudden increase in pore water pressure and a sudden loss of soil shear strength caused by shear strains, as could result from an earthquake. Research has shown that saturated, loose, fine to medium sands with a fines (silt and clay) content less than about 20 percent are most susceptible to liquefaction. Our onsite subsurface explorations revealed that the loose, saturated beach sands that underlie peat in the bog area (east 200 feet or so of the alignment) are very susceptible to liquefaction. Soils on the upland part of the site are not saturated and are well consolidated at depth, so they are not very susceptible to liquefaction.

3.7 Slope Stability Analysis

We analyzed slope stability in the landslide area under selected conditions. The following sections describe our method of analysis and present our results.

Besides the actual geometry of the slope, slope stability analyses typically involve five basic slope parameters: (1) location and shape of the potential failure surface, (2) internal friction angle of the various soils, (3) cohesion of the various soils, (4) density of the various soils, and (5) location of the piezometric groundwater surface. Once all five parameters have been estimated, the critical slip surface and associated safety factor of a given slope can be calculated. A critical slip surface is defined as the most likely surface along which a soil mass will slide, and a safety factor is defined as the ratio of the sum of all moments resisting slope movement versus the sum of all moments tending to cause slope movement. Consequently, a slope that possesses a safety factor of 1 is on the verge of sliding, whereas a slope with a safety factor greater than 1 has some resistance to sliding. According to standard geotechnical engineering practice, a static safety factor of 1.5 and a seismic safety factor of 1.1 are considered the desirable minimum values for most slopes, but 1.25 and 1.01, respectively, are often regarded as acceptable values.

Slope stability conditions for the project site were analyzed by means of Bishop Circular Analysis. All calculations were performed utilizing the computer program WINSTABLE and are attached in Appendix C.

Our onsite explorations indicate that the soil in the slope are comprised of well consolidated, in situ, silty sand and, at the base of the slope next to the existing roadway, loose colluvium and landslide deposits that are derived from the in situ silty sand. We have used conservative soil strength values to model these two general soil types. The values used in our analysis are listed in Table 2.

TABLE 3
ESTIMATED PROPERTIES OF ONSITE SOILS FOR STABILITY ANALYSIS

Soil Type	Density (pcf)	Cohesion (psf)	Internal Friction Angle (degrees)
In situ, dense silty sand	108	100	36
Loose, silty, sandy colluvium and landslide deposits	108	50	30

We performed analyses along two geologic profiles, A-A’ and B-B’, the traces of which are depicted on Figure 2. Our analyses, when using the conservative soil strength values presented in Figure 2 and after the hillside has been grade back to 2H:1V, yielded a Seismic Factor of Safety of 1.1 and a Static Factor of Safety of 1.6 for both profiles Our interpretation of soils underlying the transects are depicted in the attached Geologic Profiles (Figure 3 and Figure 4).

4.0 CONCLUSIONS AND RECOMMENDATIONS

Plans call for the widening of Eagle Hill Road from 12 to 22 feet, then paving it. As part of improving the roadway, plans also call for stabilizing a landslide area located on a ridge on the east side of the south part of the roadway. At a later date, a multi-purpose building will be constructed in a swale. The swale will likely be filled with soil generated by onsite grading activities. We offer these conclusions and recommendations:

- Landslide Area Stabilization: Based on our stability analysis, slopes in the landslide area should be graded to 2H:1V in order to achieve a stable configuration and to reduce erosion.

- Slope/Fill Stabilization Outside of the Landslide Area: We recommend that cuts and fill be graded to 2H:1V or flatter, wherever possible. In areas where 2H:1V cannot be achieved, we recommend that cuts and fill be retained. Generally, cuts should be retained by concrete retaining or Ultra Block walls and fills should be retained by MSE (Mechanically Stabilized Earth) walls, with block facings. MSE walls employ geo grid reinforcement that extends into compacted backfill. The geo grid reinforcement prism can be incorporated into the roadway embankment.

  General recommendations for wall design are presented in Section 4. Because grading plans are in their preliminary stage, the exact location and size of retaining walls has not been determined. When wall locations and sizes are determined, E3RA is available to generate specific wall designs. We also provide general recommendations for wall construction in the retaining wall portion of Section 4.

- Road Construction across the Bog Area: Widening of Eagle Hill Road will require the expansion of the existing roadbed into the adjacent peat bog. Our exploration there indicates that a layer of 7 feet of organics consisting of peat and wood cover the bog floor. The organic layer is underlain by saturated, very loose beach sand. Groundwater is present in both layers.

  We recommend that the peat be over-excavated down to the beach sand layer. Because this will require excavation into the water table, dewatering will be required if site-generated fill is used as part of the roadbed. As an alternative to dewatering, quarry spalls, which are insensitive to water and need minimal compactive effort, can be placed in the over-excavation and into water to an elevation above the water table.

  Fill slopes associated with traversing the bog should be no greater than 2H:1V.

- Preparation of Building Subgrades: A multi-purpose building, at an elevation of 88 feet and within the swale on the east side of the roadway, is planned just north of the landslide area. Existing grades there are 60 to 70 feet, and the area is currently underlain by an organic layer of 5 feet of peat and wood, so a thick layer of fill will be necessary to attain finish grade. We recommend removal of the organic layer, and any other organics before the placement of fill.

  We recognize that fill placed to raise grades will be generated during onsite grading activities. Some of the fill, as indicated by our laboratory testing, will likely be wet of optimum, so proper soil compaction could be a problem. We recommend that fill be compacted to 90 percent at elevations less than 4 feet below footing subgrade elevation and 95 percent within 4 feet of footing subgrade elevation. Grading and soil compaction should be done during extended periods of dry weather, and in general accordance with the recommendations presented in the Structural Fill part of Section 4.

In order to address potential settlement problems that may occur due to the thickness of the fill layer, we recommend that the building area, and an area extending 5 feet or more beyond the perimeter of the building area, be preloaded with 5 to 10 feet or more of fill, in order to pre-induce settlement that would otherwise occur from building construction. A preload of 10 feet or more of fill is recommended if construction is to occur less than 1 year after the preload has been placed.

The preload should be surveyed twice a month for the first two months then monthly until six months have passed. After six months have passed, surveys should be conducted quarterly until the surcharge is removed. Survey recommendations are presented in the Preloading part of Section 4.

- Road Pavement Sections: We recommend the placement of a two foot thick subbase, ideally consisting of crushed coarse rock similar in composition to the existing road surface. Subbase subgrades should be surface compacted to a medium dense or denser condition. Where subbase subgrades are loose and cannot be surface compacted to a medium dense or denser state, the subbase may be improved by placement of a geotextile fabric. After subbases have been placed and compacted, and just prior to the application of the pavement section, the roadway alignment should be proof-rolled to identify and repair any areas of subgrade/subbase deflection.

  Once it has been established that the subgrade/subbase is stable, we recommend a pavement section consisting of the 3 inches of ACP over a base course of 6 inches of 5/8 inch crushed rock. If the new roadway will be used as for logging access, we recommend that the ACP be increased to at least 4 inches in thickness.

- Soil Reuse and Construction Timing: Our field classifications, and testing by an independent laboratory, indicate that site soils generally consist of silty fine sand. Because of high silt content, this soil is very sensitive to moisture content variations. Our field observations and laboratory testing also indicate that some of the fill that will be generated on site is currently very wet of optimum, and will need aeration before it can be reused. For these reasons, we recommend that road construction occur only during the dry season, when reuse of site soils and exposed soil subgrades will be less vulnerable to rainy conditions, and when soils that are wet of optimum can be aerated to a more "workable" condition. We do not recommend the use of this soil for the subbase layer for the roadway.

  The gravel road surface consists mostly of coarse crushed rock. It is relatively insensitive to moisture content variations and can be used for the road subbase layer.

The following sections of this report present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, slab-on-grade floors, asphalt pavement, and structural fill. The Washington State Department of Transportation (WSDOT) Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

4.1 Site Preparation

Preparation of the project site should involve erosion control, temporary drainage, clearing, stripping, cutting, filling, excavations, and subgrade compaction.

Erosion Control: Before new construction begins, an appropriate erosion control system should be installed. This system should collect and filter all surface water runoff through silt fencing. We anticipate a system of berms and drainage ditches around construction areas will provide an adequate collection system. Silt fencing fabric should meet the requirements of WSDOT Standard Specification 9-33.2 Table 3. In addition, silt fencing should embed a minimum of 6 inches below existing grade. An erosion control system requires occasional observation and maintenance. Specifically, holes in the filter and areas where the filter has shifted above ground surface should be replaced or repaired as soon as they are identified.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Based on our current understanding of the construction plans, surface and subsurface conditions, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, sod and topsoil, and root-rich soil should be stripped from the site. Stripped organics should not be mixed in with non-organic site soils that will be reused as structural fill. Peaty organics, that can be 7 feet or more in the bog area and 5 feet or more in the swale where a multi-purpose building is planned, should be removed before structural fill is placed. Elsewhere, where road widening will expand into wooded areas, duff, topsoil, and root-rich soil can be a foot or more in thickness. Stripping is best performed during a period of dry weather.

Site Excavations: Based on our explorations, we expect that excavations will soils which can be adequately excavated using standard excavation equipment.

Dewatering: Our site explorations encountered significant groundwater in the bog area, where road widening will occur. We anticipate that fines-free quarry spalls can be placed in standing water there in order widen the road base. Placement of most other types of fill would require construction dewatering equipment, such as sump pumps and possibly well points.

Temporary Cut Slopes: All temporary soil slopes associated with site cutting or excavations should be adequately inclined to prevent sloughing and collapse. Temporary cut slopes in site soils should be no steeper than 1¼H:1V, and should conform to Washington Industrial Safety and Health Act (WISHA) regulations.

Subgrade Compaction: Any localized zones of looser granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be overexcavated and replaced with a suitable structural fill material.

Site Filling: Our conclusions regarding the reuse of on site soils and our comments regarding filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the Structural Fill section of this report. Specifically, structural fill should be compacted to a uniform density of at least 95 percent (based on ASTM:D-1557).

Onsite Soils: We offer the following evaluation of these onsite soils in relation to potential use as structural fill:

- *Surficial Organic Soils*: Surficial organic soils, like duff, topsoil, and root-rich soil; and peaty soils are *not* suitable for use as structural fill under any circumstances, due to high organic content.
- *Silty Fine Sand*: The silty fine sand that comprises in situ native soils, almost all of the fill used to build the existing roadway prism, and the colluvium and landslide deposits in the landslide area is very sensitive to moisture content variations. It is likely that significant quantities of this material generated during grading activities will be wet of optimum moisture content upon excavation. For this reason, we recommend reuse only during the dry period, when it will be less vulnerable to rainfall and aeration may be possible.
- *Gravely Roadway Surface*: The gravelly roadway surface is comprised of 3 to 4 inch minus crushed basalt, is relatively insensitive to moisture content variations and can be reused as roadway subbase.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to reduce long-term raveling, sloughing, and erosion. We generally recommend that no permanent slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes (such as 2½H:1V) would further reduce long-term erosion and facilitate revegetation.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

4.2 Retaining Walls

In general, cuts should be retained by concrete retaining or Ultra Block walls and fills should be retained by MSE (Mechanically Stabilized Earth) walls, with block facings. MSE walls employ geo grid reinforcement that extends into compacted backfill. The geo grid reinforcement prism can be incorporated into the roadway embankment.

Bearing Subgrades: Wall footings for poured in place concrete walls and base blocks of block walls should bear on medium dense or denser, undisturbed native soils which have been stripped of surficial organic soils, or on properly compacted structural fill.

In general, before footing concrete or blocks are placed, any localized zones of loose soils exposed across the footing subgrades should be compacted to a firm, unyielding condition, and any localized zones of soft, organic, or debris-laden soils should be overexcavated and replaced with suitable structural fill.

Lateral Overexcavations: Because foundation stresses are transferred outward as well as downward into the bearing soils, all structural fill placed under footings or blocks, should extend horizontally outward from the block or footing edge. This horizontal distance should be equal to the depth of placed fill. Therefore placed fill that extends 24 inches below the footing base should also extend 24 inches outward from the footing edges.

Bearing Pressures: In our opinion, for static loading, footings or block walls that bear on properly prepared subgrades can be designed for a maximum allowable soil bearing pressure of 2,000 psf. A one-third increase in allowable soil bearing capacity may be used for short-term loads created by seismic activities.

Lateral Resistance: We recommend using an allowable passive earth pressure of 200 psf and an allowable base friction coefficient of 0.35 for the silty fine sand that is found on the site.

Wall Drainage: Groundwater drainage should be provided behind retaining walls by placing a zone of drain rock containing less than 3 percent fines (material passing No. 200 sieve) against the wall. This drainage zone behind the slope (west) side of the building should extend back to the cut that has been graded into the slope. The drainage zone should be at least 24 inches wide (measured horizontally). The drainage zone for all walls should extend from the base of the wall to within 1 foot of the finished grade behind the wall. Smooth-walled perforated PVC drainpipe having a minimum diameter of 4 inches should be embedded within the drain rock at the base of the wall along its entire length. This drainpipe should discharge into a tightline leading to an appropriate collection and disposal system.

Backfill Soil: Onsite soils, consisting of silty fine sand, could be used as backfill if they are placed at a moisture content near optimum. A geotextile should be placed between the drainage zone and the backfill soil to prevent drain clogging.

Backfill Compaction: Because soil compactors place significant lateral pressures on subgrade walls, we recommend that only small, hand-operated compaction equipment be used within 2 feet of a backfilled wall. Also, all backfill should be compacted to a density as close as possible to 90 percent of the maximum dry density (based on ASTM:D-1557); a greater degree of compaction closely behind the wall would increase the lateral earth pressure, whereas a lesser degree of compaction might lead to excessive post-construction settlements.

Grading and Capping: To retard the infiltration of surface water into the backfill soils, we recommend that the backfill surface of exterior walls be adequately sloped to drain away from the wall. Ideally, the backfill surface directly behind the wall would be capped with asphalt, concrete, or 12 inches of low-permeability (silty) soils to minimize or preclude surface water infiltration.

Applied Soil Pressure: Walls that are designed to move 0.1 percent of the wall height during and after construction are usually referred to as unrestrained walls. We recommend that unrestrained cantilever walls supporting slopes inclined at 2H:1V or flatter be designed to resist an active pressure (triangular distribution) of 55 pounds per cubic foot (pcf). The recommended pressure does not include the effects of surcharges from surface loads hydrostatic pressures, or structural loads. If such surcharges are to apply, they should be added to the above design lateral pressures.

4.3 Preloading

We recommend that the building areas be preloaded to preinduce settlement that would likely occur due to placed fill too wet to properly compact and settlement that would occur due to the soft silt layer that underlies the swale area. The preload should be placed after the overexcavation of all organics in the area that will be filled.

Preload Thickness: In order to address settlement problems that will likely occur due to the thickness of the fill layer and the potential difficulty of attaining sufficient compaction throughout the fill layer, we recommend that the building areabe preloaded with 5 feet to 10 feet of fill, in order to pre-induce settlement. A preload of 10 feet or more of fill is recommended if construction is to occur less than 1 year after the preload has been placed.

Preload Extent: The crest of the preload should extend a minimum of 5 feet horizontally outside of the building lines

Preload Duration & Monitoring: The preload should be monitored to determine the magnitude and rate of settlement. The data will be used to determine whether the consolidation of the underlying soils has slowed sufficiently to allow removal of the preload. We recommend using surface monuments to record the amount of settlement.

After six months have passed, surveys should be conducted quarterly until the surcharge is removed. The settlement data should be provided to us immediately after the readings are taken so that we may review and comment as appropriate.

4.4 Asphalt Pavement

We offer the following comments and recommendations for pavement design and construction.

Subgrade Preparation: We recommend the placement of a two foot thick subbase, ideally consisting of crushed coarse rock similar in composition to the existing road surface. Subbase subgrades should be surface compacted to a medium dense or denser condition. Where subbase subgrades are loose and cannot be surface compacted to a medium dense or denser state, we recommend that the subbase be supported by geotextile fabric. After subbases have been placed and compacted, and just prior to the application of the pavement section, the roadway alignment should be proof-rolled to identify and repair any areas of subgrade/subbase deflection. Our experience in the Tokeland area indicates that the 3 inch minus crushed basalt that is available locally works well for this purpose. Alternatively, we recommend using imported, clean, well-graded sand and gravel such as “Ballast” or “Gravel Borrow” per WSDOT Standard Specifications 9-03.9(1) and 9-03.14, respectively.

All structural fill should be compacted according to our recommendations given in the Structural Fill section. Specifically, the upper 2 feet of soils underlying pavement section and subbase should be compacted to at least 95 percent based on ASTM D-1557 and all soils below 2 feet of the subbase should be compacted to at least 90 percent.

Pavement Materials: For the base course, we recommend using imported crushed rock, such as "Crushed Surfacing Top Course” per WSDOT Standard Specification 9-03.9(3). For the subbase course, we recommend the 3 inch minus crushed basalt that is available locally or, alternatively, we recommend using imported, clean, well-graded sand and gravel such as “Ballast” or “Gravel Borrow” per WSDOT Standard Specifications 9-03.9(1) and 9-03.14, respectively.

Conventional Asphalt Sections: A conventional pavement section typically comprises an asphalt concrete pavement over a crushed rock base course. We recommend using the following conventional pavement sections:

Pavement Section	Minimum Thickness (if no logging traffic)	Minimum Thickness (if logging traffic will occur)
Asphalt Concrete Pavement	3 inches	4 inches
Crushed Rock Base	6 inches	6 inches
Granular Fill Subbase	24 inches	24 inches

Compaction and Observation: All subbase and base course material should be compacted to at least 95 percent of the Modified Proctor maximum dry density (ASTM D-1557), and all asphalt concrete should be compacted to at least 92 percent of the Rice value (ASTM D-2041). We recommend that an E3RA representative be retained to observe the compaction of each course before any overlying layer is placed. For the subbase and pavement course, compaction is best observed by means of frequent density testing. For the base course, methodology observations and hand-probing are more appropriate than density testing.

Pavement Life and Maintenance: No asphalt pavement is maintenance-free. The above described pavement sections present our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Furthermore, a 20-year pavement life typically assumes that an overlay will be placed after about 10 years. Thicker asphalt and/or thicker base and subbase courses would offer better long-term performance, but would cost more initially; thinner courses would be more susceptible to “alligator” cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

4.5 Structural Fill

The term "structural fill" refers to any material placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other structures. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Materials: Typical structural fill materials include clean sand, gravel, pea gravel, washed rock, crushed rock, well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter or debris, nor any individual particles greater than about 6 inches in diameter. Because pervious pavement may be planned, import fill should be granular and well draining.

Fill Placement: Clean sand, gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor.

Compaction Criteria: Using the Modified Proctor test (ASTM:D-1557) as a standard, we recommend that structural fill used for various onsite applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Asphalt pavement base	95 percent
Asphalt pavement base	95 percent
Asphalt pavement subgrade (upper 2 feet)	95 percent
Asphalt pavement subgrade (below 2 feet)	90 percent
Multipurpose Building fill (within 4 feet of footing subgrade)	95 percent
Multipurpose Building fill (below 4 feet of footing subgrade)	90 percent

We note, however, that fill soils that contain large quantities of rock, like the coarse crushed rock that comprises the existing road surface, cannot be tested using standard testing techniques, such as the nuclear densometer. Rock-rich fill is better tested by proof rolling or probing.

Subgrade Observation and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the Site Preparation section of this report. The condition of all subgrades should be observed by geotechnical personnel before filling or construction begins. Also, fill soil compaction should be verified by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. For fill placement during wet-weather site work, we recommend using "clean" fill, which refers to soils that have a fines content of 5 percent or less (by weight) based on the soil fraction passing the U.S. No. 4 Sieve.

5.0 RECOMMENDED ADDITIONAL SERVICES

General recommendations for wall design are presented above. Because grading plans are in their preliminary stage, the exact location and size of retaining walls has not been determined. When wall locations and sizes are determined, E3RA can be retained to generate specific wall design plans.

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Consequently, we recommend that E3RA be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design;
- Prepare a letter summarizing all review comments (if required by the local jurisdictions);
- Check all completed subgrades and subbases in order to verify their bearing capacity;
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required);
- Review preload settlement data as it is accrued; and
- We should also be retained once plans for the multi purpose building are developed to provide design level geotechnical recommendations for this structure.

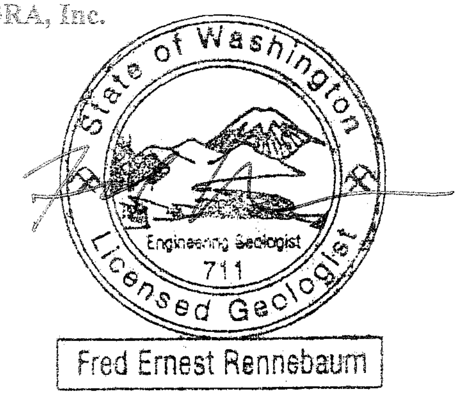
6.0 CLOSURE

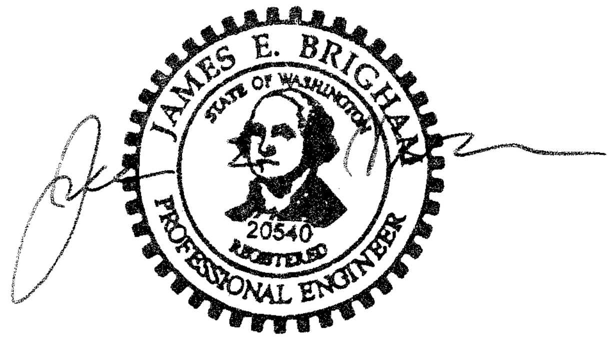
The conclusions and recommendations presented in this report are based, in part, on the explorations that we observed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. E3RA is available to provide geotechnical monitoring of soils throughout construction.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Sincerely,

E3RA, Inc.





Fred E. Rennebaum, L.E.G.
Senior Geologist

James E. Brigham, P.E.
Principal Engineer

FER:JEB:jb
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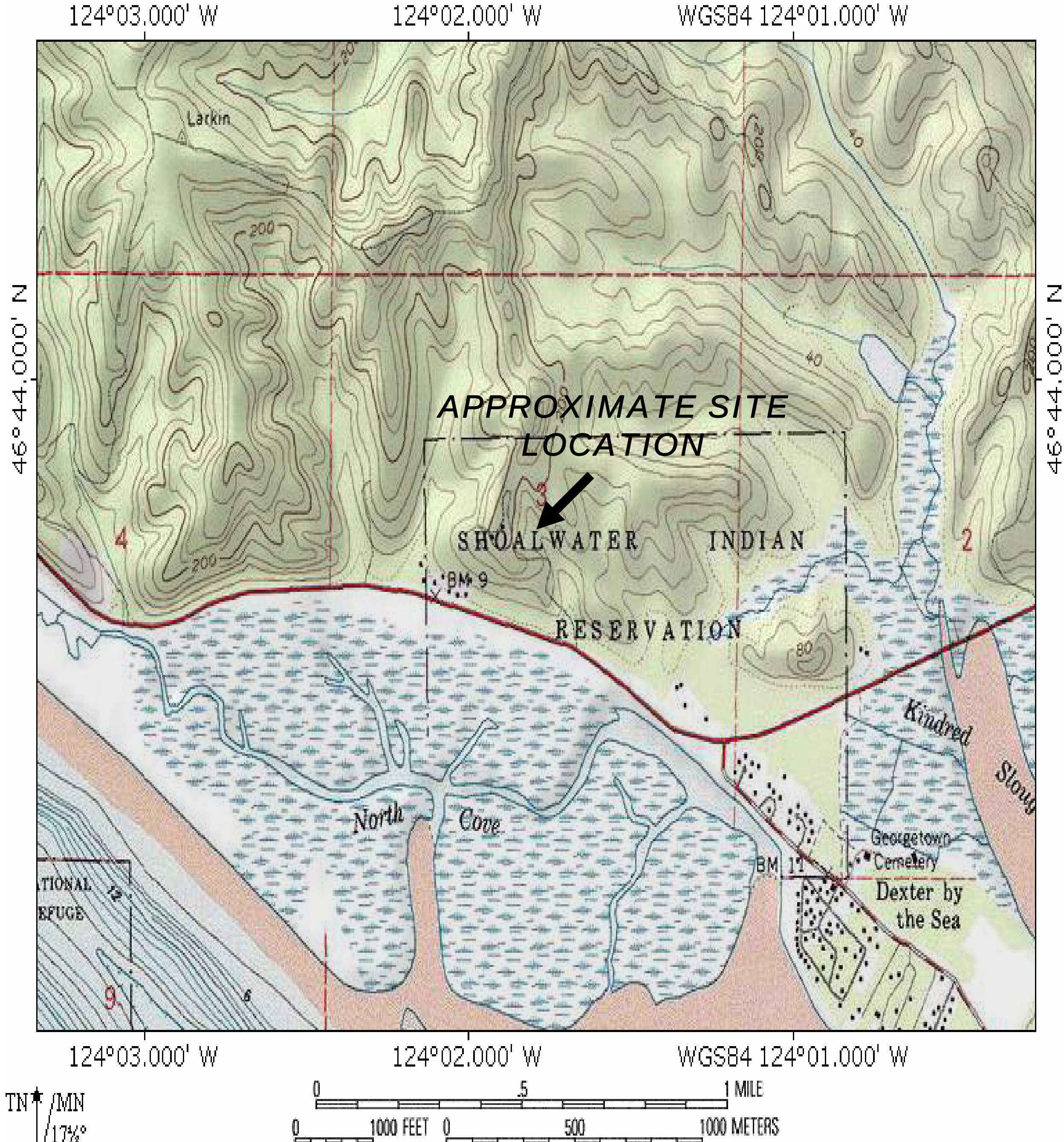
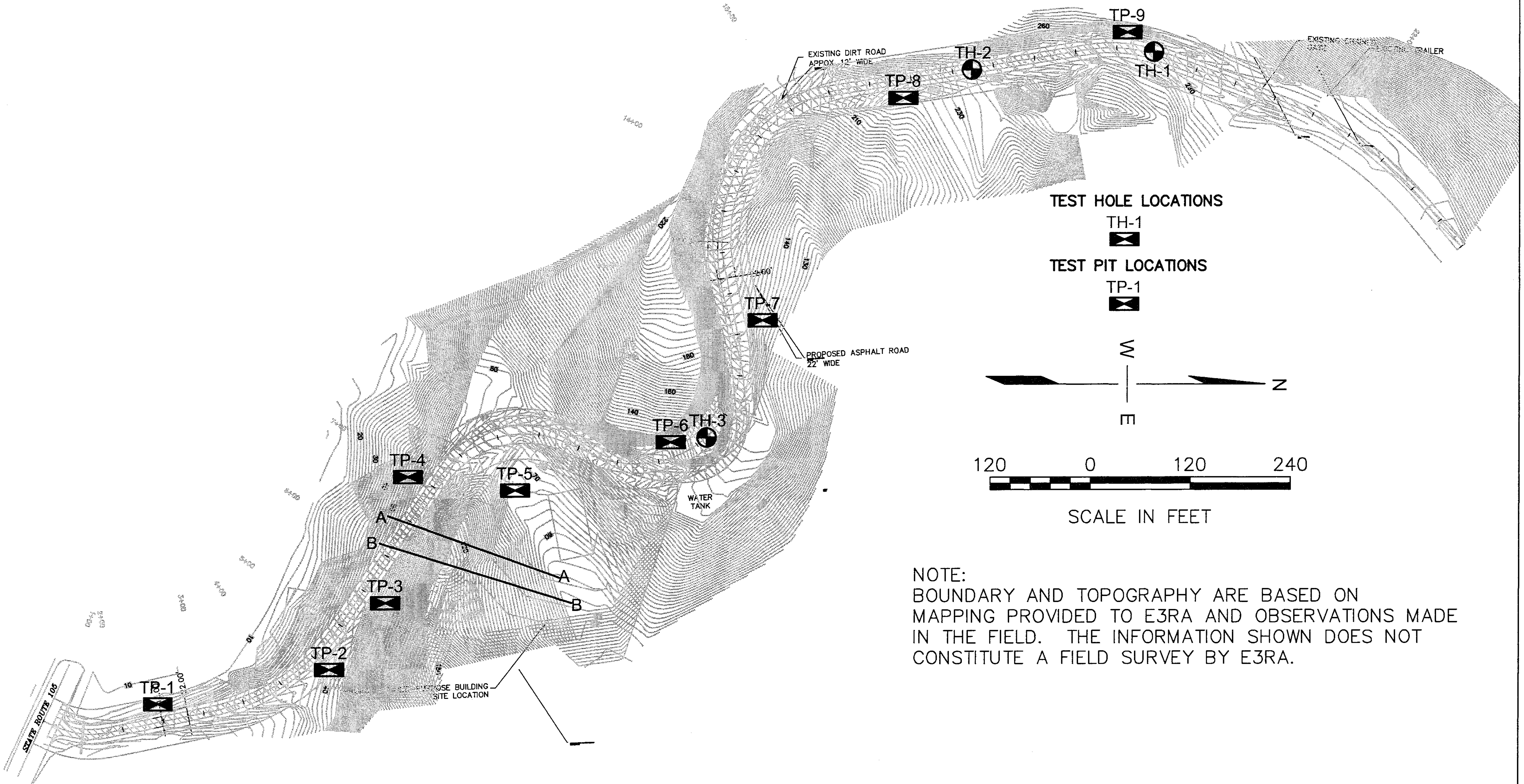
TOPO! map printed on 07/27/10 from "Untitled.tpo"



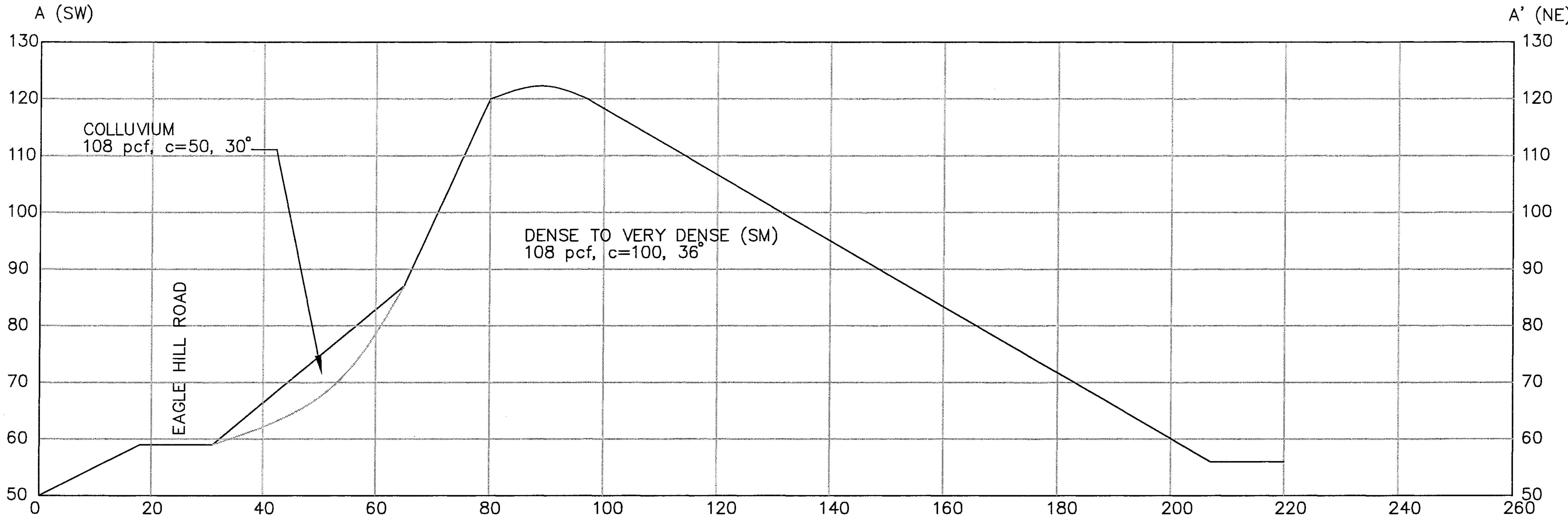
Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

E3RA, Inc. **P.O Box 44840** **Tacoma, WA 98448**	EAGLE HILL RD IMPROVEMENTS TOPOGRAPHIC AND LOCATION MAP TOKELAND, WASHINGTON	**FIGURE 1** **T10065**



NOTE:
BOUNDARY AND TOPOGRAPHY ARE BASED ON MAPPING PROVIDED TO E3RA AND OBSERVATIONS MADE IN THE FIELD. THE INFORMATION SHOWN DOES NOT CONSTITUTE A FIELD SURVEY BY E3RA.

E[3]RA Inc. 201 - 160th St. S Suite 401 Tacoma, WA 98444 253-537-9400 253-537-9401 fax www.e3ra.com	PROJECT: Shoalwater Eagle Hill Road Improvements	
	SHEET TITLE: Site and Exploration Plan	
	DESIGNER: CRL	JOB NO. T10065
	DRAWN BY: CRL	SCALE: 1"=120'
	CHECKED BY: JEB	FIGURE: 2
	DATE: July 1, 2010	FILE: T10065.dwg



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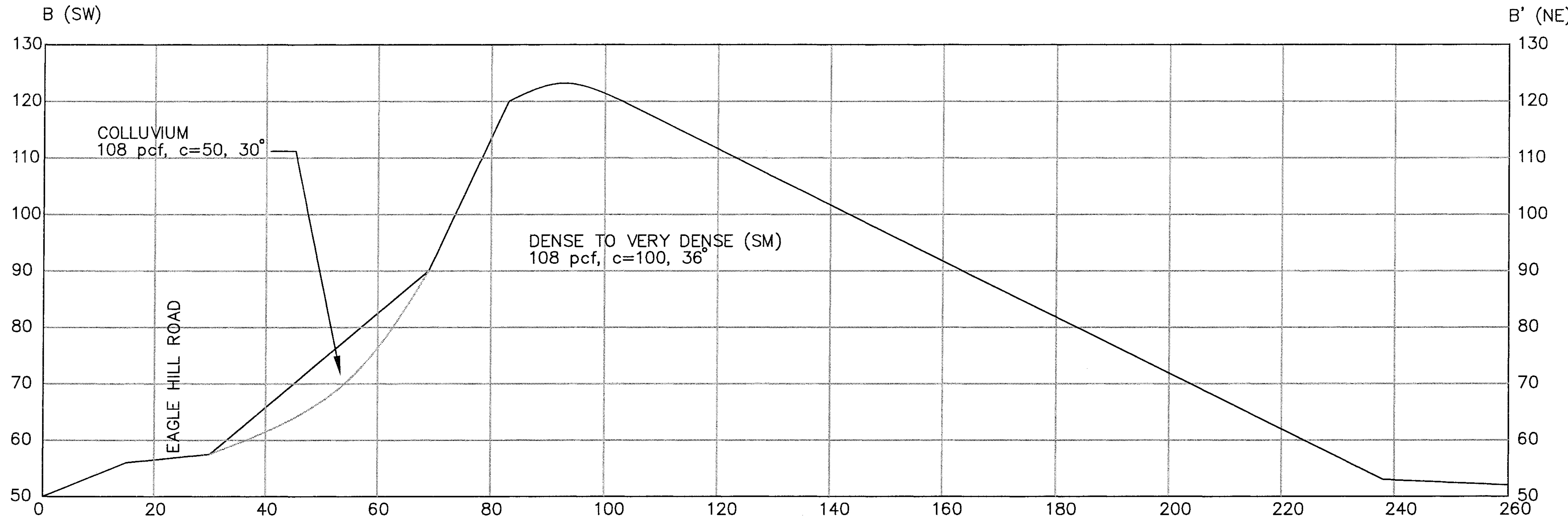
PROJECT: Shoalwater Eagle Hill Road Improvements	
SHEET TITLE: Geologic Profile A-A'	
DESIGNER: CRL	JOB NO. T10065
DRAWN BY: CRL	SCALE: 1"=20'
CHECKED BY: JEB	FIGURE: 3
DATE: July 1, 2010	FILE: T10065.dwg



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PROJECT: Shoalwater Eagle Hill Road Improvements	
SHEET TITLE: Geologic Profile B-B'	
DESIGNER: CRL	JOB NO. T10065
DRAWN BY: CRL	SCALE: 1"=20'
CHECKED BY: JEB	FIGURE: 4
DATE: July 1, 2010	FILE: T10065.dwg

APPENDIX A
SOILS CLASSIFICATION CHART AND KEY TO TEST DATA

LOG OF TEST PITS AND TEST HOLES

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

	Modified California	RV	R-Value
	Split Spoon	SA	Sieve Analysis
	Pushed Shelby Tube	SW	Swell Test
	Auger Cuttings	TC	Cyclic Triaxial
	Grab Sample	TX	Unconsolidated Undrained Triaxial
	Sample Attempt with No Recovery	TV	Torvane Shear
CA	Chemical Analysis	UC	Unconfined Compression
CN	Consolidation	(1.2)	(Shear Strength, ksf)
CP	Compaction	WA	Wash Analysis
DS	Direct Shear	(20)	(with % Passing No. 200 Sieve)
PM	Permeability	▽	Water Level at Time of Drilling
PP	Pocket Penetrometer	▼	Water Level after Drilling(with date measured)

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

Figure A-1

E3RA

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Fax: 253-537-9401

E[3]RA Inc.

TEST PIT NUMBER TP-1

Figure A-2

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					Saturated Peat with logs and wood
2.5					
5.0				7.0	
7.5	GB S-1	6	SP		(SP) Fine to medium sand with trace silt (very loose, saturated) (Beach Sand)
10.0				10.0	Slow to moderate groundwater flow observed throughout Slight to moderate caving observed from 0 to 10 feet The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 10.0 feet.

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TEST PIT NUMBER TP-2

Figure A-3

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SM		(SM) Orange-brown silty sand with some small pockets of organics (loose, moist) (Colluvium or Slide Deposit)
7.0		SM		(SM) Orange-brown fine to medium sand with some silt and abundant thin silt interbeds (medium dense, moist)
10.0				No groundwater flow observed No caving observed The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 10.0 feet.

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E^{3}RA Inc.

TEST PIT NUMBER TP-3

Figure A-4

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0 – 7.0		SM		(SM) Orange-brown silty fine sand with some small pockets of organics (loose, moist) (Slide Deposit)

Depth scale: 0.0, 2.5, 5.0; layer boundary at 7.0

No groundwater flow observed
Slight caving observed from 0 to 7 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 7.0 feet.

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TEST PIT NUMBER TP-4

Figure A-5

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SM		(SM) Orange-brown silty fine sand with pockets of organics and copious roots (loose, moist) (Fill)
1.0		SM		(SM) Orange-brown silty fine sand (loose, moist) (Fill)
7.0				No groundwater flow observed Slight caving observed from 0 to 7 feet The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 7.0 feet.

Depth scale: 2.5, 5.0

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TEST PIT NUMBER TP-5

Figure A-6

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				Sarurated Peat and chunks of wood
2.5				
5.0			5.5	
		ML		(ML) Silt (very soft, wet)
7.5			8.5	
10.0		SM		(SM) Orange-brown silty sand (loose, moist)
			11.0	
				Very slow groundwater seepage observed from 0 to 5.5 feet Slight caving observed from 0 to 11 feet The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 11.0 feet.

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TEST PIT NUMBER TP-6

Figure A-7

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0.0					0.5	Forest Duff
2.5			SM		4.0	(SM) Orange-brown silty sand (loose, moist) (Colluvium)
5.0			SM		7.0	(SM) Orange-brown silty fine sand (medium dense, moist) Grades to wet below 6 feet
7.5	GB S-1	6	ML		10.0	(ML) Orange-brown sandy silt (stiff, wet)
10.0						No groundwater flow observed Slight caving observed from 0 to 4 feet The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 10.0 feet.

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TEST PIT NUMBER TP-7

Figure A-8

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					Forest Duff
0.5			SM		(SM) Orange-brown silty fine sand with some small pockets of organics (loose, moist to wet) (Fill)
8.0	GB S-1	6	SM		(SM) Orange-brown silty fine sand (loose to medium dense, moist to wet)
11.0					No groundwater flow observed No caving observed The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 11.0 feet.

Depth scale: 0.0, 2.5, 5.0, 7.5, 10.0

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Tacoma, Washington 98448
Telephone: 253-537-9400
Fax: 253-537-9401

E^3RA Inc.

TEST PIT NUMBER TP-8

Figure A-9

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					Forest Duff
			SM	0.5	(SM) Orange-brown silty fine sand with some small pockets of organics (loose, moist to wet) (Fill)
2.5					
5.0			SM	5.0	(SM) Orange-brown silty fine sand (loose to medium dense, moist to wet)
	GB S-1	6		7.0	No groundwater flow observed No caving observed The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 7.0 feet.

E3RA Inc.
E3RA, Inc.
P.O. Box 44840
Tacoma, Washington 98448
Telephone: 253-537-9400
Fax: 253-537-9401

TEST PIT NUMBER TP-9

Figure A-10

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland, Washington
DATE STARTED 6/29/10 **COMPLETED** 6/29/10
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Shawn Maben Construction
GROUND WATER LEVELS:
EXCAVATION METHOD Steel Tracked Excavator
AT TIME OF EXCAVATION ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY LENGTH (in)	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0.0					0.5	Forest Duff
2.5			SM		3.5	(SM) Orange-brown silty fine sand with copious roots (loose, moist to wet)
5.0			SM		5.0	(SM) Orange-brown silty fine sand (medium dense, moist to wet)
	GB S-1	6				No groundwater flow observed No caving observed The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of test pit at 5.0 feet.

E3RA Inc.
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Fax: 253-537-9401

BORING NUMBER TH-1

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland
DATE STARTED 7/21/10 **COMPLETED** 7/21/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
AT TIME OF DRILLING ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0		GM	1.2	(GM) Dark gray-brown coarse crushed rock; (sandy gravel with some/trace silt and abundant cobbles); approximately 4 inch minus basalt (very dense) (Fill)
1		SM	1.5	(SM) Orange brown silty sand (medium dense, moist)
				No groundwater flow observed No caving observed The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of borehole at 1.5 feet.

E3RA Inc.
E3RA, Inc.
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Telephone: 253-537-9400
Fax: 253-537-9401

BORING NUMBER TH-2

Figure A-12

CLIENT Red Plains Professional, Inc.	**PROJECT NAME** Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065	**PROJECT LOCATION** Tokeland
DATE STARTED 7/21/10 **COMPLETED** 7/21/10	**GROUND ELEVATION** **HOLE SIZE**
DRILLING CONTRACTOR	**GROUND WATER LEVELS:**
DRILLING METHOD	**AT TIME OF DRILLING** ---
LOGGED BY FER **CHECKED BY** JEB	**AT END OF DRILLING** ---
NOTES	**AFTER DRILLING** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				Dark gray-brown coarse crushed rock; (sandy gravel with some/trace silt and abundant cobbles); approximately 4 inch minus basalt (very dense) (Fill)
1				
1.3		SM		(SM) Orange brown silty sand (medium dense, moist)
1.5				No groundwater flow observed No caving observed The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot. Bottom of borehole at 1.5 feet.

E3RA, Inc.
P.O. Box 44840
Tacoma, Washington 98448
Telephone: 253-537-9400
Fax: 253-537-9401

E[3]RA Inc.

BORING NUMBER TH-3

Figure A-13

CLIENT Red Plains Professional, Inc.
PROJECT NAME Shoalwater Eagle Hill Road Improvements
PROJECT NUMBER T10065
PROJECT LOCATION Tokeland
DATE STARTED 7/21/10 **COMPLETED** 7/21/10
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD
AT TIME OF DRILLING ---
LOGGED BY FER **CHECKED BY** JEB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0		GM	0.7	(GM) Dark gray-brown coarse crushed rock; approximately 2 inch minus basalt (dense, moist)
1		SM	1.0	(SM) Orange brown silty sand (medium dense, moist)

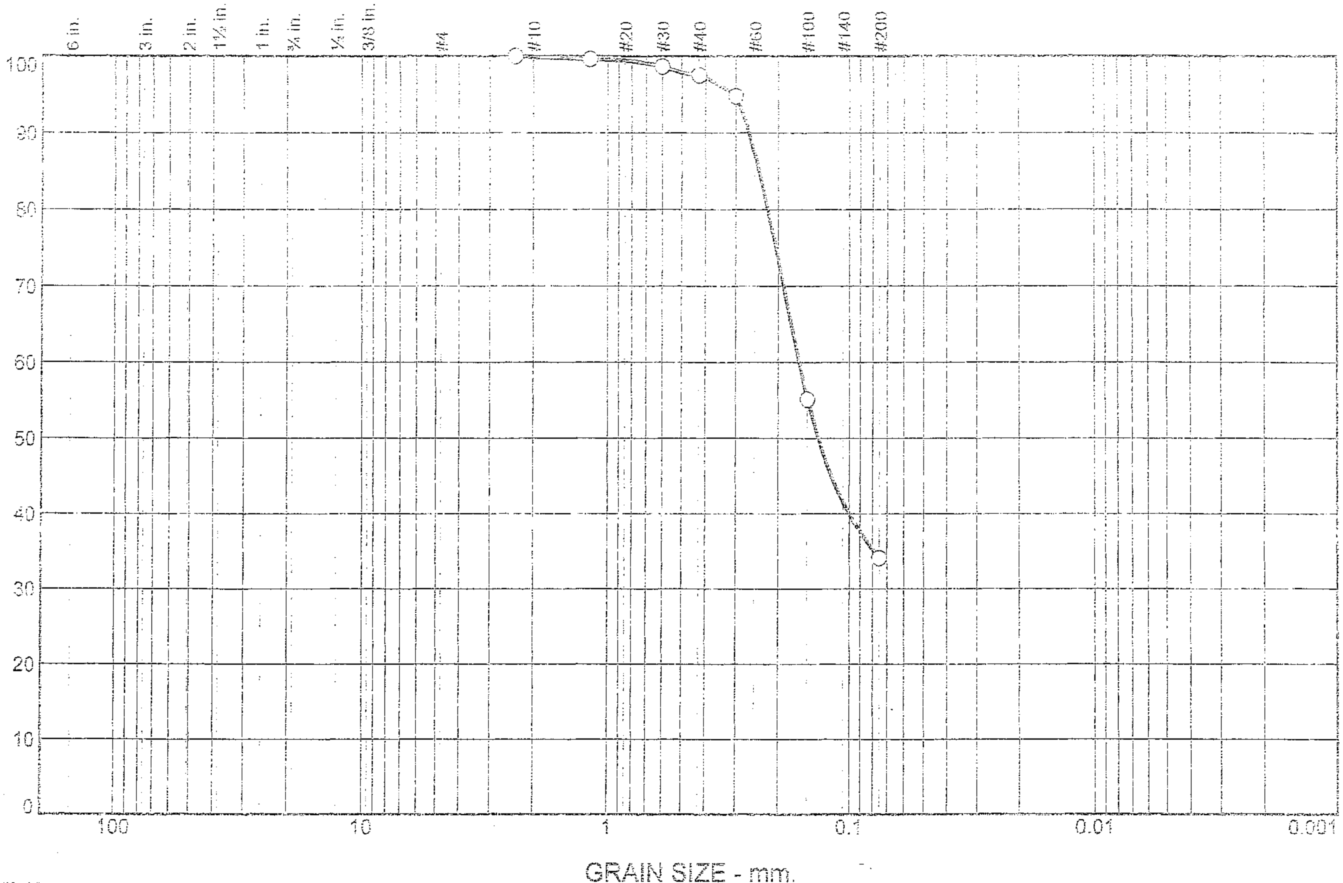
No groundwater flow observed
No caving observed

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of borehole at 1.0 feet.

APPENDIX B
LABORATORY TESTING RESULTS

Particle Size Distribution Report AASHTO T-11, T-27



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	2	64	34	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100		
#16	100		
#30	99		
#40	98		
#50	95		
#100	55		
#200	34		

* (no specification provided)

Soil Description

TP6 S1

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2641 D_{85}= 0.2402 D_{60}= 0.1632
D_{50}= 0.1352 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Report #: 1
AASHTO T-265 % Moisture= 34.7%
Sampled by: client

Source of Sample: Native, Shoalwater Bay
Sample Number: 10-389

Date: 6/30/10

Construction Testing Laboratories

Tacoma, WA

Client: E3RA
Project: Misc. Testing

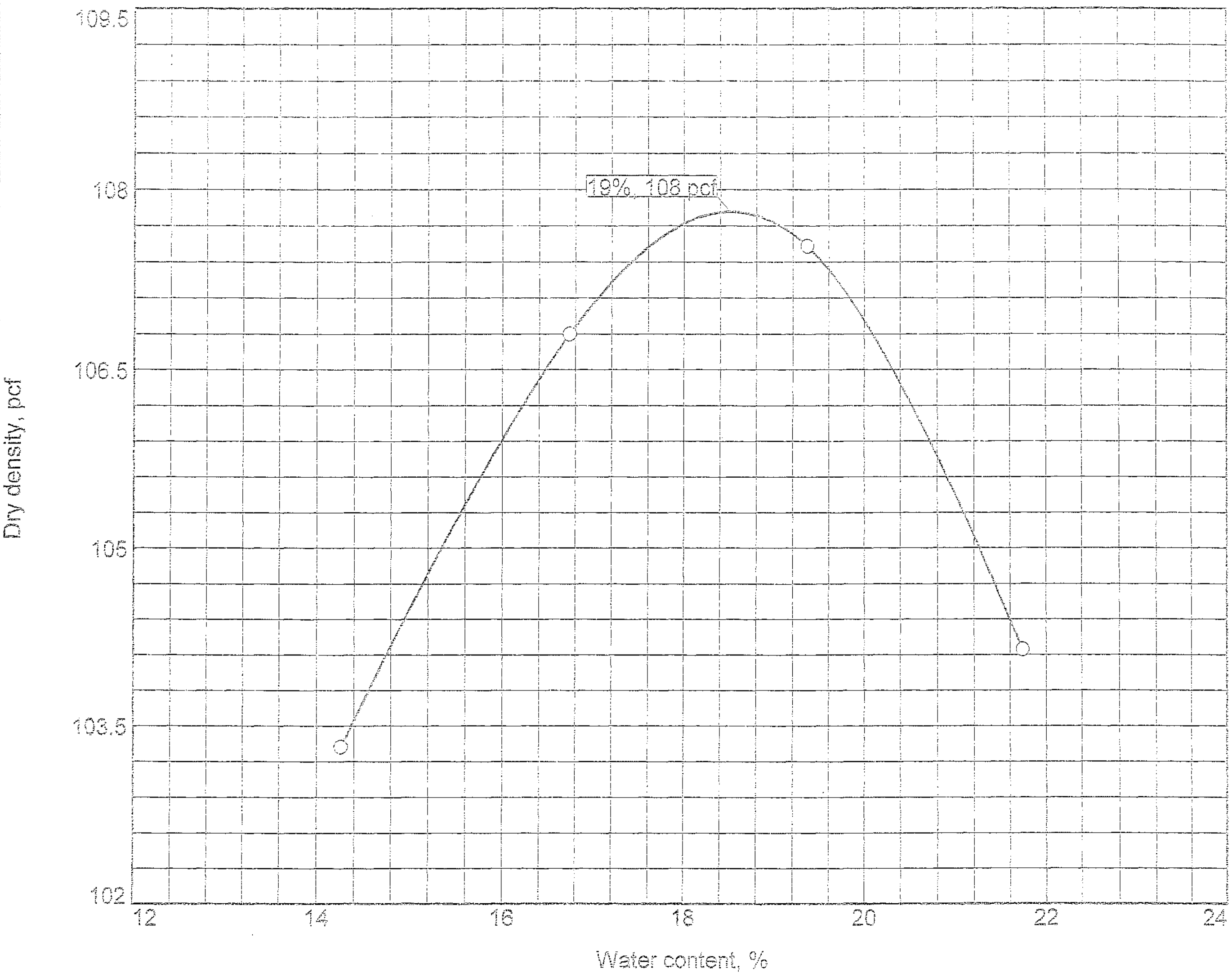
Project No: T-3966

Figure

Tested By: R Rowden

Checked By: C Pedersen

Moisture Density Relationship For Curve No. P-1



Test specification: AASHTO T 180-01 Method A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
							0	27

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 108 pcf Optimum moisture = 19 %	G-1

Project No. T-3966 **Client:** E3RA

Project: Misc. Testing

Date: 6/30/10

○ **Source of Sample:** Native, Shoalwater Bay **Sample Number:** 10-390

Construction Testing Laboratories

Tacoma, WA

Remarks:

Report #: 2

Sampled by: client

Figure

Tested By: D Detterich Checked By: C Pedersen

CONSTRUCTION TESTING LABORATORIES, INC.

1202 EAST "D" STREET, SUITE 101, TACOMA, WA 9821
Tel # 253-383-8778 / Fax # 253-383-2231
website: www.ctlwa.com

MISC. LABORATORY TEST REPORT

CLIENT	E3RA	DAE OF INSPECTION	June 30, 2010
PROJECT TITLE	MISC. TESTING	REPORT NUMBER	03
PROJECT ADDRESS	N/AL	PROJECT NUMBER	3966
CONTRACTOR	Client		

WORK ORDER NO.	N/A	CONTRACT ORDER NO.	N/A	PURCHASE ORDER NO.	N/A	JOB ORDER NUMBER	N/A

MATERIAL(S) INFORMATION

TEST(S) REQUESTED	AASHTO T265, No deviation	DATE OBTAINED	6-30-10
MATERIAL TYPE	TP-2 S-1	OBTAINED BY	Client
SOURCE OF SAMPLE	Shoal Water	SUBMITTED BY	Client
		LAB NUMER	10-391
LOCATION OF SUPPLY	TP-2 S-1	I.D. NUMBER	N/A

MISCELLANEOUS TEST(S)

CLAY LUMPS & FRIABLE PARTICLES (C-142)		% REQ. =		% MOISTURE	22.1%	REQ. =	
FINE AGGREGATE ANULARITY (T-304)		% REQ. =		% WOOD WASTE		% REQ. =	
SAND EQUIVALENT (REF. METHOD) (D-2419)		% REQ. =		% ORGANICS BY VOLUME		% REQ. =	
CLAY LUMPS & FRIABLE PARTICLES (C-142)		% REQ. =		DUST RATIO		% REQ. =	
SOIL(S) CLASSIFICATION(D-2487)		% REQ. =		FINENESS MODULUS		% REQ. =	
DEGRADATION (WSDOT-113)		% REQ. =		pH (D-2972)		% REQ. =	
LA ABRASION (C-131)						% REQ. =	

FRACTURE (SINGLE FACE) SIZE	RESULT(S)	PERCENT REQUIRED		FRACTURE (DOUBLE FACE) SIZE	RESULT(S)	PERCENT REQUIRED	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	

ATTERBERG LIMITS (D-4318)

			ORGANIC IMPURITIES (C-40)		% REQ. =	
PLASTIC LIMIT (PL)	WT PER CU/FT LOOSE (C-29)	% REQ. =	WT PER CU/FT LOOSE (C-29)		% REQ. =	
LIQUID LIMIT (LL)	wt PER CU/FT RODDED (C-29)	% REQ. =	wt PER CU/FT RODDED (C-29)		% REQ. =	
PLASTICITY INDEX (PI)		% REQ. =			% REQ. =	

SULFATE SOUNDNESS (C-88) SODIUM

COARSE SIZE	% LOSS	FINE SIZE	% LOSS
TOTAL →		TOTAL →	

SPECIFIC GRAVITY (SG)

COARSE AGGREGATE (C-127)				FINE AGGREGATE (C-128)			
SSD →		APP. SPECIFIC GRAVITY →		SSD →		APP. SPECIFIC GRAVITY →	
OVEN DRY →		% ABSORPTION →		OVEN DRY →		% ABSORPTION →	

FLAT & ELONGATED PIECES (3:1) (D-4791)

SIZE	RESULT(S)	REEQUIRED PERCENT

ADDITIONAL TEST(S)

TYPE OF TEST	RESULT(S)	REEQUIRED PERCENT

RESULT(S) STATUS

CONFORMS

LAB REMARK(S):

FIELD REMARK(S):

EQUIPMENT SET #s: Set #s

LAB TECHNICIAN: B. Rowden / caa

DATE COMPLETED: 7-07-10

REVIEWED BY / APPROVED BY: C. Pedersen / D. Smith

DATE RECD: 07-07-10

MISC. LAB TEST REPORT PROFILE
cc: FILE, CLIENT, MAIL DIST. LIST

CONSTRUCTION TESTING LABORATORIES, INC.

1202 EAST "D" STREET, SUITE 101, TACOMA, WA 9821
Tel # 253-383-8778 / Fax # 253-383-2231
website: www.ctlwa.com

MISC. LABORATORY TEST REPORT

CLIENT	E3RA	DAE OF INSPECTION	June 30, 2010
PROJECT TITLE	MISC. TESTING	REPORT NUMBER	04
PROJECT ADDRESS	N/AL	PROJECT NUMBER	3966
CONTRACTOR	Client		

WORK ORDER NO.	N/A	CONTRACT ORDER NO.	N/A	PURCHASE ORDER NO.	N/A	JOB ORDER NUMBER	N/A

MATERIAL(S) INFORMATION

TEST(S) REQUESTED	AASHTO T265, No deviation	DATE OBTAINED	6-30-10
MATERIAL TYPE	TP-9 S-1	OBTAINED BY	Client
SOURCE OF SAMPLE	Shoal Water Bay	SUBMITTED BY	Client
		LAB NUMER	10-392
LOCATION OF SUPPLY	Native at TP-9 S-1	I.D. NUMBER	N/A

MISCELLANEOUS TEST(S)

CLAY LUMPS & FRIABLE PARTICLES (C-142)		% REQ. =		% MOISTURE	31.0%	REQ. =	
FINE AGGREGATE ANULARITY (T-304)		% REQ. =		% WOOD WASTE		% REQ. =	
SAND EQUIVALENT (REF. METHOD) (D-2419)		% REQ. =		% ORGANICS BY VOLUME		% REQ. =	
CLAY LUMPS & FRIABLE PARTICLES (C-142)		% REQ. =		DUST RATIO		% REQ. =	
SOIL(S) CLASSIFICATION (D-2487)		% REQ. =		FINENESS MODULUS		% REQ. =	
DEGRADATION (WSDOT-113)		% REQ. =		pH (D-2972)		% REQ. =	
LAABRASION (C-131)						% REQ. =	

FRACTURE (SINGLE FACE)	SIZE	RESULT(S)	PERCENT REQUIRED	FRACTURE (DOUBLE FACE)	SIZE	RESULT(S)	PERCENT REQUIRED
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	

SULFATE SOUNDNESS (C-88) SODIUM

COARSE SIZE	COARSE % LOSS	FINE SIZE	FINE % LOSS
TOTAL →		TOTAL →	

ATTERBERG LIMITS (D-4318)

PLASTIC LIMIT (PL)	WT PER CU/FT LOOSE (C-29)	% REQ. =	ORGANIC IMPURITIES (C-40)		% REQ. =	
LIQUID LIMIT (LL)	wt PER CU/FT RODDED (C-29)	% REQ. =	WT PER CU/FT LOOSE (C-29)		% REQ. =	
PLASTICITY INDEX (PI)		% REQ. =	wt PER CU/FT RODDED (C-29)		% REQ. =	

SPECIFIC GRAVITY (SG)

COARSE AGGREGATE (C-127)				FINE AGGREGATE (C-128)			
SSD →		APP. SPECIFIC GRAVITY →		SSD →		APP. SPECIFICGRAVITY →	
OVEN DRY →		% ABSORPTION →		OVEN DRY →		% ABSORPTION →	

FLAT & ELONGATED PIECES (3:1) (D-4791)

SIZE	RESULT(S)	REEQUIRED PERCENT

ADDITIONAL TEST(S)

TYPE OF TEST	RESULT(S)	REEQUIRED PERCENT

RESULT(S) STATUS

CONFORMS

LAB REMARK(S):

FIELD REMARK(S):

EQUIPMENT SET #s: Set #s

LAB TECHNICIAN: B. Rowden / caa

DATE COMPLETED: 7-07-10

REVIEWED BY / APPROVED BY: C. Pedersen / D. Smith

DATE RECD: 07-07-10
MISC. LAB TEST REPORT PROFILE
cc: FILE, CLIENT, MAIL DIST. LIST

CONSTRUCTION TESTING LABORATORIES, INC.

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Tel # 253-383-8778 / Fax # 253-383-2231
website: www.ctlwa.com

MISC. LABORATORY TEST REPORT

CLIENT	E3RA	DAE OF INSPECTION	June 30, 2010
PROJECT TITLE	MISC. TESTING	REPORT NUMBER	05
PROJECT ADDRESS	N/AL	PROJECT NUMBER	3966
CONTRACTOR	Client		

WORK ORDER NO.	N/A	CONTRACT ORDER NO.	N/A	PURCHASE ORDER NO.	N/A	JOB ORDER NUMBER	N/A

MATERIAL(S) INFORMATION

TEST(S) REQUESTED	AASHTO T265, No deviation	DATE OBTAINED	6-30-10
MATERIAL TYPE	TP-8 S-1	OBTAINED BY	Client
SOURCE OF SAMPLE	Shoal Water Bay	SUBMITTED BY	Client
		LAB NUMER	10-393
LOCATION OF SUPPLY	Native at TP-8 S-1	I.D. NUMBER	N/A

MISCELLANEOUS TEST(S)

Test	Result	% REQ. =		Test	Result	REQ. =	
CLAY LUMPS & FRIABLE PARTICLES (C-142)		% REQ. =		% MOISTURE	20.3%	REQ. =	
FINE AGGREGATE ANULARITY (T-304)		% REQ. =		% WOOD WASTE		% REQ. =	
SAND EQUIVALENT (REF. METHOD) (D-2419)		% REQ. =		% ORGANICS BY VOLUME		% REQ. =	
CLAY LUMPS & FRIABLE PARTICLES (C-142)		% REQ. =		DUST RATIO		% REQ. =	
SOIL(S) CLASSIFICATION (D-2487)		% REQ. =		FINENESS MODULUS		% REQ. =	
DEGRADATION (WSDOT-113)		% REQ. =		pH (D-2972)		% REQ. =	
LAABRASION (C-131)						% REQ. =	

FRACTURE (SINGLE FACE) SIZE	RESULT(S)	PERCENT REQUIRED		FRACTURE (DOUBLE FACE) SIZE	RESULT(S)	PERCENT REQUIRED	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	
		% REQ. =				% REQ. =	

ATTERBERG LIMITS (D-4318)							
				ORGANIC IMPURITIES (C-40)		% REQ. =	
PLASTIC LIMIT (PL)	WT PER CU/FT LOOSE (C-29)	% REQ. =		WT PER CU/FT LOOSE (C-29)		% REQ. =	
LIQUID LIMIT (LL)	wt PER CU/FT RODDED (C-29)	% REQ. =		wt PER CU/FT RODDED (C-29)		% REQ. =	
PLASTICITY INDEX (PI)		% REQ. =				% REQ. =	

SULFATE SOUNDNESS (C-88) SODIUM

COARSE SIZE	% LOSS	FINE SIZE	% LOSS
TOTAL →		TOTAL →	

SPECIFIC GRAVITY (SG)

COARSE AGGREGATE (C-127)				FINE AGGREGATE (C-128)			
SSD →		APP. SPECIFIC GRAVITY →		SSD →		APP. SPECIFICGRAVITY →	
OVEN DRY →		% ABSORPTION →		OVEN DRY →		% ABSORPTION →	

FLAT & ELONGATED PIECES (3:1) (D-4791)

SIZE	RESULT(S)	REEQUIRED PERCENT

ADDITIONAL TEST(S)

TYPE OF TEST	RESULT(S)	REEQUIRED PERCENT

RESULT(S) STATUS

CONFORMS

LAB REMARK(S):

FIELD REMARK(S):

REVIEWED BY / APPROVED BY: [signature]

EQUIPMENT SET #s: Set #s

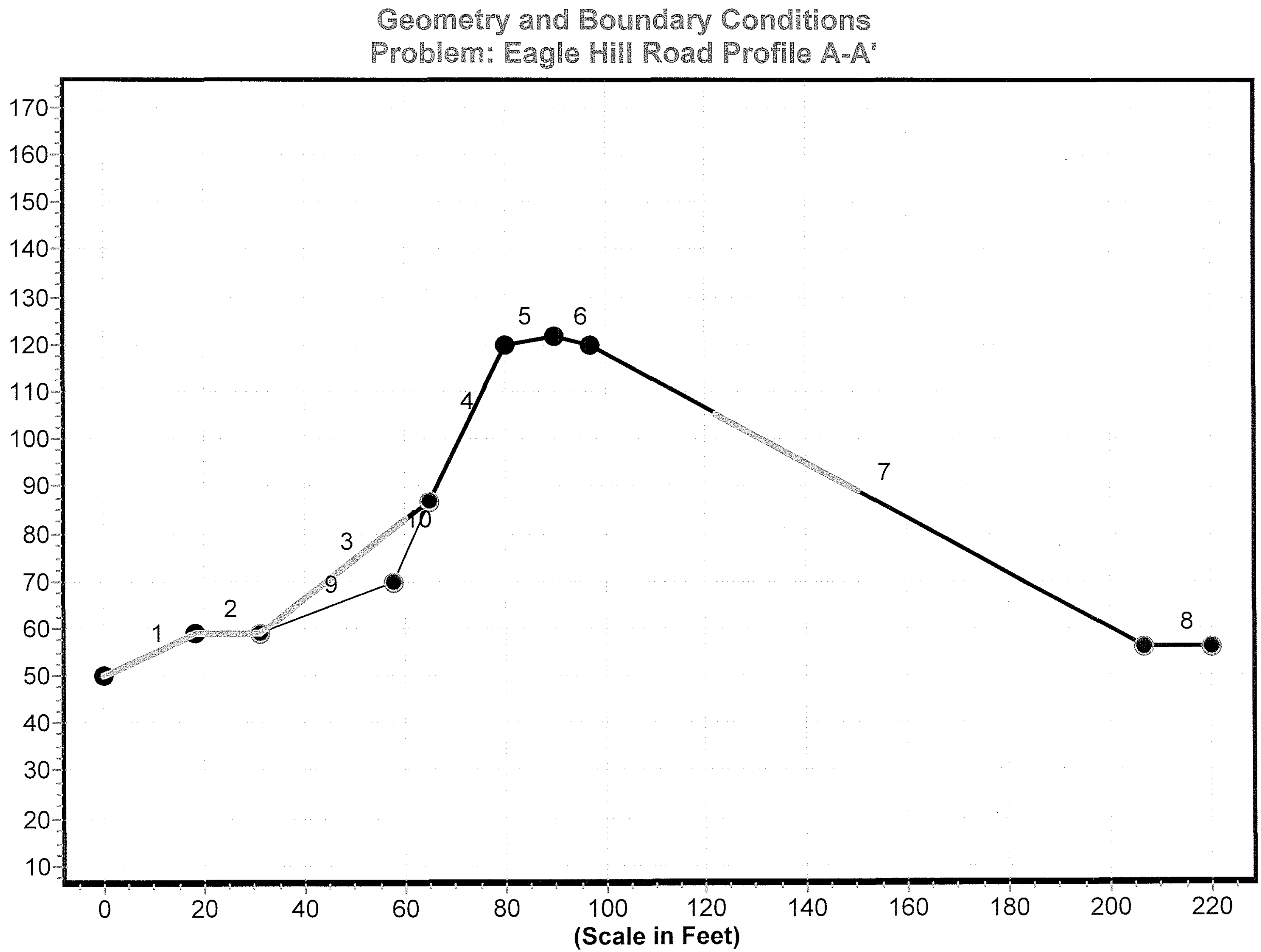
LAB TECHNICIAN: B. Rowden / caa

DATE COMPLETED: 7-07-10

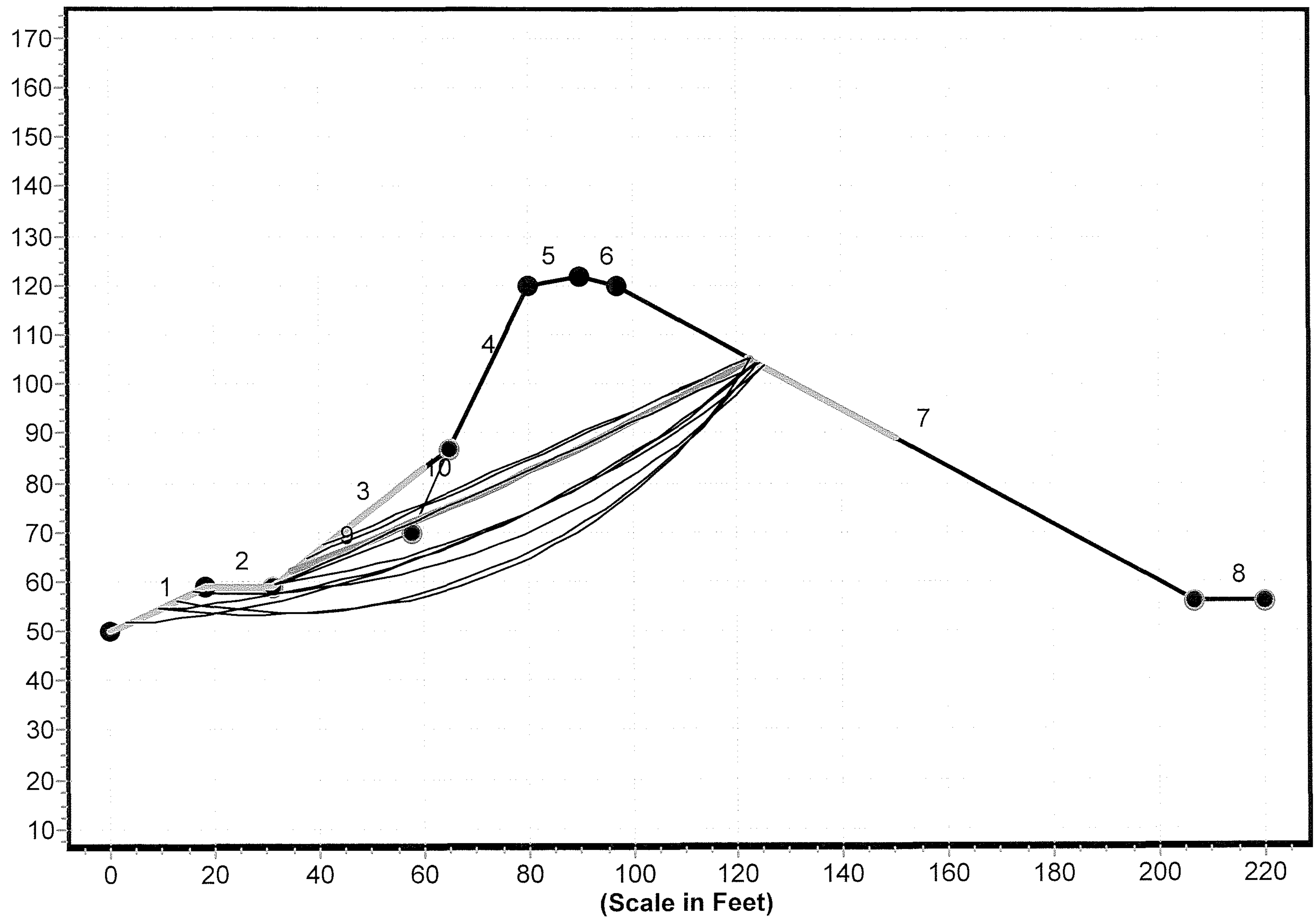
C. Pedersen / D. Smith

DATE RECD: 07-07-10
MISC. LAB TEST REPORT PROFILE
cc: FILE, CLIENT& MAIL DIST. LIST

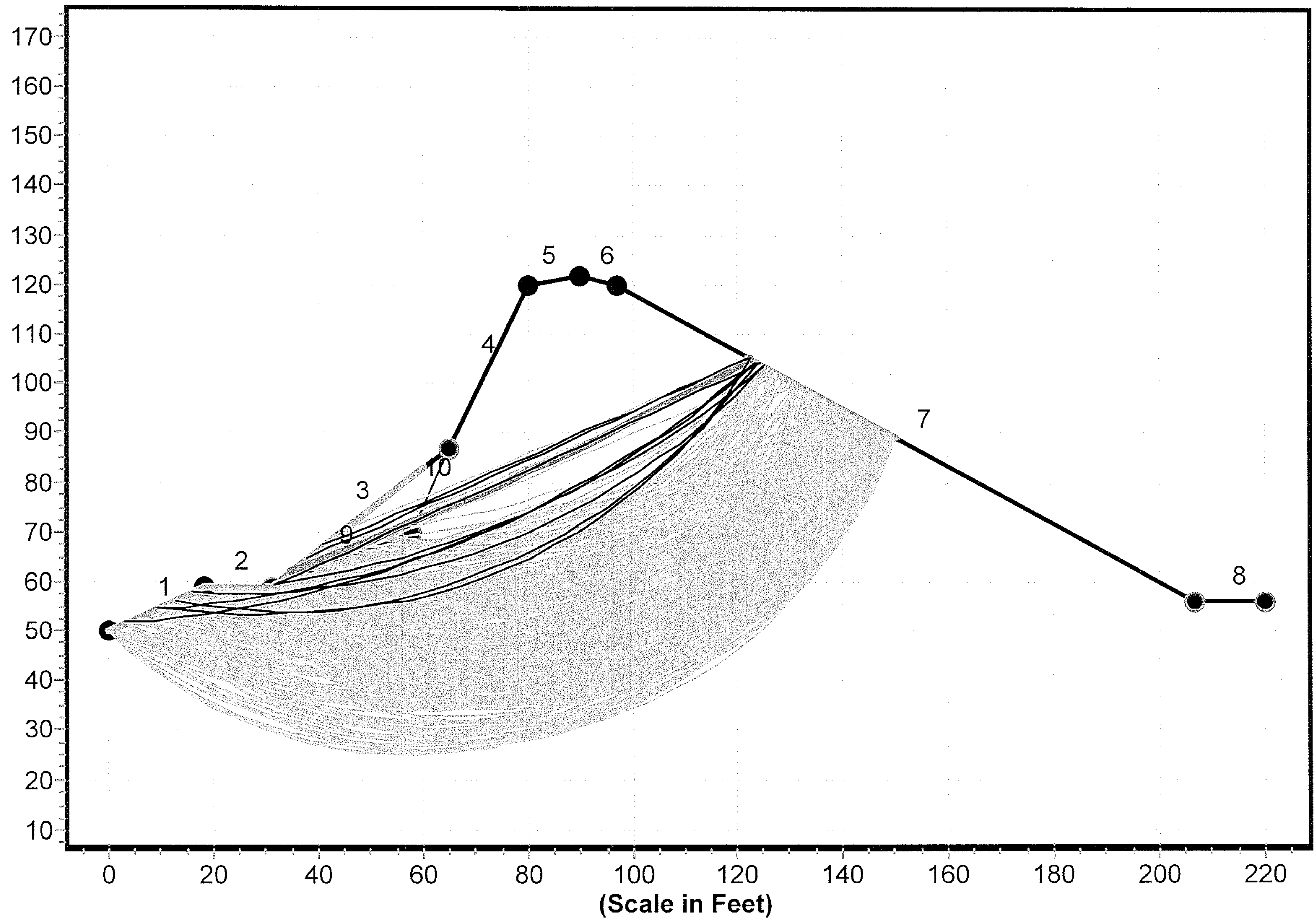
APPENDIX C
SLOPE STABILITY ANALYSIS

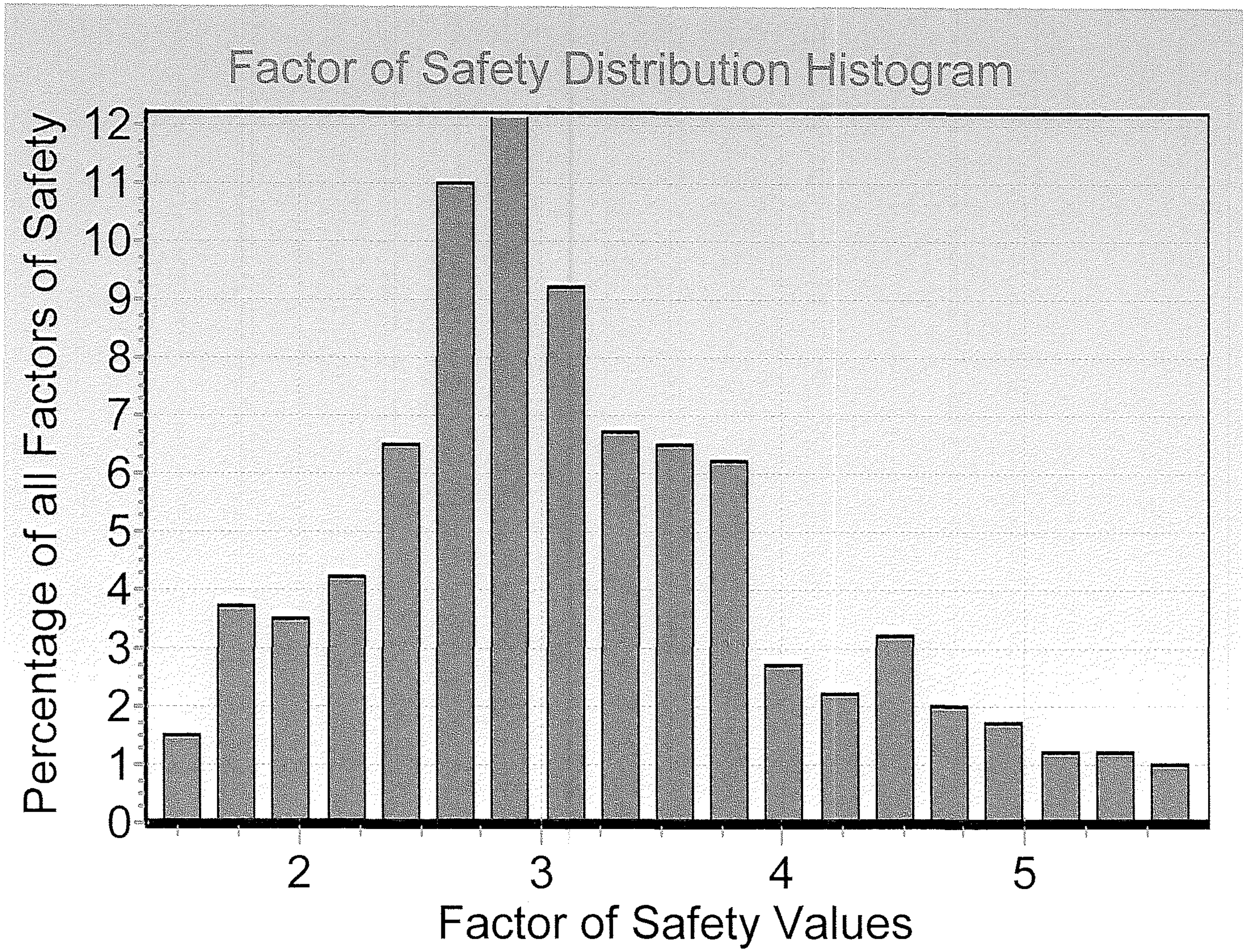

Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile A-A'
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
20
40
60
80
100
120
140
160
180
200
220
(Scale in Feet)
1
2
3
4
5
6
7
8
9
10

Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile A-A' Static - FS Min = 1.549



Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile A-A' Static - FS Min = 1.549




Factor of Safety Distribution Histogram
Percentage of all Factors of Safety
0
1
2
3
4
5
6
7
8
9
10
11
12
2
3
4
5
Factor of Safety Values

result.out
** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Eagle Hill Road Profile A-A' Static

BOUNDARY COORDINATES

8 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	50.00	18.00	59.00	1
2	18.00	59.00	31.00	59.00	1
3	31.00	59.00	65.00	87.00	2
4	65.00	87.00	80.00	120.00	1
5	80.00	120.00	90.00	122.00	1
6	90.00	122.00	97.00	120.00	1
7	97.00	120.00	207.00	56.00	1
8	207.00	56.00	220.00	56.00	1
9	31.00	59.00	58.00	70.00	1
10	58.00	70.00	65.00	87.00	1

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	108.0	108.0	100.0	36.0	0.00	0.0	0
2	108.0	108.0	50.0	30.0	0.00	0.0	0

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 0.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 122.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	34.74	62.08
2	39.36	63.98
3	43.97	65.92
4	48.57	67.89
5	53.15	69.89
6	57.72	71.92
7	62.27	73.98
8	66.81	76.07
9	71.34	78.19
10	75.85	80.35
11	80.35	82.53
12	84.83	84.75
13	89.30	86.99
14	93.75	89.27
15	98.19	91.58
16	102.61	93.91
17	107.01	96.28
18	111.40	98.68
19	115.77	101.10
20	120.13	103.56
21	122.71	105.04

Circle Center At X = -242.7 ; Y = 741.9 and Radius, 734.2

*** 1.549 ***

Individual data on the 25 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.6	474.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	4.6	1409.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	4.6	2318.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	4.6	3200.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	4.6	4056.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.3	1326.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	3.2	3559.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.7	3318.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	1.8	2615.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	4.5	9210.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	4.5	12984.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	4.1	15262.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.4	1425.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	4.5	17852.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	4.5	17147.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.7	2624.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	3.8	13437.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	3.2	10643.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	1.2	3645.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	4.4	12067.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	4.4	9684.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	4.4	7307.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	4.4	4938.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	4.4	2577.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	2.6	416.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.16	51.58
2	8.13	52.08
3	13.10	52.70
4	18.04	53.44
5	22.97	54.30
6	27.87	55.28
7	32.75	56.38
8	37.60	57.60
9	42.41	58.93
10	47.20	60.39
11	51.94	61.95
12	56.65	63.64
13	61.32	65.44
14	65.94	67.35
15	70.51	69.38

16	75.03	71.51
17	79.50	73.76
18	83.91	76.11
19	88.26	78.57
20	92.55	81.14
21	96.78	83.81
22	100.94	86.58
23	105.03	89.45
24	109.06	92.42
25	113.00	95.49
26	116.88	98.65
27	120.67	101.91
28	123.58	104.54

Circle Center At X = -14.8 ; Y = 255.7 and Radius, 204.9

*** 1.551 ***

1

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.47	54.74
2	14.46	55.11
3	19.43	55.63
4	24.39	56.27
5	29.33	57.06
6	34.24	57.98
7	39.13	59.03
8	43.99	60.22
9	48.81	61.54
10	53.59	63.00
11	58.34	64.58
12	63.03	66.29
13	67.68	68.14
14	72.28	70.10
15	76.82	72.20
16	81.30	74.42
17	85.72	76.76
18	90.07	79.22
19	94.36	81.80
20	98.57	84.49
21	102.70	87.30
22	106.76	90.22
23	110.73	93.26
24	114.63	96.40
25	118.43	99.64
26	122.14	102.99
27	123.69	104.47

Circle Center At X = -1.7 ; Y = 236.5 and Radius, 182.2

*** 1.562 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	59.48
2	36.11	61.59
3	40.64	63.72
4	45.16	65.84
5	49.68	67.98
6	54.20	70.11
7	58.72	72.26
8	63.24	74.41
9	67.75	76.56
10	72.26	78.72
11	76.77	80.88
12	81.27	83.05
13	85.77	85.23
14	90.27	87.40
15	94.77	89.59
16	99.27	91.78
17	103.76	93.97
18	108.25	96.17
19	112.74	98.38
20	117.22	100.59
21	121.70	102.80
22	124.32	104.10

Circle Center At X = ****** ; Y = 3994.3 and Radius, 4342.2

*** 1.596 ***

1

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	59.48
2	36.51	60.30
3	41.42	61.26
4	46.30	62.36
5	51.14	63.58
6	55.95	64.95
7	60.73	66.44
8	65.45	68.07
9	70.14	69.82
10	74.77	71.71
11	79.35	73.72
12	83.87	75.85
13	88.33	78.11
14	92.72	80.49
15	97.05	83.00
16	101.31	85.62
17	105.49	88.36

18	109.60	91.21
19	113.63	94.17
20	117.57	97.25
21	121.43	100.43
22	125.11	103.64

Circle Center At X = 4.2 ; Y = 238.6 and Radius, 181.2

*** 1.601 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.90	64.68
2	42.43	66.79
3	46.96	68.90
4	51.49	71.02
5	56.02	73.14
6	60.54	75.28
7	65.06	77.41
8	69.57	79.56
9	74.09	81.71
10	78.60	83.87
11	83.11	86.03
12	87.61	88.20
13	92.11	90.38
14	96.61	92.56
15	101.11	94.75
16	105.60	96.94
17	110.09	99.14
18	114.57	101.35
19	119.06	103.57
20	122.40	105.22

Circle Center At X = ****** ; Y = 3315.3 and Radius, 3583.3

*** 1.615 ***

1

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.47	54.74
2	14.43	54.07
3	19.41	53.61
4	24.40	53.37
5	29.40	53.34
6	34.40	53.53
7	39.38	53.93

8	44.34	54.55
9	49.27	55.38
10	54.17	56.42
11	59.01	57.67
12	63.79	59.12
13	68.51	60.79
14	73.15	62.65
15	77.70	64.71
16	82.16	66.96
17	86.53	69.41
18	90.78	72.04
19	94.91	74.85
20	98.92	77.83
21	102.80	80.99
22	106.54	84.31
23	110.13	87.79
24	113.57	91.41
25	116.86	95.19
26	119.97	99.10
27	122.92	103.14
28	123.77	104.42

Circle Center At X = 27.5 ; Y = 169.5 and Radius, 116.1

*** 1.622 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.63	56.32
2	17.54	55.34
3	22.48	54.62
4	27.46	54.14
5	32.45	53.90
6	37.45	53.91
7	42.45	54.17
8	47.42	54.68
9	52.37	55.44
10	57.26	56.43
11	62.11	57.67
12	66.89	59.15
13	71.58	60.86
14	76.19	62.80
15	80.70	64.97
16	85.09	67.36
17	89.36	69.96
18	93.49	72.77
19	97.49	75.78
20	101.32	78.99
21	105.00	82.38
22	108.50	85.95
23	111.82	89.69
24	114.95	93.59
25	117.88	97.64
26	120.61	101.82
27	122.54	105.14

Circle Center At X = 34.7 ; Y = 154.8 and Radius, 101.0

*** 1.632 ***

1

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	15.79	57.89
2	20.79	57.70
3	25.79	57.69
4	30.78	57.86
5	35.77	58.22
6	40.74	58.77
7	45.69	59.49
8	50.60	60.40
9	55.48	61.50
10	60.32	62.77
11	65.10	64.21
12	69.83	65.84
13	74.50	67.64
14	79.09	69.61
15	83.61	71.75
16	88.05	74.05
17	92.40	76.52
18	96.65	79.15
19	100.81	81.93
20	104.86	84.86
21	108.79	87.94
22	112.62	91.17
23	116.31	94.53
24	119.89	98.03
25	123.33	101.66
26	125.08	103.66

Circle Center At X = 23.6 ; Y = 192.7 and Radius, 135.0

*** 1.634 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.05	67.28
2	45.61	69.33
3	50.17	71.39
4	54.72	73.46
5	59.27	75.54
6	63.81	77.63

7	68.35	79.73
8	72.88	81.84
9	77.41	83.95
10	81.94	86.08
11	86.46	88.21
12	90.98	90.36
13	95.49	92.51
14	100.00	94.67
15	104.50	96.84
16	109.00	99.02
17	113.50	101.21
18	117.99	103.41
19	122.07	105.41

Circle Center At X = -973.3 ; Y = 2327.3 and Radius, 2477.3

*** 1.648 ***

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1

                Y           A     X     I     S          F     T

                 0.00     27.50     55.00     82.50    110.00    137.50

X          0.00 +---------+-------*-+---------+---------+---------+
                -                ..2
                -              ....23
                -             .....239
                -            ......23*
                -           .......729
          27.50 +          ........723
                -          .........8*4
                -         .........782416
                -         .........72516
                -        ...........7.2516.
                -        ...........7.32.16.
A         55.00 +        ............79251.6..
                -        ............7.32*16...
                -        ............7.925.16...*
                -        .............7.92..16..
                -         ............87.32.146..
                -         .............87932.160..           *
X         82.50 +         ..............7.932.16..
                -          .............87.932.11..
                -          ...............7.932.16.          *
                -           ...............7892..16.         *
                -            ...............7792341..
                -             ................875241.
I        110.00 +              ................875241.
                -               .................75241.
                -                ..................5221
                -                 ...................31
                -                  ...................
                -                    ................
S        137.50 +                      ..............
                -                        ...........
                -                           .......
                -                               ..
                -
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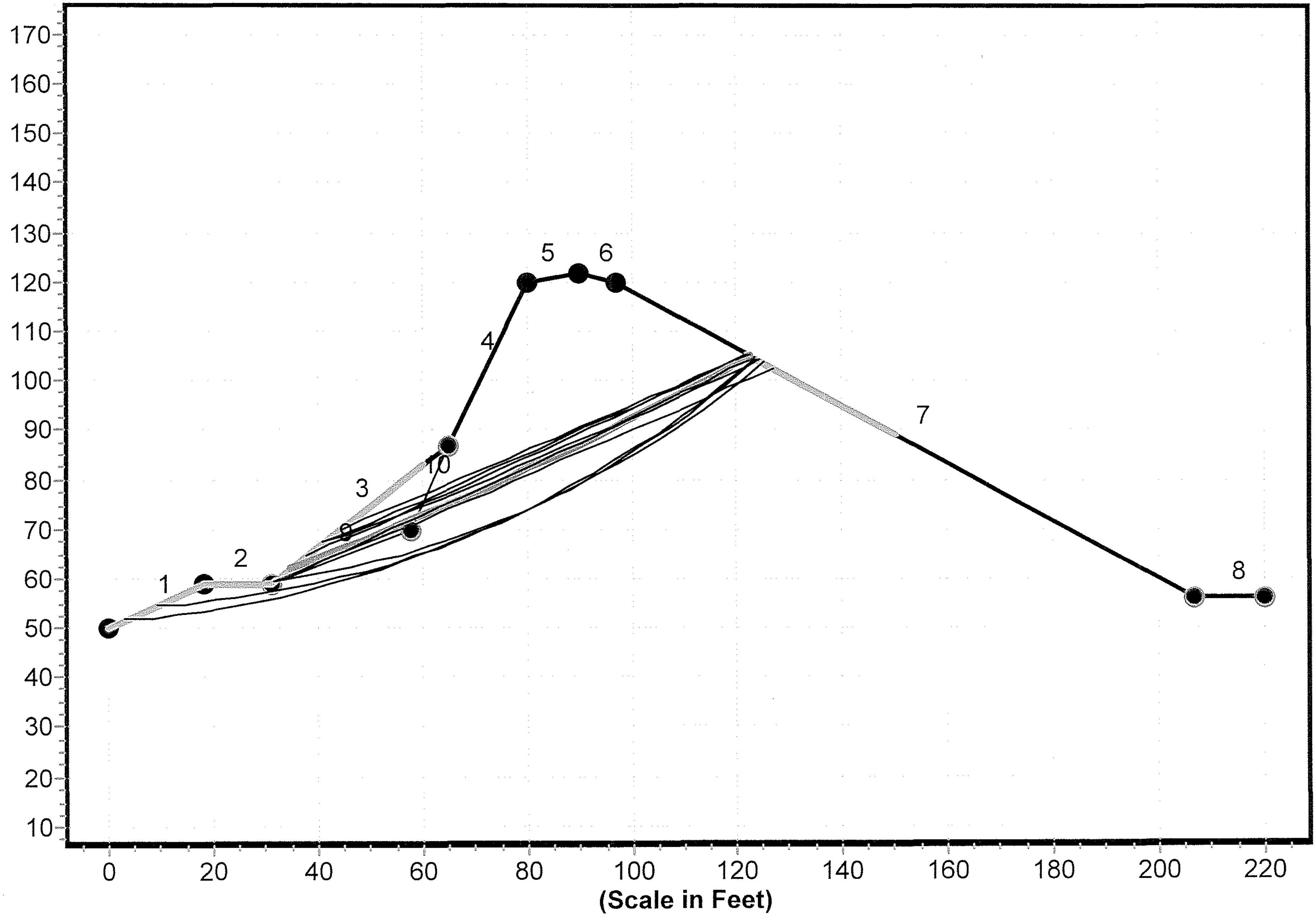
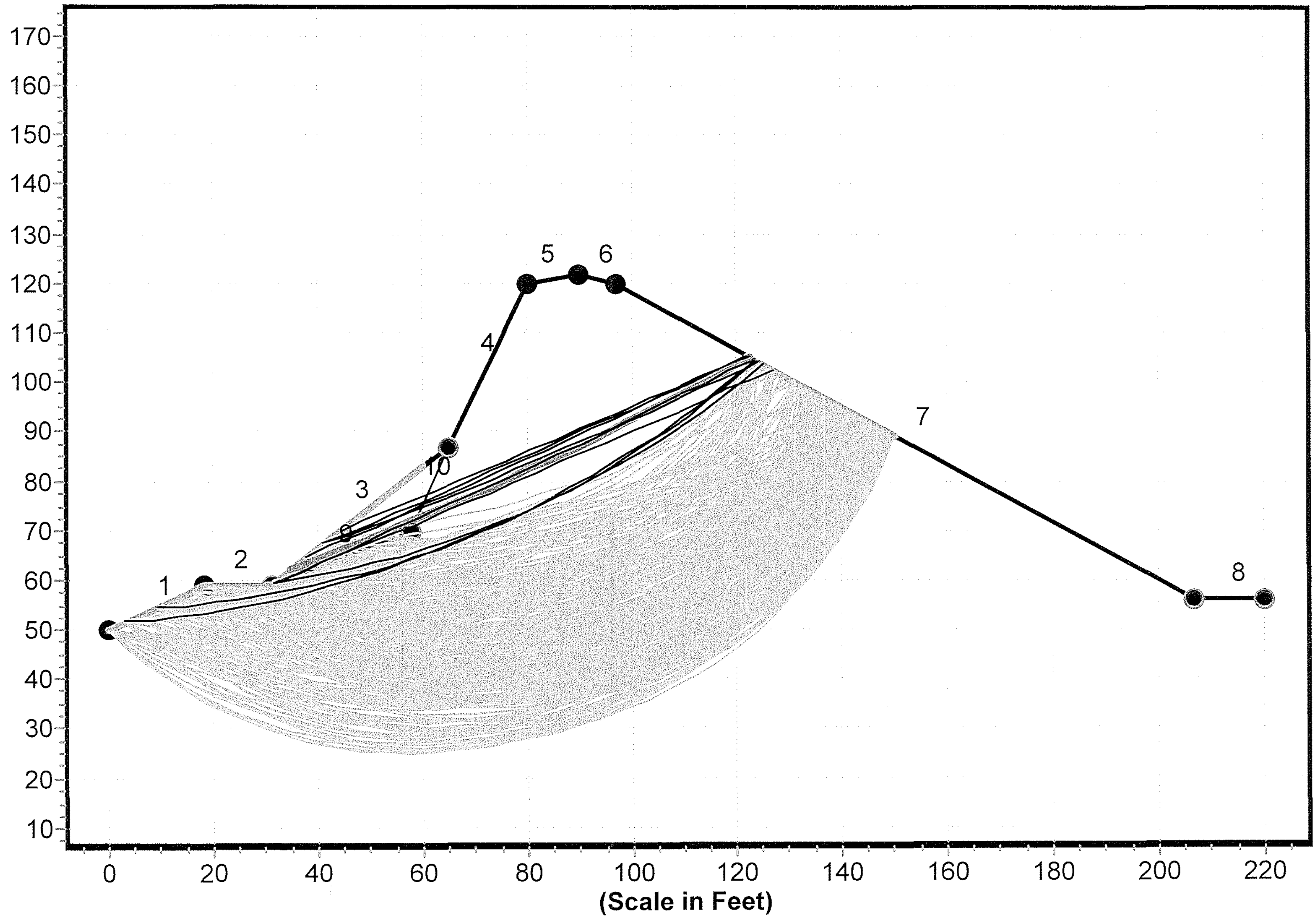
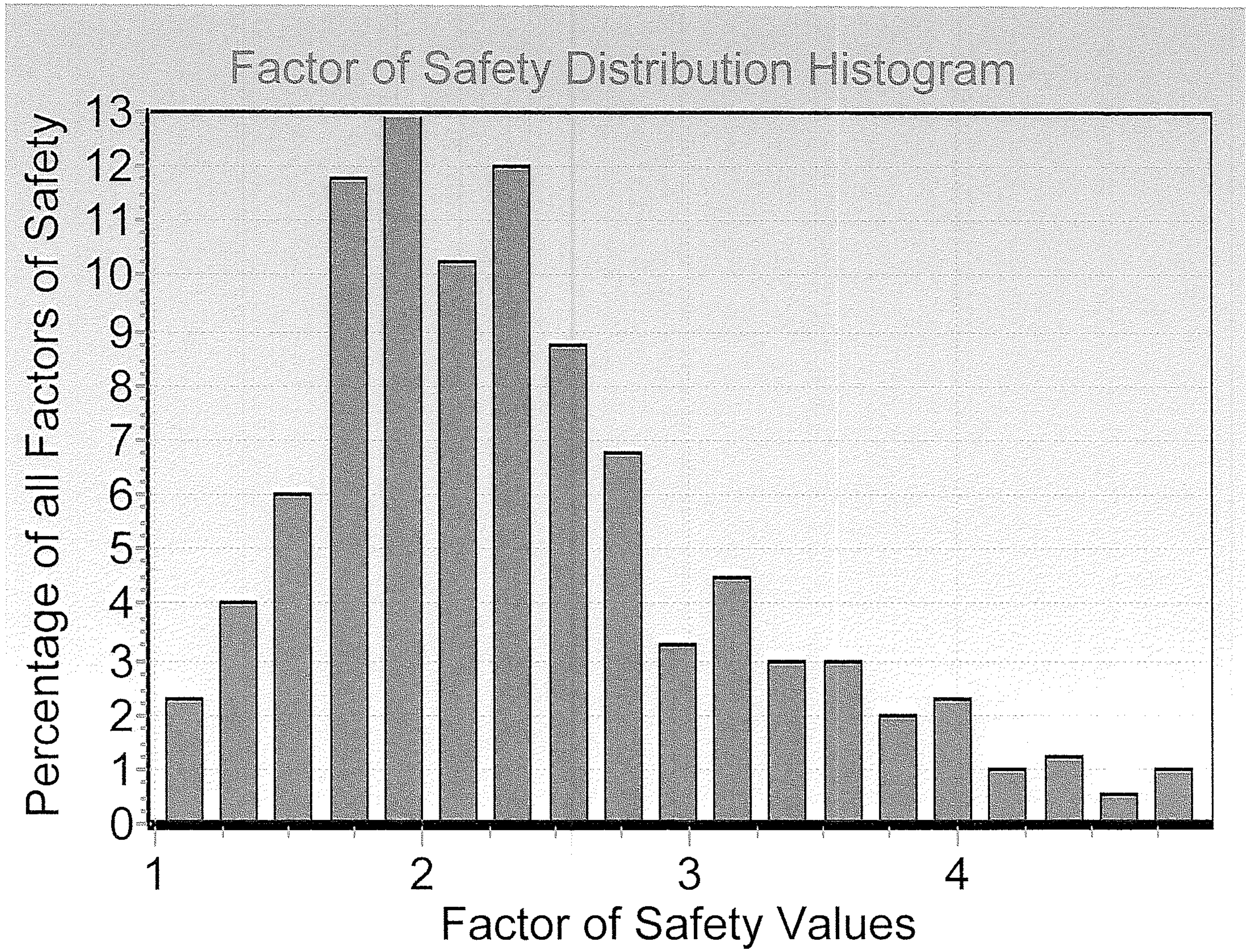
                 -
        165.00 +
                 -
                 -
                 -
                 -
                 -
F       192.50 +
                 -
                 -
                 -                    *
                 -
                 -
T       220.00 +                      *
```

Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile A-A' Seismic - FS Min = 1.115



Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile A-A' Seismic - FS Min = 1.115





Factor of Safety Distribution Histogram
Percentage of all Factors of Safety
0
1
2
3
4
5
6
7
8
9
10
11
12
13
1
2
3
4
Factor of Safety Values

result.out

** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Eagle Hill Road Profile A-A' Seismic

BOUNDARY COORDINATES

8 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	50.00	18.00	59.00	1
2	18.00	59.00	31.00	59.00	1
3	31.00	59.00	65.00	87.00	2
4	65.00	87.00	80.00	120.00	1
5	80.00	120.00	90.00	122.00	1
6	90.00	122.00	97.00	120.00	1
7	97.00	120.00	207.00	56.00	1
8	207.00	56.00	220.00	56.00	1
9	31.00	59.00	58.00	70.00	1
10	58.00	70.00	65.00	87.00	1

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	108.0	108.0	100.0	36.0	0.00	0.0	0
2	108.0	108.0	50.0	30.0	0.00	0.0	0

A Horizontal Earthquake Loading Coefficient
Of0.150 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 (psf)

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 0.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 122.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	34.74	62.08
2	39.36	63.98
3	43.97	65.92
4	48.57	67.89
5	53.15	69.89
6	57.72	71.92
7	62.27	73.98
8	66.81	76.07
9	71.34	78.19
10	75.85	80.35
11	80.35	82.53

12	84.83	84.75
13	89.30	86.99
14	93.75	89.27
15	98.19	91.58
16	102.61	93.91
17	107.01	96.28
18	111.40	98.68
19	115.77	101.10
20	120.13	103.56
21	122.71	105.04

Circle Center At X = -242.7 ; Y = 741.9 and Radius, 734.2

*** 1.115 ***

Individual data on the 25 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.6	474.8	0.0	0.0	0.0	0.0	71.2	0.0	0.0
2	4.6	1409.7	0.0	0.0	0.0	0.0	211.5	0.0	0.0
3	4.6	2318.3	0.0	0.0	0.0	0.0	347.8	0.0	0.0
4	4.6	3200.5	0.0	0.0	0.0	0.0	480.1	0.0	0.0
5	4.6	4056.4	0.0	0.0	0.0	0.0	608.5	0.0	0.0
6	1.3	1326.3	0.0	0.0	0.0	0.0	199.0	0.0	0.0
7	3.2	3559.5	0.0	0.0	0.0	0.0	533.9	0.0	0.0
8	2.7	3318.6	0.0	0.0	0.0	0.0	497.8	0.0	0.0
9	1.8	2615.4	0.0	0.0	0.0	0.0	392.3	0.0	0.0
10	4.5	9210.5	0.0	0.0	0.0	0.0	1381.6	0.0	0.0
11	4.5	12984.0	0.0	0.0	0.0	0.0	1947.6	0.0	0.0
12	4.1	15262.4	0.0	0.0	0.0	0.0	2289.4	0.0	0.0
13	0.4	1425.9	0.0	0.0	0.0	0.0	213.9	0.0	0.0
14	4.5	17852.7	0.0	0.0	0.0	0.0	2677.9	0.0	0.0
15	4.5	17147.9	0.0	0.0	0.0	0.0	2572.2	0.0	0.0
16	0.7	2624.0	0.0	0.0	0.0	0.0	393.6	0.0	0.0
17	3.8	13437.1	0.0	0.0	0.0	0.0	2015.6	0.0	0.0
18	3.2	10643.4	0.0	0.0	0.0	0.0	1596.5	0.0	0.0
19	1.2	3645.5	0.0	0.0	0.0	0.0	546.8	0.0	0.0
20	4.4	12067.6	0.0	0.0	0.0	0.0	1810.1	0.0	0.0
21	4.4	9684.1	0.0	0.0	0.0	0.0	1452.6	0.0	0.0
22	4.4	7307.5	0.0	0.0	0.0	0.0	1096.1	0.0	0.0
23	4.4	4938.3	0.0	0.0	0.0	0.0	740.7	0.0	0.0
24	4.4	2577.1	0.0	0.0	0.0	0.0	386.6	0.0	0.0
25	2.6	416.4	0.0	0.0	0.0	0.0	62.5	0.0	0.0

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	59.48
2	36.11	61.59
3	40.64	63.72
4	45.16	65.84
5	49.68	67.98

6	54.20	70.11
7	58.72	72.26
8	63.24	74.41
9	67.75	76.56
10	72.26	78.72
11	76.77	80.88
12	81.27	83.05
13	85.77	85.23
14	90.27	87.40
15	94.77	89.59
16	99.27	91.78
17	103.76	93.97
18	108.25	96.17
19	112.74	98.38
20	117.22	100.59
21	121.70	102.80
22	124.32	104.10

Circle Center At X = ****** ; Y = 3994.3 and Radius, 4342.2

*** 1.138 ***

1

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.16	51.58
2	8.13	52.08
3	13.10	52.70
4	18.04	53.44
5	22.97	54.30
6	27.87	55.28
7	32.75	56.38
8	37.60	57.60
9	42.41	58.93
10	47.20	60.39
11	51.94	61.95
12	56.65	63.64
13	61.32	65.44
14	65.94	67.35
15	70.51	69.38
16	75.03	71.51
17	79.50	73.76
18	83.91	76.11
19	88.26	78.57
20	92.55	81.14
21	96.78	83.81
22	100.94	86.58
23	105.03	89.45
24	109.06	92.42
25	113.00	95.49
26	116.88	98.65
27	120.67	101.91
28	123.58	104.54

Circle Center At X = -14.8 ; Y = 255.7 and Radius, 204.9

*** 1.149 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.90	64.68
2	42.43	66.79
3	46.96	68.90
4	51.49	71.02
5	56.02	73.14
6	60.54	75.28
7	65.06	77.41
8	69.57	79.56
9	74.09	81.71
10	78.60	83.87
11	83.11	86.03
12	87.61	88.20
13	92.11	90.38
14	96.61	92.56
15	101.11	94.75
16	105.60	96.94
17	110.09	99.14
18	114.57	101.35
19	119.06	103.57
20	122.40	105.22

Circle Center At X = ****** ; Y = 3315.3 and Radius, 3583.3

*** 1.151 ***

1

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.47	54.74
2	14.46	55.11
3	19.43	55.63
4	24.39	56.27
5	29.33	57.06
6	34.24	57.98
7	39.13	59.03
8	43.99	60.22
9	48.81	61.54
10	53.59	63.00
11	58.34	64.58
12	63.03	66.29
13	67.68	68.14
14	72.28	70.10

15	76.82	72.20
16	81.30	74.42
17	85.72	76.76
18	90.07	79.22
19	94.36	81.80
20	98.57	84.49
21	102.70	87.30
22	106.76	90.22
23	110.73	93.26
24	114.63	96.40
25	118.43	99.64
26	122.14	102.99
27	123.69	104.47

Circle Center At X = -1.7 ; Y = 236.5 and Radius, 182.2

*** 1.160 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.05	67.28
2	45.61	69.33
3	50.17	71.39
4	54.72	73.46
5	59.27	75.54
6	63.81	77.63
7	68.35	79.73
8	72.88	81.84
9	77.41	83.95
10	81.94	86.08
11	86.46	88.21
12	90.98	90.36
13	95.49	92.51
14	100.00	94.67
15	104.50	96.84
16	109.00	99.02
17	113.50	101.21
18	117.99	103.41
19	122.07	105.41

Circle Center At X = -973.3 ; Y = 2327.3 and Radius, 2477.3

*** 1.172 ***

1

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	31.58	59.48
2	36.51	60.30
3	41.42	61.26
4	46.30	62.36
5	51.14	63.58
6	55.95	64.95
7	60.73	66.44
8	65.45	68.07
9	70.14	69.82
10	74.77	71.71
11	79.35	73.72
12	83.87	75.85
13	88.33	78.11
14	92.72	80.49
15	97.05	83.00
16	101.31	85.62
17	105.49	88.36
18	109.60	91.21
19	113.63	94.17
20	117.57	97.25
21	121.43	100.43
22	125.11	103.64

Circle Center At X = 4.2 ; Y = 238.6 and Radius, 181.2

*** 1.180 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.05	67.28
2	45.73	69.05
3	50.39	70.86
4	55.04	72.71
5	59.67	74.59
6	64.29	76.50
7	68.89	78.45
8	73.48	80.44
9	78.06	82.46
10	82.61	84.51
11	87.16	86.60
12	91.68	88.73
13	96.19	90.89
14	100.68	93.08
15	105.16	95.31
16	109.62	97.57
17	114.06	99.86
18	118.49	102.19
19	122.89	104.55
20	123.23	104.74

Circle Center At X = -189.1 ; Y = 681.0 and Radius, 655.4

*** 1.191 ***

1

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	59.48
2	36.17	61.47
3	40.75	63.46
4	45.33	65.47
5	49.91	67.48
6	54.49	69.49
7	59.06	71.51
8	63.63	73.54
9	68.20	75.58
10	72.76	77.62
11	77.32	79.66
12	81.88	81.71
13	86.44	83.77
14	90.99	85.84
15	95.54	87.91
16	100.09	89.99
17	104.64	92.07
18	109.18	94.16
19	113.72	96.26
20	118.26	98.36
21	122.79	100.46
22	127.11	102.48

Circle Center At X = ****** ; Y = 3448.6 and Radius, 3693.5

*** 1.196 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.21	69.88
2	48.78	71.91
3	53.34	73.95
4	57.91	76.00
5	62.47	78.04
6	67.03	80.10
7	71.59	82.15
8	76.14	84.22
9	80.69	86.28
10	85.24	88.35
11	89.79	90.43
12	94.34	92.51
13	98.88	94.59
14	103.43	96.68
15	107.97	98.78
16	112.50	100.88

```
    17          117.04        102.98
    18          121.57        105.09
    19          122.16        105.36

Circle Center At X = ****** ; Y = 4543.1  and Radius, 4895.6

      ***       1.210     ***


1

           Y            A     X     I     S            F     T

          0.00      27.50     55.00     82.50    110.00    137.50

X      0.00 +---------+-------*-+---------+---------+---------+
            -                ..3
            -              ....35
            -             .....35.
            -            ......35*
            -           ........3.
      27.50 +          .........35
            -          ..........*2
            -         ...........3214
            -         ...........3714
            -        .............3714.
            -        .............53.14.
A     55.00 +        ..............37184..
            -        ..............53*140..
            -        ...............37.14...*
            -        ................3.914..
            -         ...............53.124..
            -         ................53.146..          *
X     82.50 +         .................53.14..
            -          .................53911..
            -          ..................53914.         *
            -           ..................3.914.        *
            -            ..................3521..
            -             ..................7321.
I    110.00 +              ..................7321.
            -               ..................7321.
            -                ..................7321
            -                 ...................21
            -                  ..................9
            -                    ................
S    137.50 +                      ..............
            -                        ...........
            -                           .......
            -                               ..
            -
            -
     165.00 +
            -
            -
            -
            -
            -
F    192.50 +
            -
            -
```

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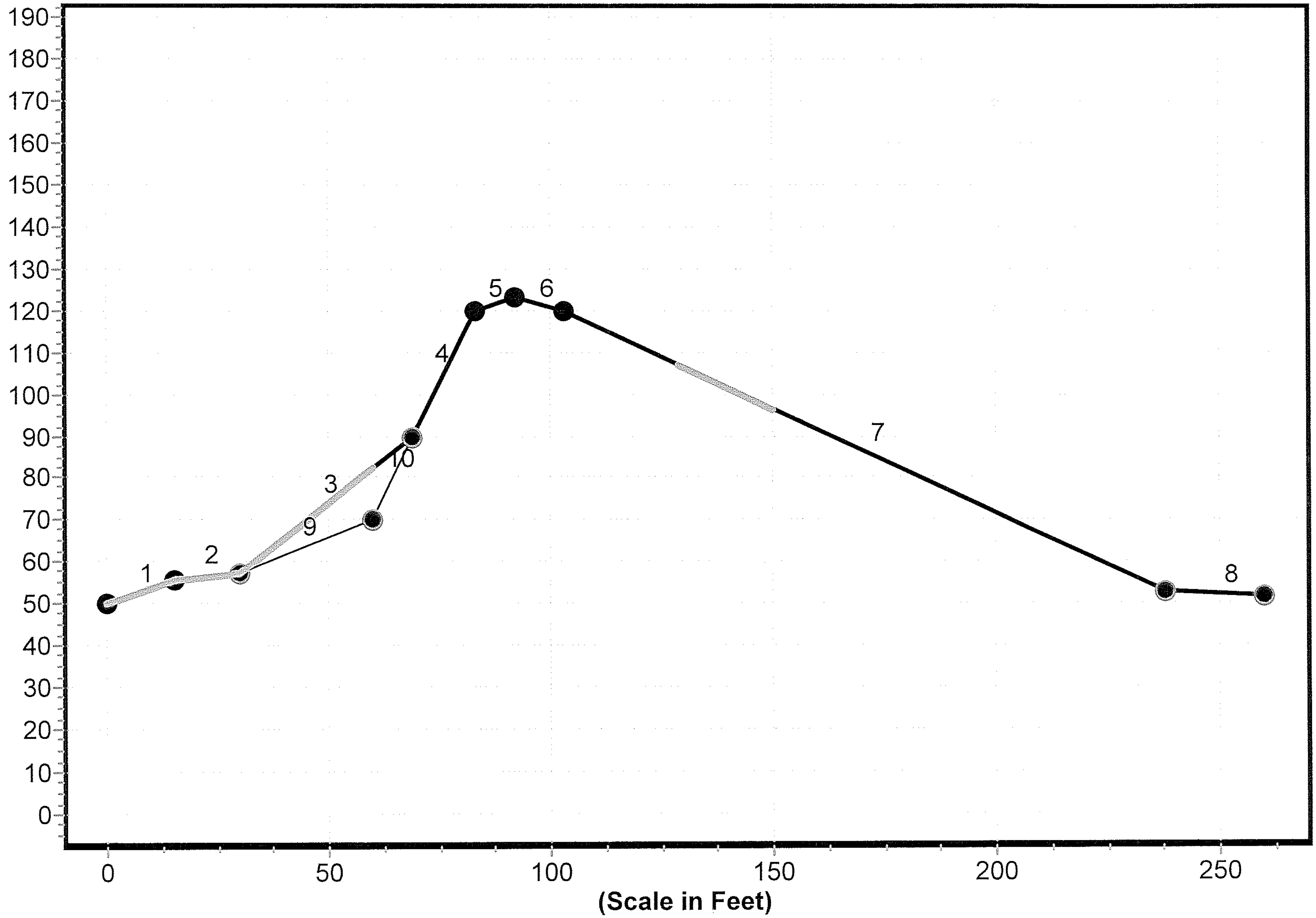
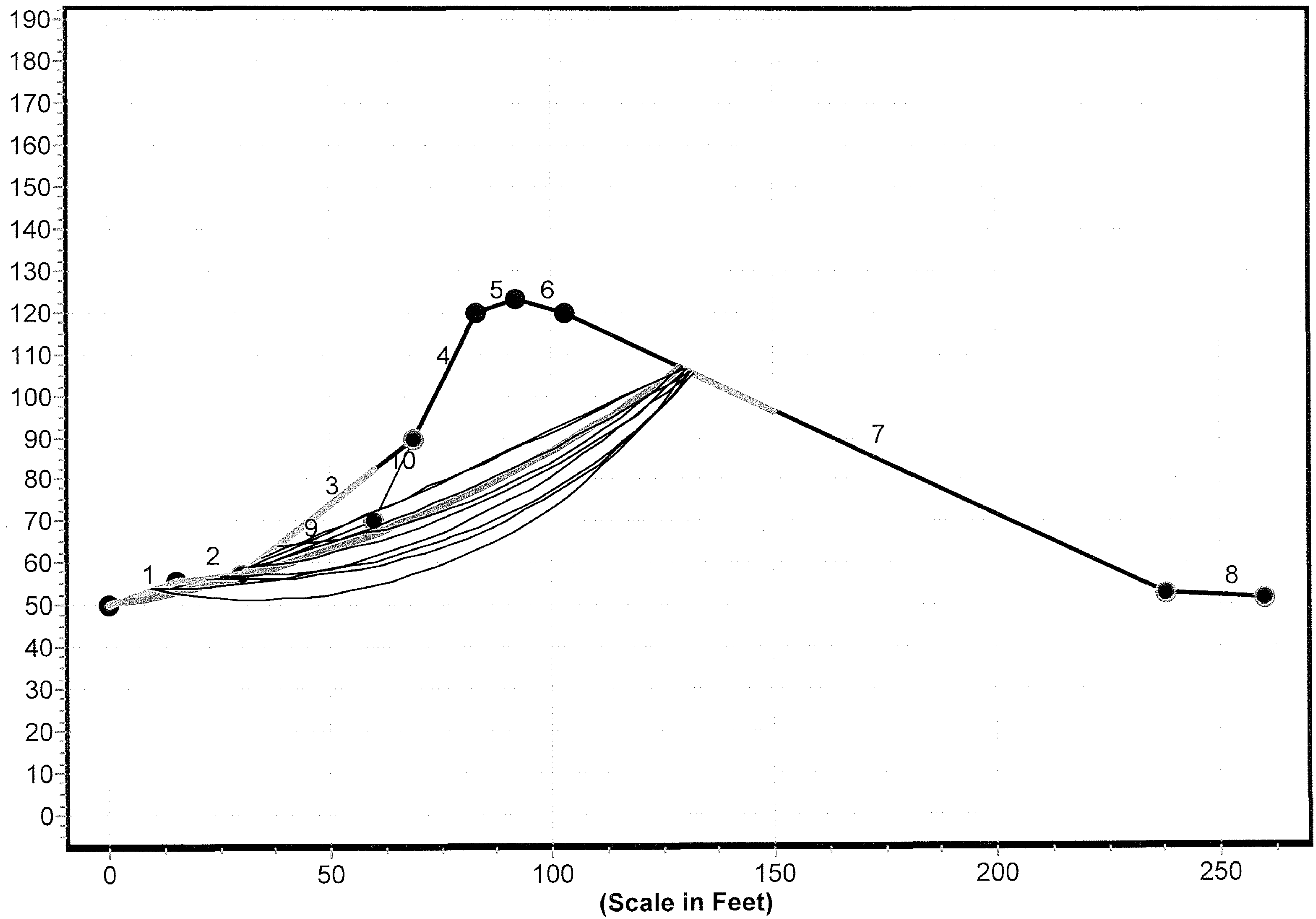
           -                    *
           -
           -
T   220.00 +                    *
```

Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile B-B'

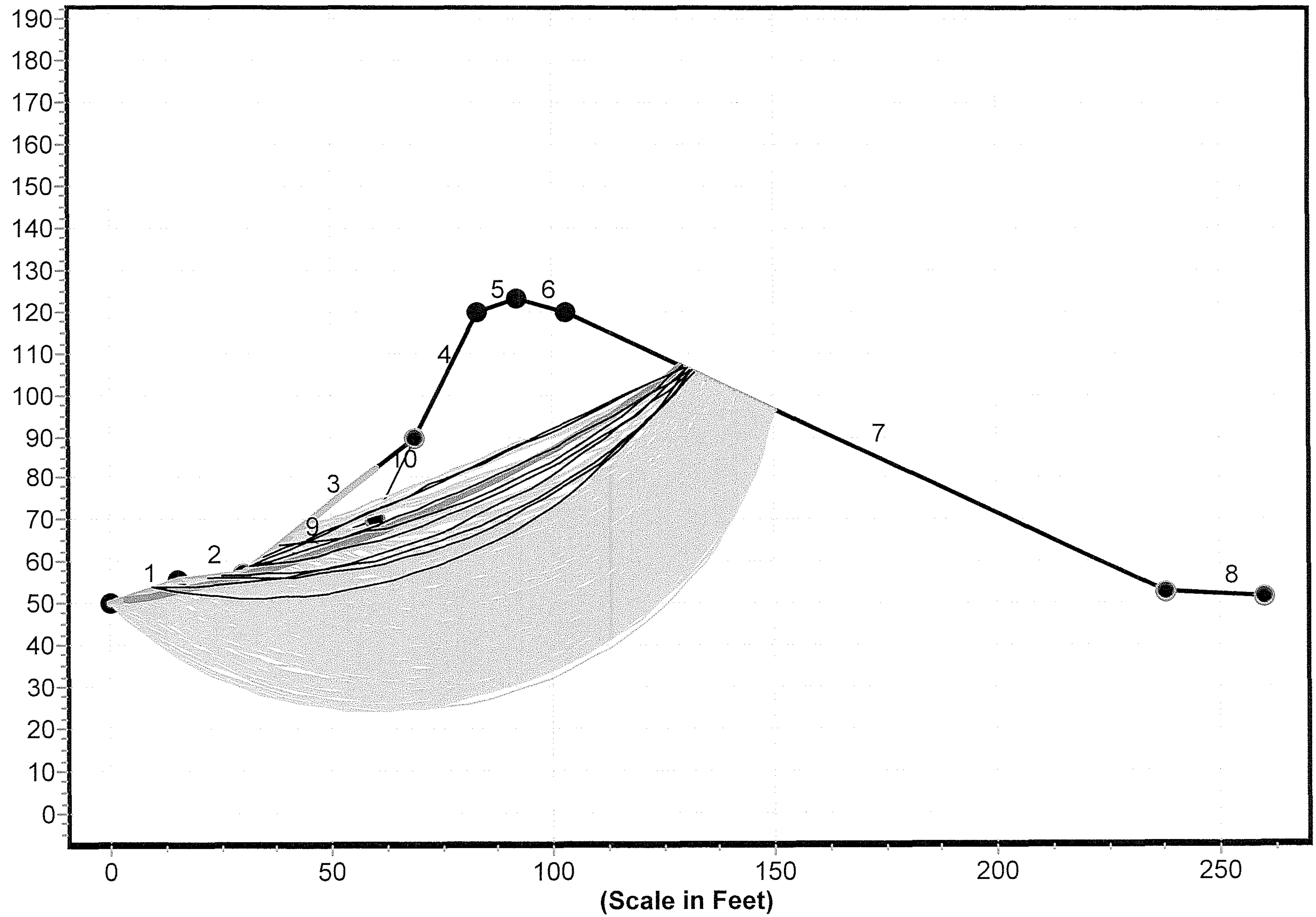


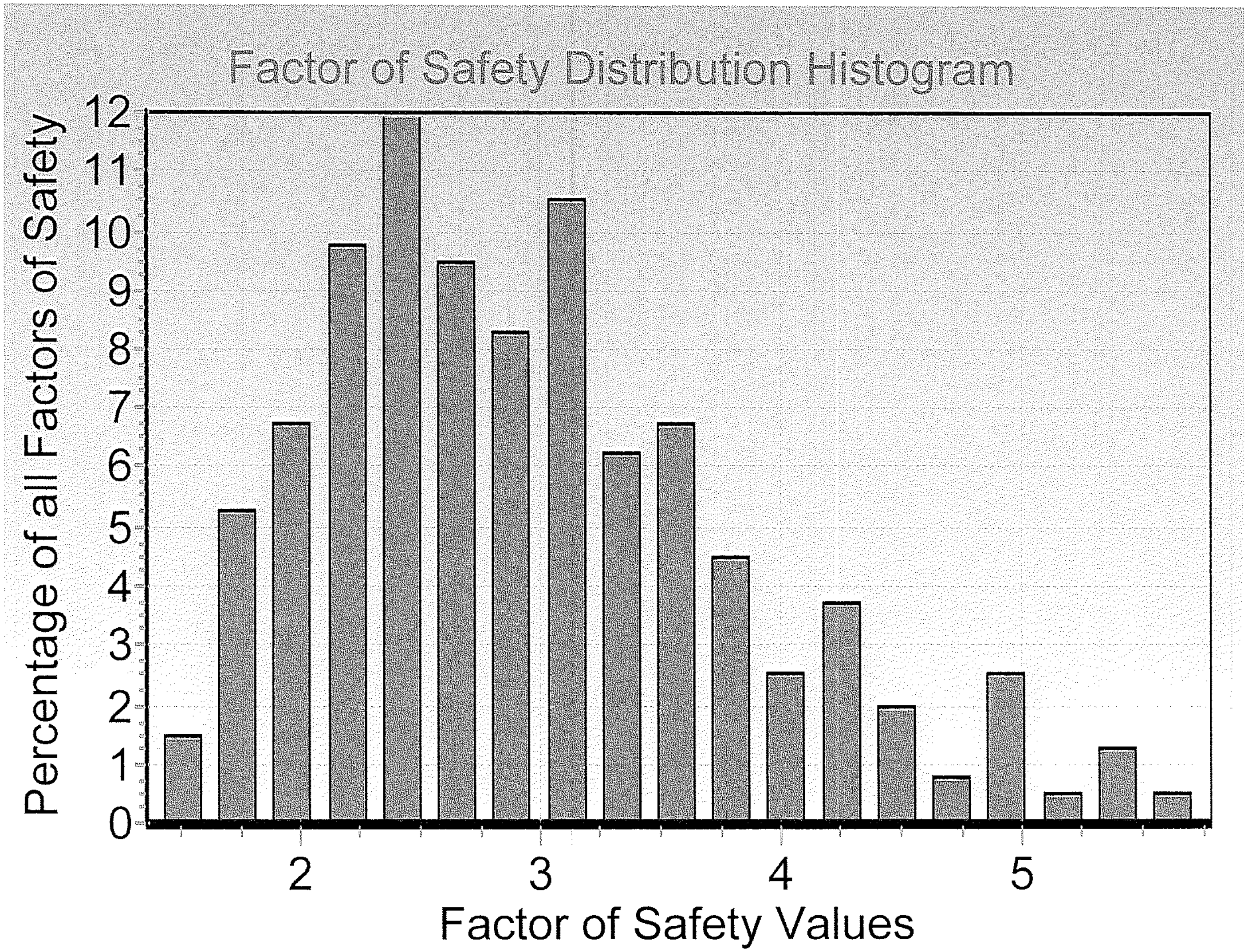
Geometry and Boundary Conditions

Problem: Eagle Hill Road Profile B-B' Static - FS Min = 1.557



Geometry and Boundary Conditions
Problem: Eagle Hill Road Profile B-B' Static - FS Min = 1.557





Factor of Safety Distribution Histogram
Percentage of all Factors of Safety
12
11
10
9
8
7
6
5
4
3
2
1
0
2
3
4
5
Factor of Safety Values

** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Eagle Hill Road Profile B-B' Static

BOUNDARY COORDINATES

8 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	50.00	15.00	56.00	1
2	15.00	56.00	30.00	57.50	1
3	30.00	57.50	69.00	90.00	2
4	69.00	90.00	83.00	120.00	1
5	83.00	120.00	92.00	123.00	1
6	92.00	123.00	103.00	120.00	1
7	103.00	120.00	238.00	53.00	1
8	238.00	53.00	260.00	52.00	1
9	30.00	57.50	60.00	70.00	1
10	60.00	70.00	69.00	90.00	1

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	108.0	108.0	100.0	36.0	0.00	0.0	0
2	108.0	108.0	50.0	30.0	0.00	0.0	0

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 0.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 129.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.16	51.26
2	8.08	52.15
3	12.99	53.11
4	17.87	54.17
5	22.74	55.31
6	27.59	56.55
7	32.41	57.86
8	37.21	59.26
9	41.98	60.75
10	46.73	62.32
11	51.45	63.98
12	56.13	65.72
13	60.79	67.55
14	65.41	69.45
15	70.00	71.44
16	74.55	73.51
17	79.06	75.67
18	83.54	77.90
19	87.97	80.21
20	92.36	82.60
21	96.71	85.07

22	101.01	87.61
23	105.27	90.23
24	109.48	92.93
25	113.64	95.70
26	117.75	98.55
27	121.81	101.47
28	125.82	104.46
29	129.14	107.03

Circle Center At X = -43.8 ; Y = 327.6 and Radius, 280.3

*** 1.557 ***

Individual data on the 35 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.9	288.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	4.9	838.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	2.0	492.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	2.9	708.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	4.9	939.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	4.8	568.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	2.4	131.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.4	252.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	4.8	1526.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	4.8	2829.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	4.7	4062.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	4.7	5223.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	4.7	6313.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	3.9	6017.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.8	1314.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	4.6	8277.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	3.6	7083.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	1.0	2137.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	4.6	12058.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	4.5	15663.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	3.9	16644.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.5	2450.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	4.4	20045.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	4.0	17855.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.4	1578.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	4.3	18068.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	4.3	16169.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	2.0	6875.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	2.3	7334.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	4.2	11933.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	4.2	9632.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	4.1	7358.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	4.1	5113.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	4.0	2901.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	3.3	755.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.47	53.79
2	14.47	53.86
3	19.47	54.08
4	24.46	54.45
5	29.43	54.97
6	34.38	55.65
7	39.31	56.47
8	44.22	57.44
9	49.09	58.57
10	53.93	59.84
11	58.72	61.25
12	63.47	62.81
13	68.17	64.52
14	72.82	66.36
15	77.41	68.35
16	81.93	70.48
17	86.39	72.74
18	90.78	75.13
19	95.10	77.66
20	99.33	80.32
21	103.48	83.10
22	107.55	86.01
23	111.52	89.05
24	115.41	92.20
25	119.19	95.47
26	122.87	98.85
27	126.45	102.34
28	129.92	105.94
29	130.36	106.42

Circle Center At X = 9.7 ; Y = 218.4 and Radius, 164.6

*** 1.575 ***

1

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	58.82
2	36.10	60.96
3	40.61	63.10
4	45.13	65.25
5	49.64	67.41
6	54.15	69.56
7	58.66	71.73
8	63.16	73.90
9	67.67	76.07
10	72.17	78.25
11	76.67	80.43
12	81.16	82.62
13	85.66	84.81
14	90.15	87.01
15	94.64	89.21

16	99.12	91.41
17	103.61	93.62
18	108.09	95.84
19	112.57	98.06
20	117.05	100.29
21	121.52	102.51
22	126.00	104.75
23	129.85	106.68

Circle Center At X = ****** ; Y = 4388.7 and Radius, 4789.9

*** 1.576 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	34.74	61.45
2	39.35	63.38
3	43.95	65.33
4	48.55	67.30
5	53.13	69.30
6	57.71	71.32
7	62.27	73.36
8	66.82	75.42
9	71.37	77.51
10	75.90	79.62
11	80.42	81.75
12	84.93	83.91
13	89.44	86.09
14	93.93	88.29
15	98.40	90.51
16	102.87	92.75
17	107.33	95.02
18	111.77	97.31
19	116.21	99.62
20	120.63	101.95
21	125.04	104.31
22	129.44	106.69
23	129.62	106.79

Circle Center At X = -350.1 ; Y = 988.9 and Radius, 1004.2

*** 1.587 ***

1

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	58.82

2	36.35	60.31
3	41.11	61.86
4	45.84	63.47
5	50.55	65.15
6	55.24	66.89
7	59.90	68.68
8	64.54	70.54
9	69.16	72.46
10	73.75	74.45
11	78.32	76.49
12	82.85	78.59
13	87.36	80.75
14	91.84	82.97
15	96.29	85.24
16	100.71	87.58
17	105.11	89.97
18	109.46	92.42
19	113.79	94.93
20	118.08	97.49
21	122.34	100.11
22	126.56	102.79
23	130.75	105.52
24	131.36	105.93

Circle Center At X = -79.6 ; Y = 423.5 and Radius, 381.2

*** 1.607 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	58.82
2	36.52	59.59
3	41.44	60.50
4	46.33	61.54
5	51.19	62.71
6	56.02	64.00
7	60.81	65.43
8	65.56	66.98
9	70.28	68.65
10	74.94	70.45
11	79.56	72.37
12	84.12	74.42
13	88.63	76.58
14	93.07	78.86
15	97.46	81.26
16	101.78	83.78
17	106.04	86.41
18	110.22	89.15
19	114.32	92.00
20	118.35	94.96
21	122.31	98.02
22	126.17	101.19
23	129.96	104.46
24	131.49	105.86

Circle Center At X = 4.8 ; Y = 245.3 and Radius, 188.4

*** 1.615 ***

1

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.90	64.08
2	42.87	64.60
3	47.82	65.28
4	52.75	66.14
5	57.64	67.16
6	62.50	68.35
7	67.31	69.70
8	72.08	71.22
9	76.78	72.90
10	81.43	74.74
11	86.02	76.74
12	90.53	78.89
13	94.97	81.20
14	99.32	83.65
15	103.59	86.25
16	107.77	89.00
17	111.85	91.89
18	115.83	94.92
19	119.71	98.08
20	123.47	101.37
21	127.12	104.79
22	129.28	106.96

Circle Center At X = 25.3 ; Y = 209.8 and Radius, 146.2

*** 1.638 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.47	53.79
2	14.39	52.89
3	19.35	52.20
4	24.32	51.74
5	29.32	51.48
6	34.32	51.45
7	39.31	51.64
8	44.30	52.04
9	49.26	52.66
10	54.19	53.50
11	59.08	54.55

12	63.91	55.81
13	68.69	57.28
14	73.40	58.96
15	78.03	60.85
16	82.58	62.93
17	87.03	65.21
18	91.37	67.68
19	95.61	70.34
20	99.72	73.18
21	103.71	76.20
22	107.56	79.39
23	111.27	82.74
24	114.83	86.26
25	118.23	89.92
26	121.47	93.73
27	124.53	97.68
28	127.43	101.76
29	130.14	105.96
30	130.40	106.40

Circle Center At X = 32.6 ; Y = 166.0 and Radius, 114.6

*** 1.665 ***

1

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	22.11	56.71
2	27.10	56.38
3	32.09	56.26
4	37.09	56.33
5	42.09	56.61
6	47.06	57.09
7	52.02	57.78
8	56.94	58.66
9	61.82	59.74
10	66.65	61.02
11	71.43	62.49
12	76.15	64.15
13	80.79	66.00
14	85.36	68.04
15	89.83	70.27
16	94.22	72.67
17	98.50	75.25
18	102.68	78.00
19	106.74	80.91
20	110.68	83.99
21	114.49	87.22
22	118.17	90.61
23	121.71	94.14
24	125.10	97.82
25	128.35	101.62
26	131.43	105.56
27	131.61	105.80

```
 Circle Center At X =   32.7 ; Y =  179.8  and Radius,  123.5

       ***      1.665    ***
```

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.26	57.03
2	30.26	56.98
3	35.26	57.12
4	40.25	57.44
5	45.22	57.95
6	50.18	58.65
7	55.10	59.53
8	59.98	60.59
9	64.83	61.83
10	69.62	63.26
11	74.36	64.86
12	79.03	66.64
13	83.63	68.59
14	88.16	70.71
15	92.61	73.00
16	96.96	75.45
17	101.23	78.06
18	105.39	80.84
19	109.44	83.76
20	113.39	86.83
21	117.21	90.05
22	120.92	93.41
23	124.49	96.91
24	127.93	100.53
25	131.24	104.29
26	132.23	105.50

```
 Circle Center At X =   29.1 ; Y =  190.8  and Radius,  133.9

       ***      1.667    ***

1

                Y            A      X      I      S             F      T

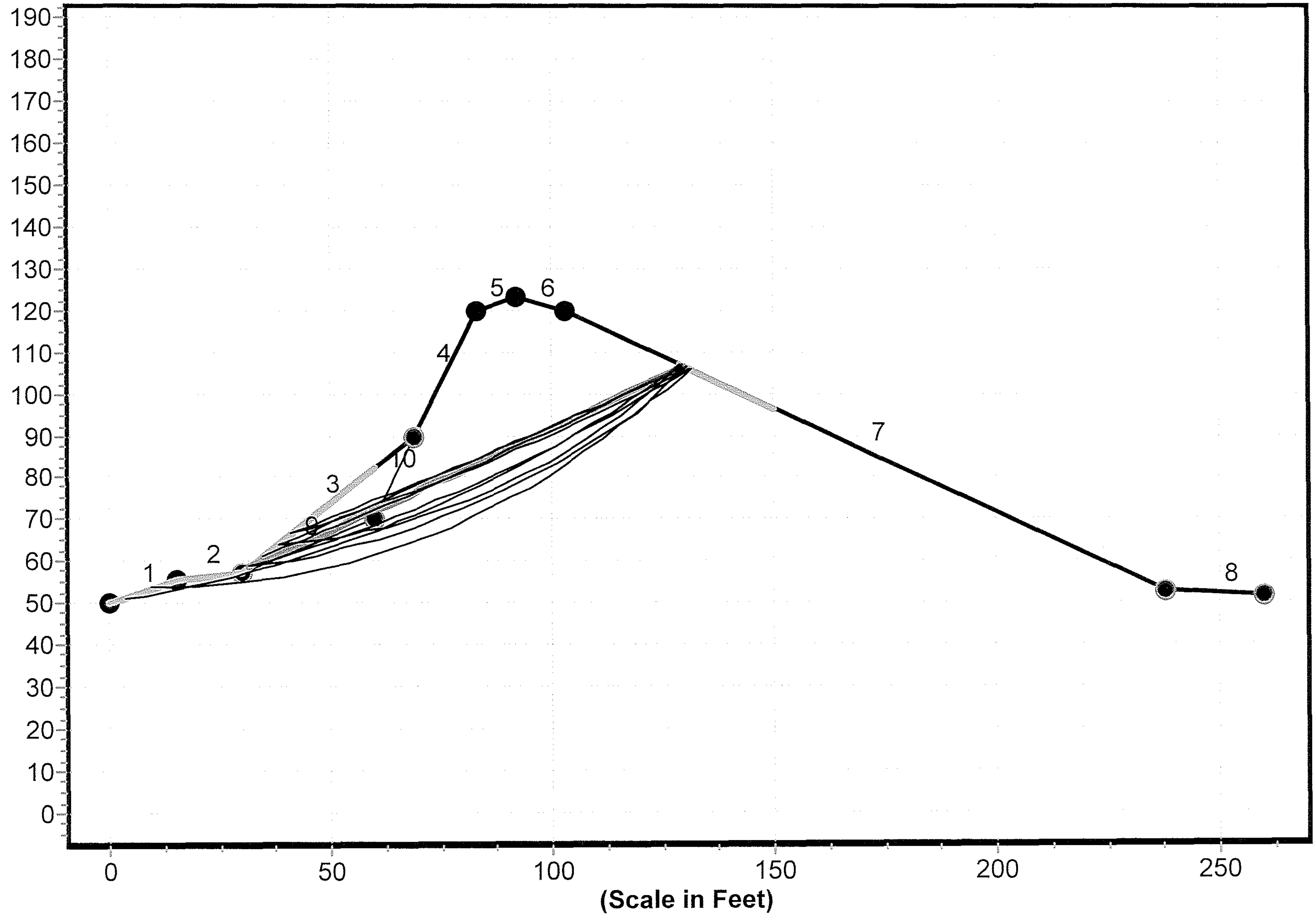
                 0.00     32.50     65.00     97.50    130.00    162.50

 X        0.00 +---------+----*----+---------+---------+---------+
               -           ...1
               -          ....12
               -         .....8*
               -        ......81
               -       .......810
         32.50 +       .......82*4
               -      ........82134
```

```
            -       ........89213.
            -       ........8.2113..
            -       ........8.2.13....
            -       .........89261*4..
A     65.00 +       .........8.2.153..
            -       ..........89261.3..  *
            -       ..........88926143.
            -       ...........8902113..         *
            -       ............8926613..
            -        ............8926143.         *
X     97.50 +        .............88221.3.
            -          ............8902113       *
            -          .............892651.
            -           .............8.22134
            -            ...............82113
            -              ...............221
I    130.00 +               ...............851
            -                 ...............
            -                    ............
            -                      .........
            -                           ...
            -
S    162.50 +
            -
            -
            -
            -
            -
     195.00 +
            -
            -
            -
            -
            -
F    227.50 +
            -
            -               *
            -
            -
            -
T    260.00 +               *
```

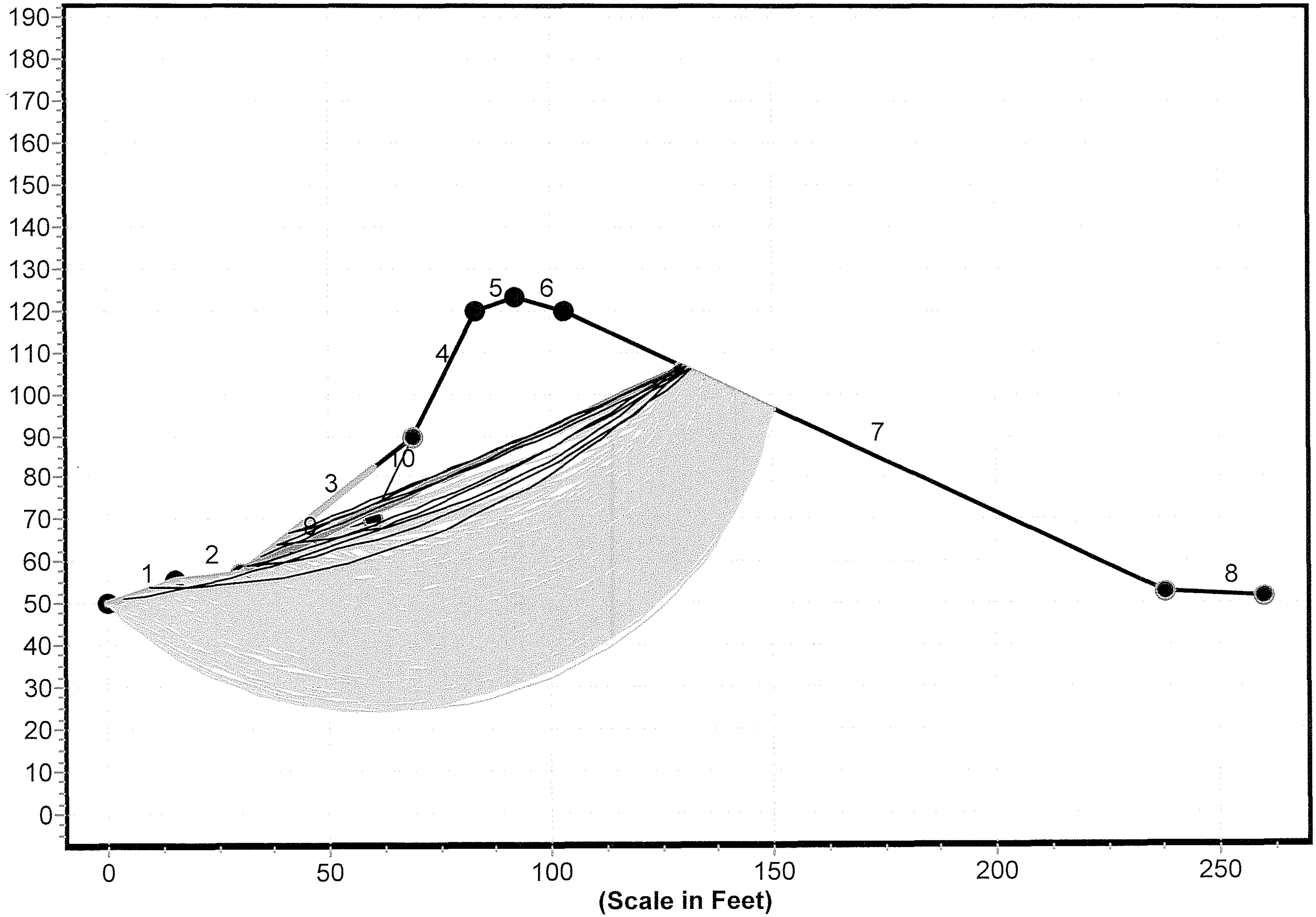
Geometry and Boundary Conditions

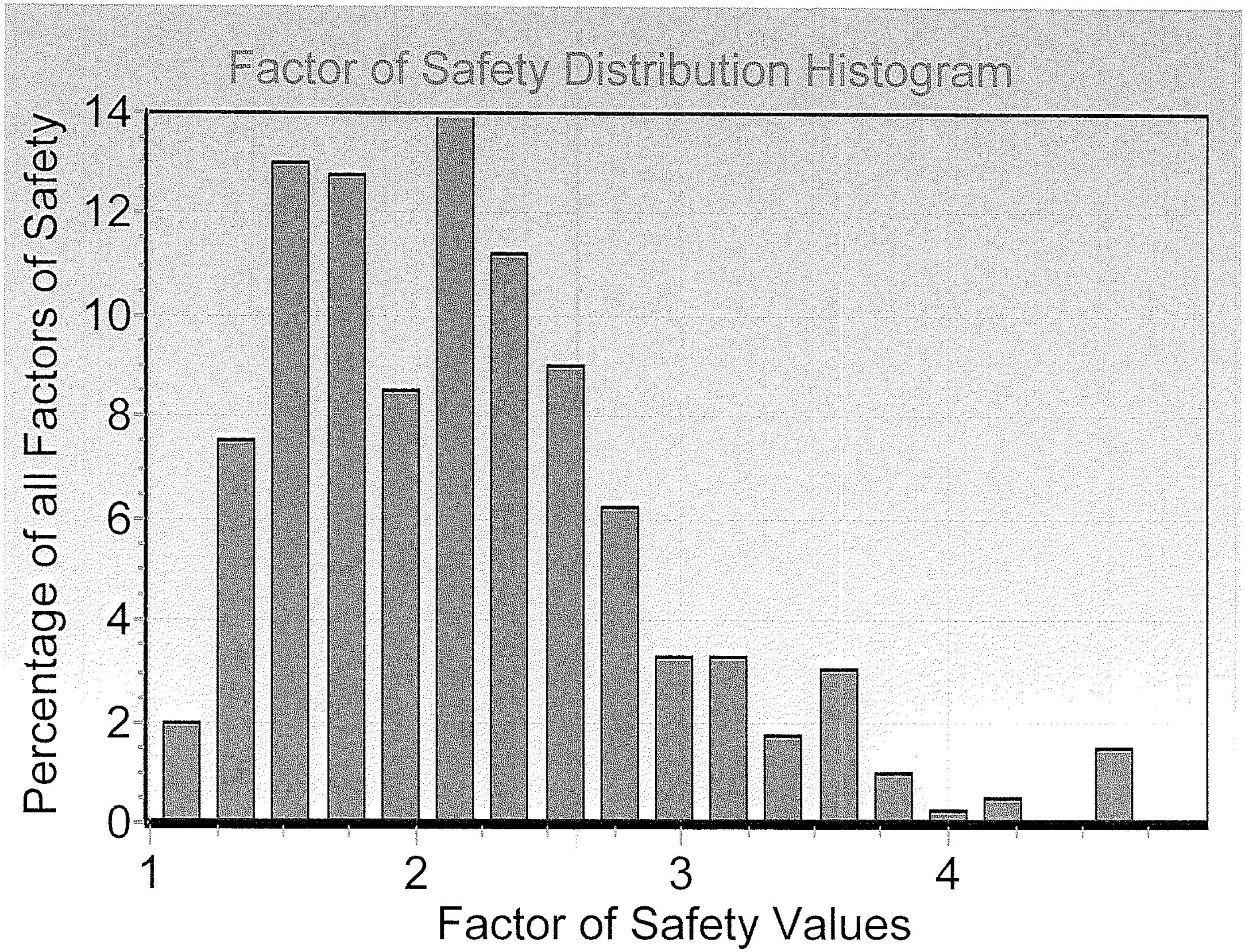
Problem: Eagle Hill Road Profile B-B' Seismic - FS Min = 1.125



Geometry and Boundary Conditions

Problem: Eagle Hill Road Profile B-B' Seismic - FS Min = 1.125




Factor of Safety Distribution Histogram
Percentage of all Factors of Safety
0
2
4
6
8
10
12
14
1
2
3
4
Factor of Safety Values

** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Eagle Hill Road Profile B-B' Seismic

BOUNDARY COORDINATES

8 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	50.00	15.00	56.00	1
2	15.00	56.00	30.00	57.50	1
3	30.00	57.50	69.00	90.00	2
4	69.00	90.00	83.00	120.00	1
5	83.00	120.00	92.00	123.00	1
6	92.00	123.00	103.00	120.00	1
7	103.00	120.00	238.00	53.00	1
8	238.00	53.00	260.00	52.00	1
9	30.00	57.50	60.00	70.00	1
10	60.00	70.00	69.00	90.00	1

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	108.0	108.0	100.0	36.0	0.00	0.0	0
2	108.0	108.0	50.0	30.0	0.00	0.0	0

A Horizontal Earthquake Loading Coefficient
Of0.150 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 (psf)

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 0.00 ft.
and X = 60.00 ft.

Each Surface Terminates Between X = 129.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	58.82
2	36.10	60.96
3	40.61	63.10
4	45.13	65.25
5	49.64	67.41
6	54.15	69.56
7	58.66	71.73
8	63.16	73.90
9	67.67	76.07
10	72.17	78.25
11	76.67	80.43

12	81.16	82.62
13	85.66	84.81
14	90.15	87.01
15	94.64	89.21
16	99.12	91.41
17	103.61	93.62
18	108.09	95.84
19	112.57	98.06
20	117.05	100.29
21	121.52	102.51
22	126.00	104.75
23	129.85	106.68

Circle Center At X = ****** ; Y = 4388.7 and Radius, 4789.9

*** 1.125 ***

Individual data on the 27 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.5	396.6	0.0	0.0	0.0	0.0	59.5	0.0	0.0
2	4.5	1187.7	0.0	0.0	0.0	0.0	178.2	0.0	0.0
3	4.5	1974.7	0.0	0.0	0.0	0.0	296.2	0.0	0.0
4	4.5	2757.8	0.0	0.0	0.0	0.0	413.7	0.0	0.0
5	4.5	3536.8	0.0	0.0	0.0	0.0	530.5	0.0	0.0
6	4.5	4311.9	0.0	0.0	0.0	0.0	646.8	0.0	0.0
7	2.7	2959.6	0.0	0.0	0.0	0.0	443.9	0.0	0.0
8	1.8	2123.4	0.0	0.0	0.0	0.0	318.5	0.0	0.0
9	4.5	5850.1	0.0	0.0	0.0	0.0	877.5	0.0	0.0
10	1.3	1879.3	0.0	0.0	0.0	0.0	281.9	0.0	0.0
11	3.2	5443.4	0.0	0.0	0.0	0.0	816.5	0.0	0.0
12	4.5	10818.5	0.0	0.0	0.0	0.0	1622.8	0.0	0.0
13	4.5	14431.8	0.0	0.0	0.0	0.0	2164.8	0.0	0.0
14	1.8	6940.0	0.0	0.0	0.0	0.0	1041.0	0.0	0.0
15	2.7	10407.3	0.0	0.0	0.0	0.0	1561.1	0.0	0.0
16	4.5	17330.3	0.0	0.0	0.0	0.0	2599.6	0.0	0.0
17	1.9	7047.9	0.0	0.0	0.0	0.0	1057.2	0.0	0.0
18	2.6	9705.6	0.0	0.0	0.0	0.0	1455.8	0.0	0.0
19	4.5	15196.0	0.0	0.0	0.0	0.0	2279.4	0.0	0.0
20	3.9	11787.6	0.0	0.0	0.0	0.0	1768.1	0.0	0.0
21	0.6	1733.9	0.0	0.0	0.0	0.0	260.1	0.0	0.0
22	4.5	11547.3	0.0	0.0	0.0	0.0	1732.1	0.0	0.0
23	4.5	9392.2	0.0	0.0	0.0	0.0	1408.8	0.0	0.0
24	4.5	7237.6	0.0	0.0	0.0	0.0	1085.6	0.0	0.0
25	4.5	5083.5	0.0	0.0	0.0	0.0	762.5	0.0	0.0
26	4.5	2929.9	0.0	0.0	0.0	0.0	439.5	0.0	0.0
27	3.8	797.7	0.0	0.0	0.0	0.0	119.7	0.0	0.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	34.74	61.45

2	39.35	63.38
3	43.95	65.33
4	48.55	67.30
5	53.13	69.30
6	57.71	71.32
7	62.27	73.36
8	66.82	75.42
9	71.37	77.51
10	75.90	79.62
11	80.42	81.75
12	84.93	83.91
13	89.44	86.09
14	93.93	88.29
15	98.40	90.51
16	102.87	92.75
17	107.33	95.02
18	111.77	97.31
19	116.21	99.62
20	120.63	101.95
21	125.04	104.31
22	129.44	106.69
23	129.62	106.79

Circle Center At X = -350.1 ; Y = 988.9 and Radius, 1004.2

*** 1.135 ***

1

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.16	51.26
2	8.08	52.15
3	12.99	53.11
4	17.87	54.17
5	22.74	55.31
6	27.59	56.55
7	32.41	57.86
8	37.21	59.26
9	41.98	60.75
10	46.73	62.32
11	51.45	63.98
12	56.13	65.72
13	60.79	67.55
14	65.41	69.45
15	70.00	71.44
16	74.55	73.51
17	79.06	75.67
18	83.54	77.90
19	87.97	80.21
20	92.36	82.60
21	96.71	85.07
22	101.01	87.61
23	105.27	90.23
24	109.48	92.93
25	113.64	95.70

26	117.75	98.55
27	121.81	101.47
28	125.82	104.46
29	129.14	107.03

Circle Center At X = -43.8 ; Y = 327.6 and Radius, 280.3

*** 1.144 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	58.82
2	36.35	60.31
3	41.11	61.86
4	45.84	63.47
5	50.55	65.15
6	55.24	66.89
7	59.90	68.68
8	64.54	70.54
9	69.16	72.46
10	73.75	74.45
11	78.32	76.49
12	82.85	78.59
13	87.36	80.75
14	91.84	82.97
15	96.29	85.24
16	100.71	87.58
17	105.11	89.97
18	109.46	92.42
19	113.79	94.93
20	118.08	97.49
21	122.34	100.11
22	126.56	102.79
23	130.75	105.52
24	131.36	105.93

Circle Center At X = -79.6 ; Y = 423.5 and Radius, 381.2

*** 1.161 ***

1

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.47	53.79
2	14.47	53.86
3	19.47	54.08
4	24.46	54.45

5	29.43	54.97
6	34.38	55.65
7	39.31	56.47
8	44.22	57.44
9	49.09	58.57
10	53.93	59.84
11	58.72	61.25
12	63.47	62.81
13	68.17	64.52
14	72.82	66.36
15	77.41	68.35
16	81.93	70.48
17	86.39	72.74
18	90.78	75.13
19	95.10	77.66
20	99.33	80.32
21	103.48	83.10
22	107.55	86.01
23	111.52	89.05
24	115.41	92.20
25	119.19	95.47
26	122.87	98.85
27	126.45	102.34
28	129.92	105.94
29	130.36	106.42

Circle Center At X = 9.7 ; Y = 218.4 and Radius, 164.6

*** 1.175 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.90	64.08
2	42.47	66.10
3	47.04	68.13
4	51.61	70.16
5	56.17	72.20
6	60.73	74.25
7	65.29	76.31
8	69.84	78.37
9	74.40	80.44
10	78.94	82.52
11	83.49	84.60
12	88.03	86.69
13	92.57	88.79
14	97.11	90.89
15	101.64	93.00
16	106.17	95.12
17	110.69	97.25
18	115.22	99.38
19	119.73	101.52
20	124.25	103.67
21	128.76	105.82
22	130.19	106.50

Circle Center At X = ****** ; Y = 3053.4 and Radius, 3267.1

*** 1.185 ***

1

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	31.58	58.82
2	36.52	59.59
3	41.44	60.50
4	46.33	61.54
5	51.19	62.71
6	56.02	64.00
7	60.81	65.43
8	65.56	66.98
9	70.28	68.65
10	74.94	70.45
11	79.56	72.37
12	84.12	74.42
13	88.63	76.58
14	93.07	78.86
15	97.46	81.26
16	101.78	83.78
17	106.04	86.41
18	110.22	89.15
19	114.32	92.00
20	118.35	94.96
21	122.31	98.02
22	126.17	101.19
23	129.96	104.46
24	131.49	105.86

Circle Center At X = 4.8 ; Y = 245.3 and Radius, 188.4

*** 1.187 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.90	64.08
2	42.87	64.60
3	47.82	65.28
4	52.75	66.14
5	57.64	67.16
6	62.50	68.35
7	67.31	69.70
8	72.08	71.22
9	76.78	72.90

10	81.43	74.74
11	86.02	76.74
12	90.53	78.89
13	94.97	81.20
14	99.32	83.65
15	103.59	86.25
16	107.77	89.00
17	111.85	91.89
18	115.83	94.92
19	119.71	98.08
20	123.47	101.37
21	127.12	104.79
22	129.28	106.96

Circle Center At X = 25.3 ; Y = 209.8 and Radius, 146.2

*** 1.210 ***

1

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.05	66.71
2	45.69	68.59
3	50.31	70.49
4	54.93	72.40
5	59.55	74.33
6	64.15	76.27
7	68.75	78.23
8	73.35	80.20
9	77.94	82.19
10	82.52	84.19
11	87.09	86.21
12	91.66	88.24
13	96.22	90.29
14	100.78	92.35
15	105.33	94.43
16	109.87	96.52
17	114.40	98.63
18	118.93	100.75
19	123.45	102.89
20	127.96	105.04
21	130.59	106.31

Circle Center At X = -527.9 ; Y = 1474.5 and Radius, 1518.5

*** 1.223 ***

Failure Surface Specified By 21 Coordinate Points

Point X-Surf Y-Surf

No.	(ft)	(ft)
1	41.05	66.71
2	45.80	68.30
3	50.52	69.93
4	55.23	71.60
5	59.93	73.33
6	64.60	75.09
7	69.26	76.91
8	73.91	78.76
9	78.53	80.66
10	83.14	82.61
11	87.72	84.60
12	92.29	86.63
13	96.84	88.71
14	101.37	90.83
15	105.87	93.00
16	110.36	95.21
17	114.82	97.46
18	119.27	99.75
19	123.69	102.09
20	128.08	104.47
21	131.02	106.09

Circle Center At X = -121.3 ; Y = 560.1 and Radius, 519.5

*** 1.224 ***

1

```
            Y           A     X     I     S             F     T

           0.00     32.50     65.00     97.50    130.00    162.50

X       0.00 +---------+----*----+---------+---------+---------+
             -            ...3
             -           ....35
             -          ......*
             -         .......3
             -        ........3.
        32.50 +       ........5*2
             -       .........5312
             -       ..........5319
             -       ..........53319.
             -       ..........5.316...
             -       ...........573*2..
A       65.00 +      ...........5.341..
             -       ............573.1.. *
             -       .............57321.
             -       ..............53316.         *
             -       ..............577316.
             -        ..............57321.         *
X       97.50 +       ...............55301.
             -          ...............5331       *
             -          ...............57416
             -           ...............55312
             -            ................5311
             -              ...............541
I      130.00 +              ................41
```

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            -                 ...............
            -                    ............
            -                      .........
            -                           ...
            -
S    162.50 +
            -
            -
            -
            -
            -
     195.00 +
            -
            -
            -
            -
            -
F    227.50 +
            -
            -               *
            -
            -
            -
T    260.00 +               *
```