SOILS AND FOUNDATION
REPORT NO. 06-07

PROJECT BLRI 2E15
LANDSLIDE REPAIR, MP 270.3

BLUE RIDGE PARKWAY
WILKES COUNTY, NORTH CAROLINA

U.S. Department of Transportation
Federal Highway Administration
Eastern Federal Lands Highway Division
21400 Ridgetop Circle
Sterling, VA 20166

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Note: Design changes subsequent to publication of this report and prior to the project's advertisement will be documented by a memo inserted after the title page.

GEOTECHNICAL
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INTRODUCTION

General

This report presents the results of geotechnical subsurface investigations, design analyses, and summarizes our recommendations for landslide repair for Project BLRI 2E15. The project site is located along the Blue Ridge Parkway at Milepost 270.3 in Wilkes County, North Carolina. The general site location is shown on Figure 1, "Site Location and Vicinity Map," in Appendix A.

Project Description

Project BLRI 2E15 is located in the Highlands District of the Blue Ridge Parkway, approximately 6 miles north of U.S. Route 421 and Deep Gap. The two-lane, asphalt concrete (AC) paved roadway generally runs west to east at this location. The pavement is supported on a deep embankment fill placed for the original roadway. The slope of the embankment fill varies, but averages approximately 1.5(H):1(V) from the crest of the slope to the silt fence. The slope below the silt fence gradually flattens and averages approximately 2(H):1(V).

This project consists of landslide repair along approximately 340 feet of the Parkway, and is located in an area approximately 6 miles north of U.S. Route 421 and Deep Gap. The first mention of an active landslide was reported by NPS staff in the early 1970s. However, it is possible that it was active prior to this date.

Past Corrective Measures

Corrective measures were taken in 1978. This work included removing 3 to 4 feet of pavement/embankment to reduce embankment loads and installing 17 horizontal pipe drains to dewater the embankment. The initial drains were installed in the central and eastern portions of the slide area. After continuing slide movement was observed, five additional horizontal drains were installed in the western slide area in 1981. After these additional drains were installed, the slide stabilized for several years.

The slide was activated again in the late 1980s and another geotechnical investigation was performed in 1990. In 1992, the pavement was repaired and a horizontal drainage gallery

consisting of rock-filled drilled shafts was installed to intercept groundwater and direct it down the slope, beyond the slide area. These drainage columns extended to the top of bedrock. Additional horizontal drains were drilled from part way down the slope to intercept the drainage columns and remove groundwater. These measures appear to have slowed or stabilized the slide for several years, but it was reactivated in 1995 with up to 5 inches of settlement within a two-year period.

An inspection of the landslide was conducted in May 1997 by EFLHD personnel. At that time, of the 16 horizontal drains installed in 1992 as part of the drainage gallery, four (4) were running water and three were dripping. Recommendations were given to seal the pavement cracks and restore the Parkway grade by placing an AC patch. Further recommendations were given to install piezometers to measure water levels and drill into one of the drainage shafts to determine if they were becoming clogged. Piezometers were installed by EFLHD personnel in July 1997. The drainage shaft was not drilled. Another inspection of the 16 horizontal drains (installed in 1992) was conducted in 2000. At that time, two were running water and one was dripping water. The NPS has continued patching cracks as they appear. The project site has been patched recently, as observed during the September 2007 subsurface investigation (geophysics). Observations indicate that subsidence of the Parkway is continuing, along with evidence of some lateral sliding.

Regional Geology

The project site is located within the Blue Ridge Belt. According to the "Geologic Map of North Carolina (1985)," the project site is predominantly underlain by finely laminated to thinly-layered gneiss of the Alligator Back Formation. This deposit locally contains massive gneiss and micaceous granule conglomeration, including schist, phyllite and amphibolite. Refer to Figure 2 in Appendix A for a Geologic Map of the project area.

According to "Soil Survey of Wilkes County, North Carolina (1921)," the project site is predominantly underlain by Talladega Clay Loam. The soil survey describes Talladega Clay Loam as follows: Surface soil is brownish-red to red loam or clay loam, 6 to 10 inches deep. Subsoil is red to brownish-red friable, crumbly, clay loam or clay, extending to 36 inches in depth. The subsoil has a greasy feel, due to the presence of mica scales. This soil is derived from mica schist, mica gneiss, and talc schist, which are frequently encountered at depths of 2 or 3 feet. It occurs at the foot of mountains and on ridge crests. Refer to Figure 3 in Appendix A for a "Soil Survey Map" of the project area.

PROCEDURES AND RESULTS

General

The EFLHD Subsurface Investigation Team has performed several subsurface investigation programs at the project site since the initial slide was observed in the 1970's. Investigation records prior to 1990 are not available.

Investigations from 1990 through 2003 were reproduced into our current boring log format. EFLHD drilled five (5) C-series borings (C-1 through C-5) at the project site from 24 through 28 July 1990. Froehling & Robertson, Inc. drilled twelve (12) FD-series borings (FD-1 and FD-4 through FD-14) from 5 through 7 February 1991. EFLHD drilled four (4) B270-series borings (B270-1 through B270-4) with observation wells from 18 to 31 July 1997, with the intent of analyzing the effectiveness of the horizontal drains at draining the embankment fill. EFLHD drilled three (3) B-series borings (B-1 through B-3) to gather information at mid-slope from 14 through 28 May, 2003. No borings were performed at the toe of the landslide. EFLHD borings were typically advanced with a rotary, track-mounted drill rig and using hollow stem augers. NQ core barrels with a wireline were typically used for rock coring.

Eastern Federal Lands Highway Division (EFLHD) conducted a geophysical refraction survey at the project site on 12 and 13 September, 2007. Three refraction survey lines were performed at the site using a Smartseis S24 System with 24 channels. Geophones were spaced at either 15 or 20 feet, and total geophone array length ranged from 220 to 345 feet. Shots were typically taken at the first sensor, at the midpoint of the sensor array, at the last sensor, and at 10-foot and 20-foot offsets from each end of the array, for a total of 7 shots per line. Shots were produced with a sledgehammer on a striker plate. Blackhawk – a Division of Zapata Engineering of Golden, Colorado, processed the geophysical data collected by EFLHD. Their report, dated October 24, 2007, is included in Appendix D.

Geophysical surveys were conducted in September 2005 for additional subsurface information at the location of proposed cuts and soldier pile wall that was part of the roadway realignment option. EFLHD completed a refraction microtremor (Remi) line on the north side of the roadway. EFLHD also completed 3 seismic refraction lines - Line A along the northern shoulder of the Parkway, and Lines B and C along the proposed cut slopes. Summit Peak Technologies, LLC of Parker, Colorado processed this data using tomographic analysis to create a 3-dimensional subsurface image.

The location of each boring and geophysical survey lines are referenced on “Boring Location Plan and Profile” sheet in Appendix B. Logs of borings are included in Appendix C. Geophysical survey results are included in Appendix D.

Sampling

Information available to us since 1990 indicates that borings were drilled to depths ranging from 16 to 75.5 ft below the existing ground surface. Borings were advanced using hollow stem augers. Standard Penetration Testing was performed using a 2¼-in. (outside diameter) split-spoon sampler in accordance with AASHTO 7200-87 and AASHTO T206-87. SPT soil samples were typically recovered at 5.0 ft intervals by driving the split-spoon sampler a distance of 18 or 24-in. into the undisturbed soil under the impact of a 140 lb. automatic hammer free-falling 30 inches. Continuous sampling was utilized in some borings, and some of the C-series borings have large intervals without any sample. The number of hammer blows required to advance the split-spoon sampler the middle foot of the 24-in. sample interval is designated as the “Standard Penetration Resistance” or N-value. Spoon refusal is defined by 50 blows per 1-inch of penetration of the split-spoon sampler. The

number of blows required to advance the sampler through each 6-in. interval was recorded on field boring logs. Representative portions of split-spoon samples were preserved in glass jars.

Rock coring was performed in Borings C-3, C-4, B-1, and B-2. Rock coring was performed using rotary drilling techniques and samples were retrieved using an NQ core barrel and wireline. Rock core samples were preserved in wooden boxes for laboratory testing.

Water levels, if present, were measured in the boring logs at the time and under the conditions stated on boring logs.

The sampling sequence and associated jar samples for each boring are presented on its appropriate Boring Log in Appendix C.

Field Tests and Measurements

The EFLHD geotechnical crew performed field tests and took measurements during the course of the subsurface exploration.

A field description by color and texture was made for each recovered sample. Percent core recovery (CR) and rock quality designation (RQD) were determined for each core run to provide a quantitative basis for evaluation of the conditions of the rock.

It is not known how the location and elevation of previously completed borings was determined. The September 2007 seismic refraction survey locations were determined through a combination of GPS coordinates and measurements with a tape measure. Seismic refraction survey line elevations were determined by overlaying the refraction lines on the topographic plan, and checking with approximate field measurements made with a hypsometer. The approximate location of borings and refraction survey lines is as shown on the Exploration Location Plan and Profile sheet in Appendix B.

Data Summary

The results of field tests and measurements were recorded on the driller's logs and appropriate data sheet in the field. These data sheets and logs contain information concerning the boring methods; samples attempted and recovered; indications of the presence of various material such as gravel, pebbles, organic matter, etc.; and observations of groundwater. They also contain interpretations by the exploration foreman of the subsurface conditions based on the performance of the equipment and cuttings brought to the surface by the drilling tools. Therefore, the field data represents both factual and interpretative information.

The boring logs in Appendix C of this report represent a compilation of field laboratory data and description of the soil samples by a geotechnical engineer. These records occasionally do not include all data recorded on driller's logs and field data sheets, but do include all information considered relevant to the design and preparation of this report.

Groundwater level readings were made in the boreholes at the times and under the conditions stated on the boring logs. However, fluctuations in groundwater level due to seasonal variations, rainfall, temperature, and other factors not evident at the time measurements were made should be expected.

Laboratory Testing

A laboratory testing program was conducted on representative rock samples recovered during the subsurface explorations. The primary purpose of the testing program was to aid in evaluation of the engineering properties of rock present at the site. Samples were tested for unconfined compressive strength (ASTM 2938). All tests were conducted in accordance with applicable ASTM/AASHTO standard test methods. Note that these samples were tested in 2007, approximately 4 years after collection in the field.

The results of the laboratory testing program are presented in Appendix E and summarized below in Table 1.

Table 1. Summary of Laboratory Test Results

Boring No.	Sample No.	Sample Depth (ft)	Unconfined Compressive Strength (psi)	Description
B-1	1	44.0-44.4	6,220	Gray Mica Schist
B-1	1	46.3-46.7	2,470	Gray Mica Schist
B-2	2	50.2-50.7	5,180	Gray and White Mica Schist
B-2	2	53.6-53.9	4,980	Gray and White Mica Schist
B-2	3	56.7-57.1	1,560	Gray Mica Schist

Findings

C-series borings, 1990

Descriptions of the soil conditions encountered during the subsurface explorations conducted at the site are provided below in order of increasing depth below the ground surface. The stratification lines designating the interfaces between soil types on the boring logs in Appendix C represent approximate boundaries. The transition between materials

may be gradual. It should be noted that one or more of the units may be absent at specific locations.

TOPSOIL – Topsoil was encountered in most borings, ranging in thickness from 0.5 to 1.0 feet.

SILT AND SAND - Brown sand, some silt, some mica, trace gravel, trace to some clay; to brownish gray silt, some fine sand, trace mica, trace black organic silt, with hard layers was encountered at depths of 0.5 to 1.0 feet below ground surface. This deposit included brown clay in boring C-2. N-values recorded within this stratum ranged between 4 to 27 blows per foot (bpf), indicating loose to medium dense soil conditions.

SAPROLITE – Beneath the silt and sand stratum, brown clay, some silt, some mica, trace fine sand; to brown silt, some clay, trace fine sand, trace quartz was encountered to a depth of 21.5 feet. N-values recorded within this stratum ranged between 4 to 21 bpf, indicating loose to medium dense soil conditions.

BEDROCK – Beneath the saprolite, light brown to gray, unweathered to moderately weathered, fine to medium textured, moderately hard to hard, sandstone to micaceous sandstone, with foliation angles of 20 to 55 degrees was encountered in borings C-3 and C-4 at depths of 43.5 to 65.5 feet. RQD values varied from 51 to 100. Refusal on what is presumed to be bedrock was encountered in borings C-1 and C-5 at depths of 41.7 to 53.3 feet.

Groundwater table was encountered in the boring C-2 at a depth of 15 feet bgs.

FD-series borings, 1991

TOPSOIL – Topsoil was encountered at a thickness of 0.6 feet.

SILT AND SAND – Beneath the topsoil, brown to tan silt to gray sand was encountered at a depth of 0.6 feet. N-values recorded within this stratum ranged between 4 to 78 bpf, indicating loose to very dense soil conditions. Soft material was noted from a depth of 25 to 40 feet in boring FD-14.

BEDROCK – Bedrock was encountered at depths of 14 to 40 feet below ground surface.

Groundwater table was encountered in the 1997 borings at depths ranging between 14 and 34 feet bgs.

B270-series borings, 1997

FILL – Brown and gray sand, some silt, some mica, trace gravel, small boulders was encountered at the ground surface. This deposit also includes topsoil and former topsoil at a depth of 20 feet in B270-3. N-values recorded within this stratum ranged between 2 to 15 bpf, indicating very loose to medium dense soil conditions.

COLLUVIUM/RESIDUUM – Beneath the fill, light brown to black sand, some silt, some mica, some weathered sandstone was encountered at depths ranging from 20 to 35 feet. N-values recorded within this stratum ranged from 7 to 49 bpf, indicating very loose to medium dense soil conditions.

WEATHERED SANDSTONE – Below the colluvium/residuum, brown weathered Sandstone was encountered at depths ranging from 40 to 54.6 feet. N-values recorded within this stratum were typically 50 blows for less than 6 inches, indicating very dense soil conditions.

Groundwater table was encountered in the 1997 borings at depths ranging between 24 and 59.5 feet bgs.

B-series borings, 2003

FILL AND COLLUVIUM – Fill and colluvium was encountered at the ground surface. This deposit was described as fill and colluvium, including cobbles and boulders in borings B-1 and B-2. This deposit is described brown silt, some sand, trace micas over fill and colluvium in boring B-3. N-values recorded within this stratum ranged between 7 to 62 bpf, indicating loose to very dense soil conditions.

SILT AND SAND – Beneath the fill or colluvium, brown silt, some sand, to silt and sand, trace mica was encountered at depths ranging from 5 to 12 feet. N-values recorded within this stratum ranged from 6 to 64 bpf, indicating loose to very dense soil conditions.

WEATHERED MICA SCHIST – Beneath the silt and sand, brown, highly weathered mica schist, interbedded with medium dense, brown silt and sand, at depths ranging from 26 to 44 feet. N-values recorded within this stratum ranged from 22 bpf to 50 blows for 2 inches of penetration, indicating medium dense to very dense soil conditions.

BEDROCK – Beneath the weathered mica schist, gray to gray and white, unweathered to slightly weathered, fine textured, very hard mica schist, with foliation angles of 40 to 60 degrees was encountered at depths ranging from 42 to 46 feet. RQD values varied from 92 to 100. Refusal on what is presumed to be bedrock was encountered in boring B-3 at a depth of 47.5 feet.

Groundwater table was encountered in the 2003 borings at depths of 28 feet bgs.

The results of laboratory testing completed on rock samples recovered within the mica schist are summarized above in Table 1 and presented in Appendix E. As shown within the table, measured unconfined compressive strength ranged from 1,560 and 6,220 psi.

Laboratory testing results for soil samples are listed on borings logs FD-6 through FD-11. These results include AASHTO classification, grain size for minus #40 and minus #200, PI, LL, and water content. Since the details of these tests are not available to us, the results are not summarized here but are presented on the logs for general information.

EFLHD measured groundwater in wells installed in borings B270-1 through B270-4, as well as additional wells WW-1 through WW-4. The exact location of WW-4, B270-1 and B270-2 are not known. The long-term groundwater measurements range from 10.5 to 59.5 feet below ground surface; a summary table of measurements is included in Appendix C.

Seismic Refraction Surveys

The purpose of performing the seismic refraction surveys was to map subsurface material, identify depth to bedrock, and compare to the information presented on the boring logs. Geophysics included seismic refraction tests performed in September 2005 and September 2007, and ReMi testing performed in 2005. The 2005 tests were concentrated at the top of the slide near the roadway, or near the existing cut slope on the north side of the project site. The 2007 tests were performed on the landslide slope to confirm and calibrate the geophysics to the B-series borings drilled at mid-slope, as well as to obtain new information at the toe of the slope and a profile down the center of the landslide.

The 2005 refraction and ReMi data were analyzed and combined into a tomographic image of the subsurface by Summit Peak Technologies. This information shows a “valley” of softer material deepen toward the south (but still on the crest of embankment slope). Because this analysis only included measurements at the top of the slope, the subsurface image is limited to this area. Profiles of individual lines A, B, and C, the ReMi line and the tomographic image are included in Appendix D.

The 2007 refraction survey reveal a valley of bedrock filled with lower velocity material. The longitudinal section (Line 1) shows that the interpreted bedrock surface changes direction (becomes shallower) at a point approximately 250 feet from the crest of the roadway embankment. The two transverse sections show the valley-shaped bedrock infilled with lower velocity material.

The seismic refraction survey results can be used for identification of soil consistency and the inferred location of soil and bedrock strata at the site based on the p-wave velocity. The soil type “saprolite” was not typically mentioned on borings logs, but is a residual soil that is a part of the weathering profile encountered at this site. The saprolite is between the boundary of the medium dense sand and silt and the partially weathered rock (PWR), and

was modeled as a low friction angle material. Our interpretation of the correlation between soil/rock and p-wave velocities, adjusted based on observations from borings logs, is presented in Table 2.

Table 2 - Seismic refraction survey results

Soil Type/Density	P -wave Velocity (ft/s)
Fill or Soft Silt	0 – 1,500
Medium Dense Sand and Silt	1,500 – 3,000
Saprolite	3,000 – 4,000
Weathered Schist/PWR	4,000 – 6,500
Bedrock	6,500 – 11,500

DESIGN ANALYSIS AND CONCLUSIONS

Design Alternatives

Several design alternatives were considered for the repair of the failed slope. The following repair alternatives were considered:

1. Realignment of the Blue Ridge Parkway into the ridge to the north and installation of a soldier pile wall with drilled shafts socketed into rock;

2. Slope stabilization with ground anchors and buried concrete blocks along the face of the fill embankment;

3. Constructing a bridge to span over the active slide area;

The Value Analysis (VA) meeting with NPS and Blue Ridge Parkway representatives on 23 July 2005 concluded that Alternative 1, realignment of the Blue Ridge Parkway, was the preferred alternative. The roadway realignment was the preferred alternative only if steep rock cuts could be achieved into the uphill side of the parkway. In addition, the realignment alternative would only be feasible if the depth to competent rock under the fill embankment was reasonable, which would enable limited lengths for soldier piles.

Based on the results of the geophysical survey that was performed for the realignment alternative, rock was encountered at deeper elevations than assumed. Because of the depth to bedrock at the cut for the realignment, retaining walls would be required on the uphill side of the road. Also, because of the deep depth to bedrock on the downhill side, an anchored soldier pile and lagging wall system would be required. These findings rendered the realignment alternative inapplicable because of concerns with cost and aesthetics.

Alternative 2 consists of ground anchors with buried concrete blocks that are designed to intersect the deep failure plane at the site. This alternative would require some clearing of

the slope. However, after completion of construction of the blocks and anchors, the blocks can be covered with soil and the slope re-vegetated.

Alternative 3 consists of constructing a bridge that would likely require drilled shafts for foundations into variable rock surfaces. The estimated average shaft length would exceed 60 feet to meet the load requirements. The roadway would likely have to be closed for 2 peak tourist seasons during construction, and the existing landslide would not be stabilized.

Based on cost, constructability, zone of disturbance and aesthetics, Alternative 2 was considered the most suitable alternative. This alternative affords for construction without road closure and provides an aesthetically-pleasing slope repair.

Landslide Repair

The proposed landslide repair consists of installing ground anchors with concrete blocks at a 20-foot by 20-foot grid pattern. Anchors were designed for 280 kips capacity with 9-foot by 9-foot concrete blocks. The design of landslide slope repair components is described as follows.

Ground Anchors

The selected design alternative consists of installing ground anchors through the existing fill, colluvium, saprolite, weathered rock and into bedrock (through the failure plane). The ground anchors were designed using principles for ground anchors as presented in FHWA's Geotechnical Engineering Circular No. 4 (1999) – "Ground Anchors and Anchored Systems." An allowable rock-grout bond stress of 50 psi was calculated based on laboratory rock strength data. A minimum bond length of 27 feet was calculated. The resistance provided by the anchors was calculated as the force needed to increase the slope stability factor of safety to a minimum of 1.3.

First, the stability of the existing slope was analyzed using soil properties determined from correlation with SPT N-values, p-wave velocity, and guided by typical values from the literature (for saprolite). These soil properties are presented in Table 3. Since this slope is at or near equilibrium, as evidenced by the slow movement of the slope, the factor of safety of the existing slope should be at or very near 1.0. This would indicate that the assigned soil properties, slope geometry and water conditions (based on measurements at the site) are appropriate. The factor of safety for existing conditions at Stations 2+80, 3+20, 3+60 and 4+00 area 0.99, 0.95, 0.99 and 0.97, respectively. This indicates that the geometry, soil properties and water conditions have been modeled appropriately for this slowly moving slide (though these are not unique solutions). The higher factors of safety at the edges of the slide (1.26, 1.16 and 1.17) are expected because of the 3-dimensional nature of the slide – subsurface conditions that appear to be valley-shaped.

Table 3. Design Parameters for Slope Stability Analysis

Material Type	Unit Weight, γ (pcf)	Friction Angle, φ (deg.)	Cohesion, c (psf)
Fill/Loose Silt	115	30	-
Medium Dense Sand & Silt	120	32	-
Saprolite	125	25	300
Weathered Mica Schist/PWR	130	36	-
Bedrock	145	30	80,000

The computer program Slope/W (Version 5) was used to analyze and complete the design of the anchored slope with regards to global stability. Slope/W calculates the Limit Equilibrium factor of safety with a variety of methods. We selected the Spencer method for stability analyses because the Spencer method satisfies both moment and force equilibrium.

Slope/W allows for reinforcement of slopes with anchors. The following lists anchor reinforcement loads we used in Slope/W, based on a 20-ft. spacing of anchors:

- Anchor working load - 14,100 lbs/ft width
- Bond resistance - 564 lbs/ft anchor length/ft width
- Bond Length – 27 feet
- Reinforcement Direction – 20 degrees

Concrete Blocks

Concrete blocks are meant to provide a reaction for the ground anchors. Based on the maximum load applied to the concrete blocks during proof and performance testing of anchors, we anticipate settlements of 2.5 inches from the 280-kip design load and 3.8 inches from the 375-kip test loads (temporary).

Analyses results indicate that the ground anchors and concrete blocks will provide adequate stability of the slope. Refer to Appendix F for examples of landslide repair design calculations.

RECOMMENDATIONS

Based on the results of our analyses we recommend that the landslide repair is to consist of constructing an array of ground anchors with concrete blocks for slope stabilization. Our recommendations are as follows:

Ground Anchors

- Provide anchors that meet the following requirements:
  - Minimum design capacity of 280 kips and a test capacity of 1.33 times the design capacity (375 kips). An anchor consisting of 8 strands of 7-wire strand (0.6-in. diameter, 270 ksi) would meet this criteria.
  - Class I corrosion protection.
  - Minimum bond length – 27 feet.
  - Minimum unbonded zone beyond critical failure zone (unweathered bedrock) – 5 feet.

Anchor and Block System

Refer to Appendix G for ground anchor layout.

- Install inclinometers and piezometers in the landslide mass prior to the start of construction. Read weekly through construction.
- Construct the anchor and block system as follows:
  - Excavate for anchors, starting at the uppermost row. Prepare shotcrete leveling pad. Set 9-ft. by 9-ft. concrete block in place and drill anchor.
  - Install blocks and anchors at 20-ft. spacing longitudinally and 20-ft. spacing transversely on the slope.
  - Perform proof and performance tests in accordance with FP-03 Section 256.08. Lock-off load is 280 kips.
- Number of anchors = 90
  - Estimated total length of unbonded zone = 6,100 ft
  - Estimated total length of bonded zone = 2,700 ft.

- Backfill over the anchors and blocks with topsoil and seed mix, covered with an erosion control mat.

CONSTRUCTION CONSIDERATIONS

The proposed slope repair consists of constructing an array of ground anchors and concrete blocks throughout the landslide slope. Based on the subsurface field investigations and design analysis results, construction recommendations are as follows:

General Considerations

Existing Horizontal Drainage System: A drainage gallery and associated drain pipes were installed in 1992. The design locations (not as-built) of these horizontal drains were overlain on the anchor block plan, and anchor locations were adjusted to minimize interference with the horizontal drains. Therefore, slight variations to the locations of anchors and blocks are shown on the drawings.

Backfill Material: Backfill material for the repaired slope should consist of AASHTO A-2-4 material or better. The maximum dimension of coarse aggregate used for backfill material should not exceed 4 inches. Backfill material should be placed and compacted in lifts not to exceed 12 inches, per Section 204 of the FP-03 Specifications. The portion of the on-site excavated material that meets the unclassified borrow specification may be used as backfill material.

Shotcrete: The anchors will be installed at 20 degrees from horizontal, meaning that the excavation for individual concrete blocks will be at 70 degrees from horizontal. A 6-inch thick shotcrete facing should be applied to the excavated bearing surface prior to installation of anchor blocks. The purpose of the shotcrete pad is to prevent sloughing of the freshly excavated bearing pad and provide a uniform bearing surface for the concrete blocks.

Instrumentation Monitoring and Construction Sequence: The existing slide is active. A monitoring program should be in place and initial baseline readings taken prior to any construction activity at the project site. Install a minimum of three (3) inclinometers at the centerline of the active slide prior to the start of construction. Install one inclinometer at the top of the slide, within 10 ft. of the edge of pavement on the Parkway. Install the second inclinometer on the dirt access road at mid-slope. Install the third inclinometer at the toe of the slope just below the last row of anchors. Temporary piezometers should be installed to measure groundwater elevations/pore pressures before and during construction. Piezometers should be located in pairs with inclinometers, with a minimum 10 feet spacing to minimize interference between instruments. Make the following minimum instrument readings: Prior to the first day of construction, twice for the first week of construction, and weekly throughout the duration of construction. The CO may increase the frequency of readings based on the need for additional information.

Excavate and install the top two (2) rows of anchors first. Anchors may subsequently be installed down the slope, or may be installed from the bottom row up. Excavate and install anchors in a manner that prevents destabilizing the slope or initiating slope movement. Accomplish backfilling as each horizontal row is competed and do not excavate immediately above or below any incomplete anchor location.

Vegetation on the Slope Face: To aid vegetation growth it is recommended that a 6-inch layer of topsoil and seed mix be placed over the repaired slope and encapsulated with a Type 5 erosion control mat after all anchors are installed and locked-off. The erosion control mat will keep the topsoil on the slope and facilitate turf establishment.

DISCLAIMER/LIMITATIONS CLAUSE

The subsurface explorations and test described in the section Procedures and Results have been conducted in accordance with standard practices and procedures (except as specifically noted). The results of these exploration and test represent conditions at the specific locations indicated. Subsurface conditions between these locations may vary. The Analysis and Conclusions sections and the Recommendations section of this report include interpretations and recommendations developed by the Government in the process of preparing the design. These interpretations are not intended as a substitute for the personal investigation, independent interpretation, and judgment of the Contractor.

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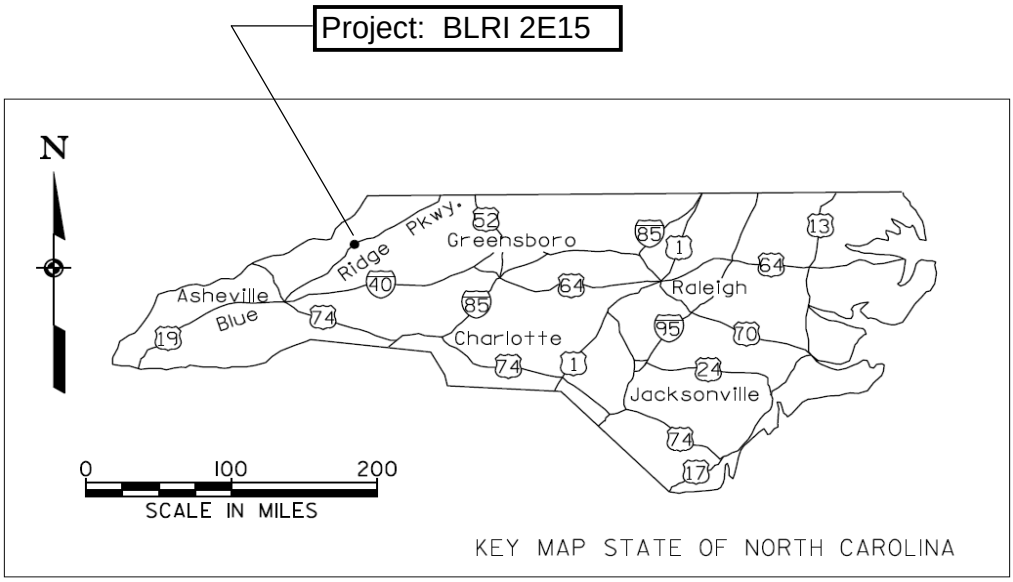
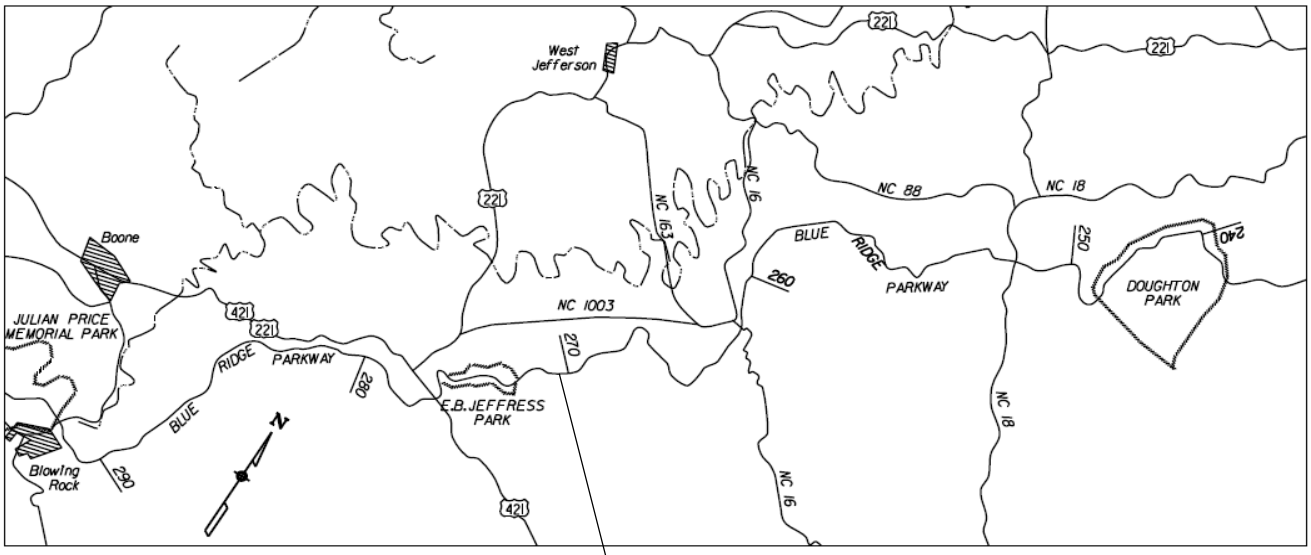
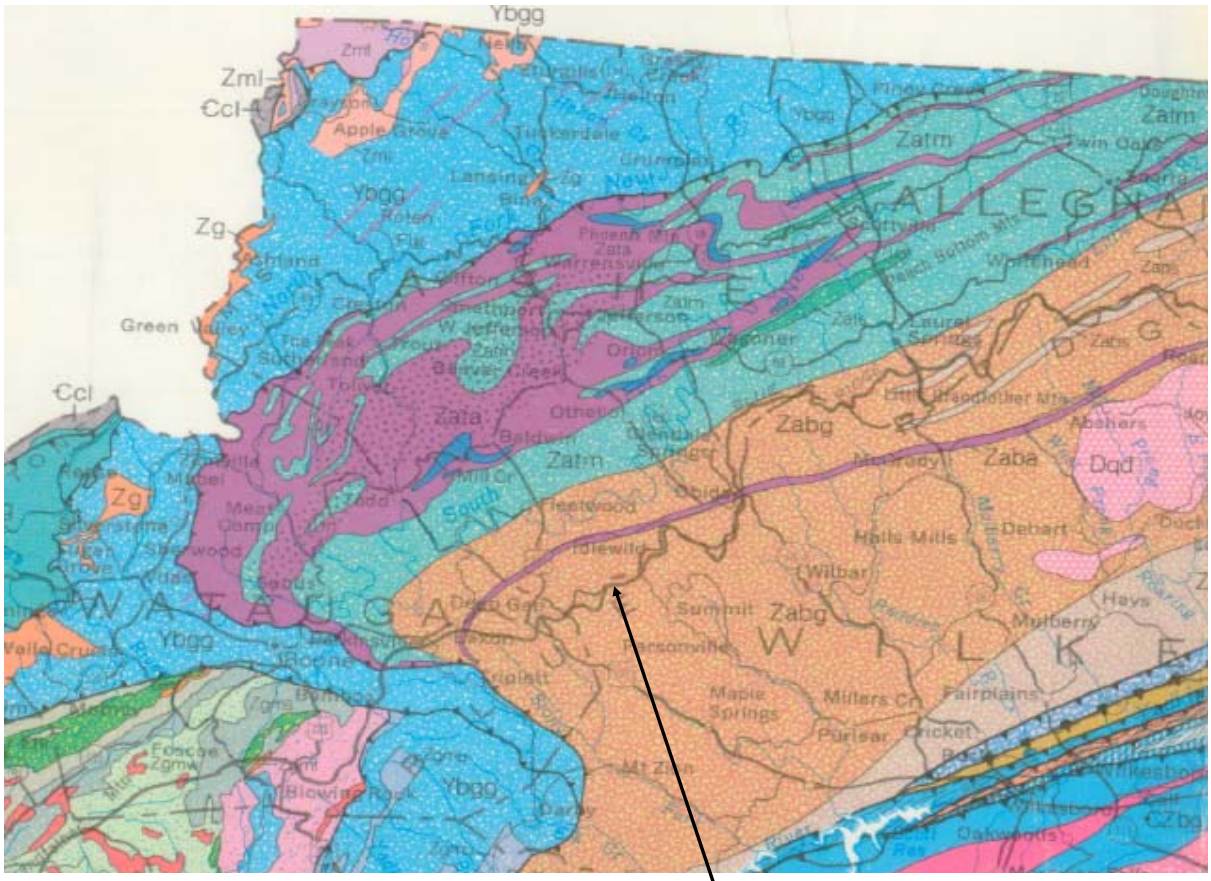
APPENDIX A

Figures





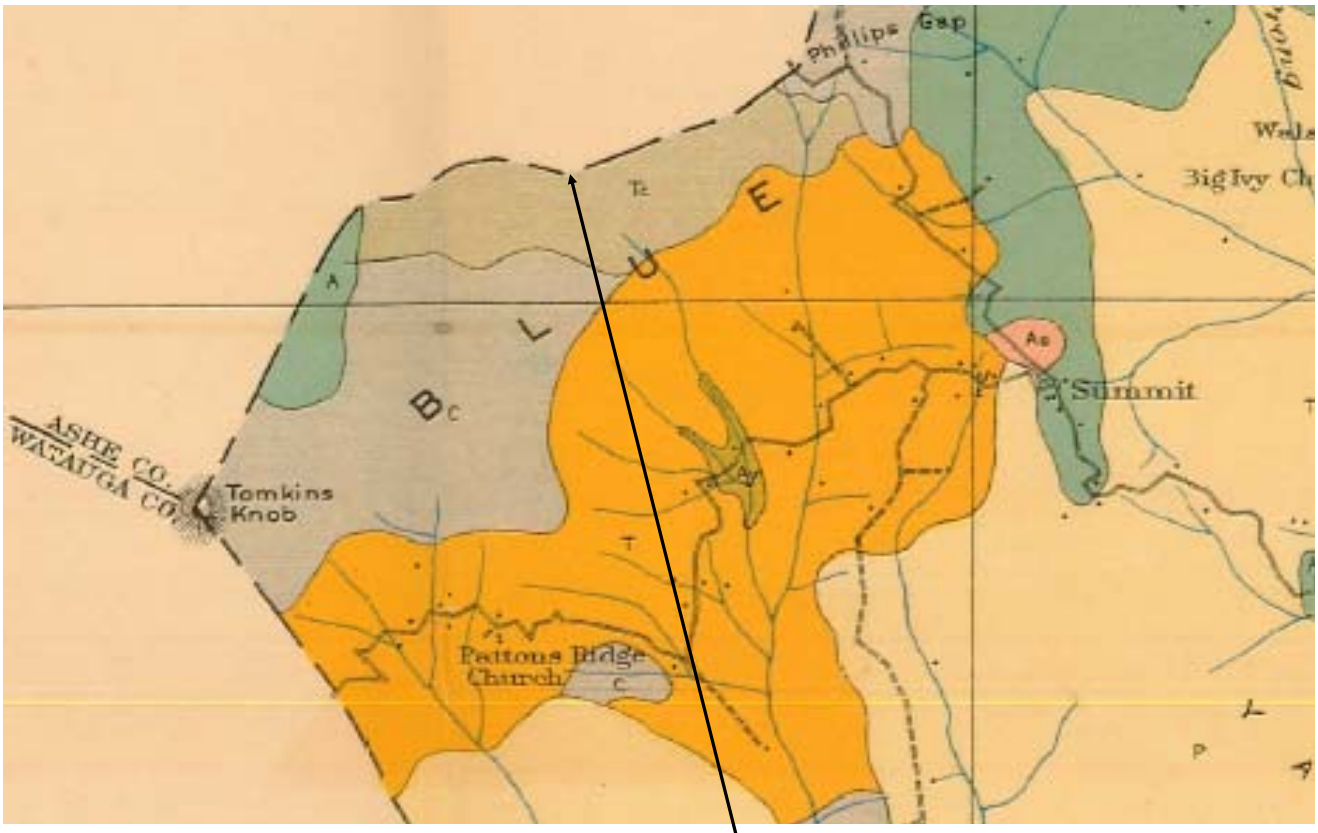
U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION EASTERN FEDERAL LANDS HIGHWAY DIVISION STERLING, VIRGINIA	**FIGURE 1** SITE LOCATION AND VICINITY MAP	REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
		SE	NC	BLRI 2E15	1	3



Zabg — GNEISS: Finely laminated to thin-layered; locally contains massive gneiss and micaceous granule conglomeration includes schist, phyllite and amphipolite.

Geologic Map of North Carolina, 1985
Department of Natural Resources and Community Development

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL LANDS HIGHWAY DIVISION EASTERN FEDERAL LANDS HIGHWAY DIVISION STERLING, VIRGINIA	**FIGURE 2** GEOLOGIC MAP	REG	STATE	PROJECT	SHEET NO.		TOTAL SHEETS
		SE	NC	BLRI 2E15	2		3



Tc

TALLADEGA CLAY LOAM: Red to brownish-red, friable, crumbly, clay loam or clay. Greasy feel due to the presence of mica scales
Derived from mica schist, mica gneiss, and talc schist, frequently encountered at depths of 2 or 3 feet
Occurs at the foot of mountains and on ridge crests.

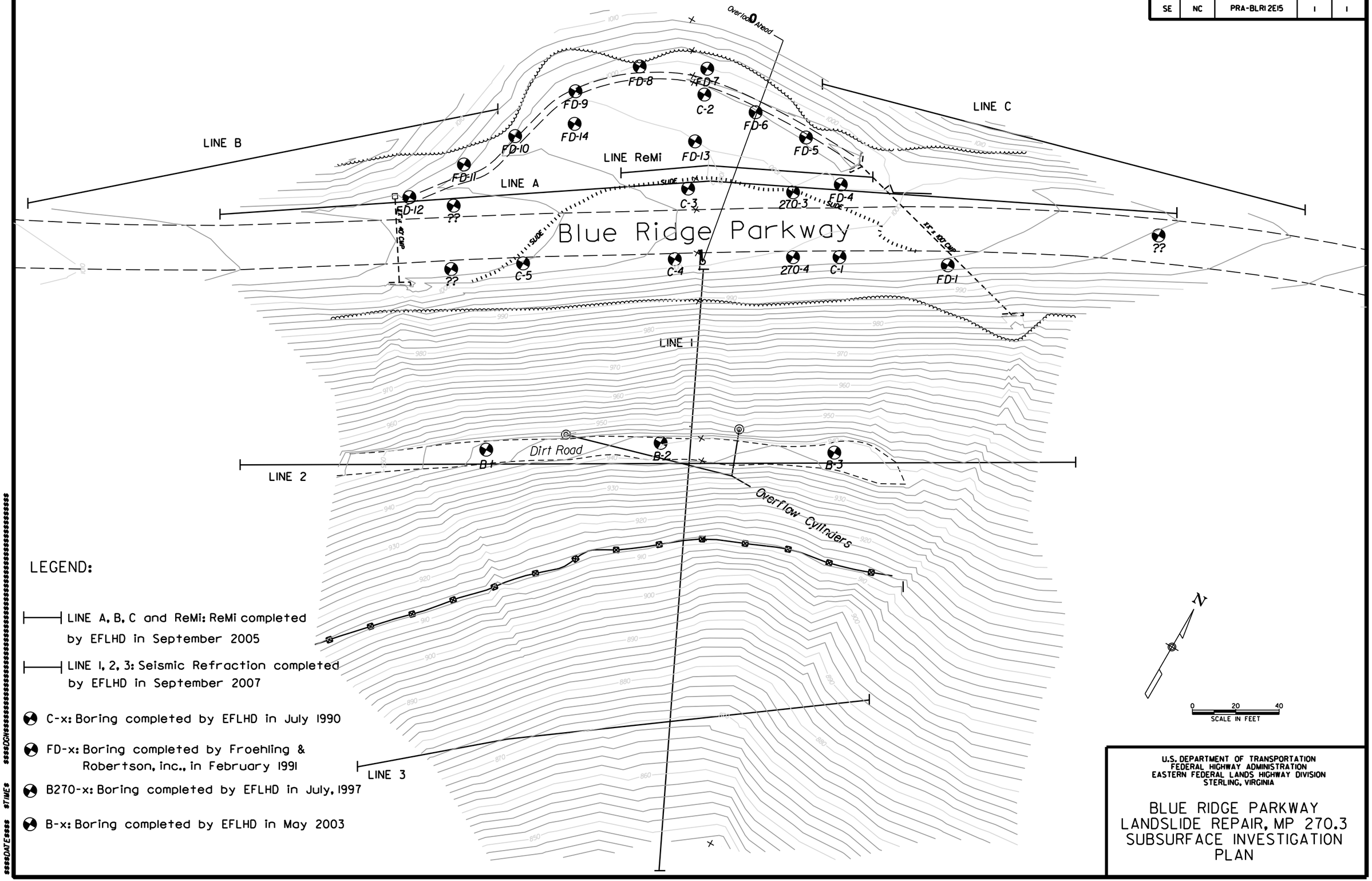
Soil Survey of Wilkes County, North Carolina, 1921
US Department of Agriculture
Soil Conservation Service

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL LANDS HIGHWAY DIVISION EASTERN FEDERAL LANDS HIGHWAY DIVISION STERLING, VIRGINIA	**FIGURE 3** SOIL SURVEY MAP	REG	STATE	PROJECT	SHEET NO.		TOTAL SHEETS
		SE	NC	BLRI 2E15	3		3

APPENDIX B

Exploration Location Plan & Subsurface Profiles

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
SE	NC	PRA-BLRI 2E15	1	1



LEGEND:

- LINE A, B, C and ReMi: ReMi completed by EFLHD in September 2005
- LINE 1, 2, 3: Seismic Refraction completed by EFLHD in September 2007
- C-x: Boring completed by EFLHD in July 1990
- FD-x: Boring completed by Froehling & Robertson, inc., in February 1991
- B270-x: Boring completed by EFLHD in July, 1997
- B-x: Boring completed by EFLHD in May 2003

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

BLUE RIDGE PARKWAY LANDSLIDE REPAIR, MP 270.3 SUBSURFACE INVESTIGATION PLAN

$$$$DATE$$$$ $TIME$ $$$$DGN$$$$

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West

East

B-1

B-2

B-3

Elevation (ft)

960
950
940
930
920
910
900
890
880
870
860
850
840
830

Existing Ground Surface

N

5.0
11
9
12.0
19
18
17
15
23
45
26.0
35
50/2"
67
50/4"
50/2"
50/2"
50/3"
42.0
50/6"
47.0
50/2"

Silt and Sand

Weathered Mica Schist

N

10.0
19
18
17
16
15
14
12
11
6
30.0
10
50/4"
36.0
54
38.0
50/3"
40.0
22
42.0
50/3"
46.0
24
50/2"
50.0
50/3"
55.0
57.2

Fill (Includes Cobbles and Boulders)

N

7
7.0
10
62
12.0
30
23
49
50/2"
37
20
18
18
11
9
7
64
29
44.0
23
20
47.5
9
50/4"
50/1"

Unweathered to Slightly Weathered Mica Schist

LEGEND

▽ - Depth water was encountered during drilling.

▼ - Groundwater depth monitored after boring completion or after 24 hours.

Note: Strata changes shown on this profile represent generalizations based on average conditions indicated by soil test borings.

GENERALIZED SUBSURFACE PROFILE

Scale: 1H = 1V	Date: 1/8/08	Drawn By: BL

PRA-BLRI 2E15, Blue Ridge Parkway
MP 270.3, Deep Gap, NC

Midslope Profile	Drawing No: 2 of 2

STRATIGRAPHY N GW BLRI2E15_BORINGS.GPJ TLB.GDT 1/8/08

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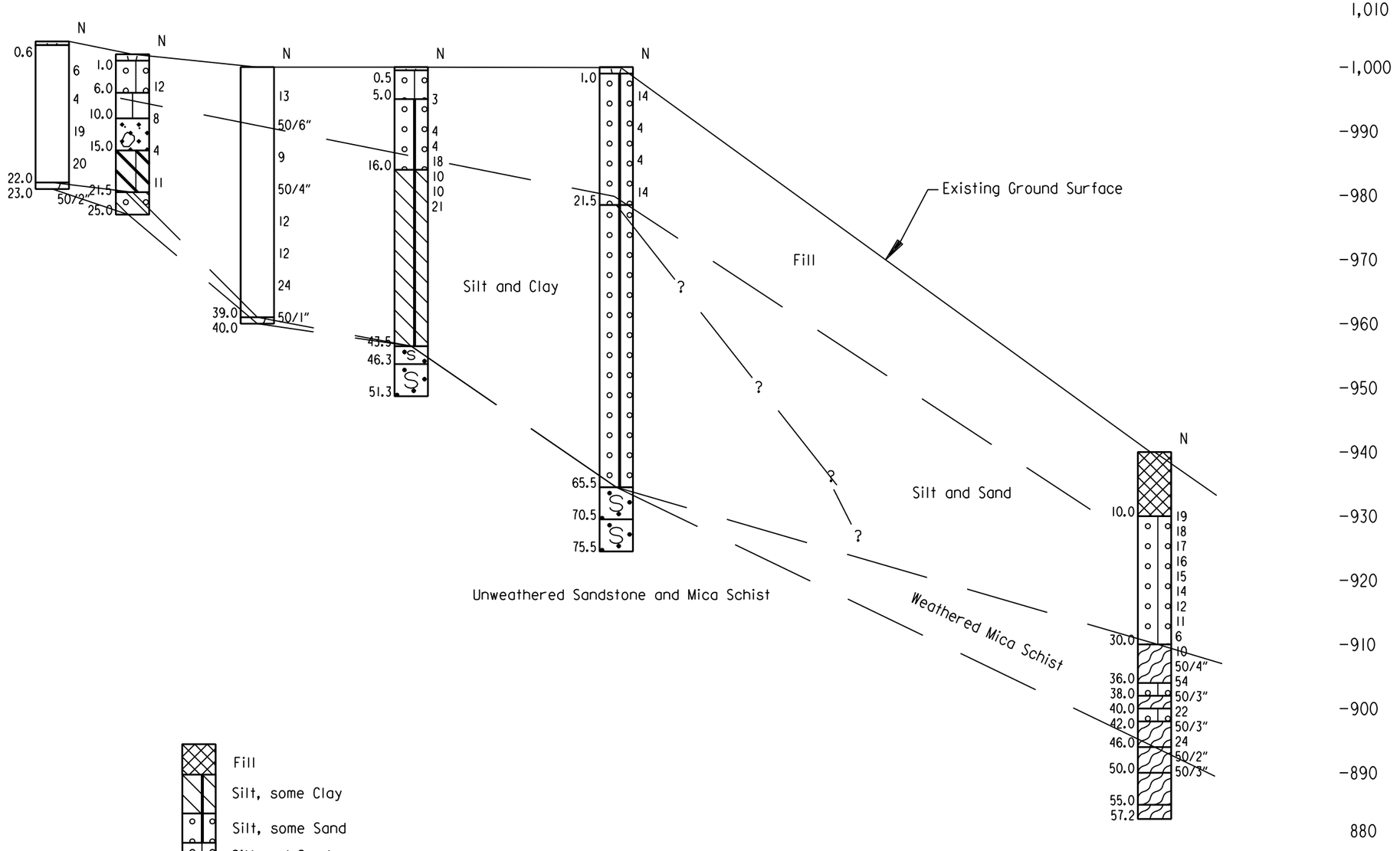
North

South

FD-7 C-2 FD-13 C-3 C-4 B-2

Elevation (ft)

1,010 1,000 990 980 970 960 950 940 930 920 910 900 890 880



LEGEND

▽ - Depth water was encountered during drilling.

▼ - Groundwater depth monitored after boring completion or after 24 hours.

Fill
Silt, some Clay
Silt, some Sand
Silt and Sand
Mica Schist
Sandstone

Note: Strata changes shown on this profile represent generalizations based on average conditions indicated by soil test borings.

GENERALIZED SUBSURFACE PROFILE		
Scale: 1H = 1V	Date: 1/8/08	Drawn By: BL
PRA-BLRI 2E15, Blue Ridge Parkway MP 270.3, Deep Gap, NC		
Downslope Profile		Drawing No: 1 of 2

STRATIGRAPHY N GW BLRI2E15_BORINGS.GPJ TLB.GDT 1/8/08

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APPENDIX C
Boring Logs

SOIL BORING GENERAL NOTES

Drilling and Sampling Symbols

SS: Split Spoon - 1 3/8" I.D., 2" O.D., except where noted
ST: Shelby Tube - 2" O.D., except where noted
PA: Power Auger Sample

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable ground water levels. In impervious soils, the accurate determination of ground water elevations is not possible, even after several days, and additional evidence on ground water elevations must be sought.

VISUAL METHODS FOR SOILS CLASSIFICATION

Component	Distinguishing Features
Boulders	Larger than 12" (300 mm)
Cobbles	3" to 12" (75 mm to 12 mm)
Gravel	Larger than No. 4 sieve and smaller than a 3" sieve, described with any of the following terms (or any combination):
Coarse	3" to 3/4" (75 mm to 19 mm) sieve
Medium	3/4" to 3/8" (19 mm to 9.5 mm) sieve
Fine	3/8" to No. 4 (9.5 mm to 4.75 mm) sieve
Sand	The finest sand grains are just visible to the naked eye, while the largest would pass a No. 4 (4.75mm) sieve (pinhead size). Described with any of the following terms (or any combination):
Coarse	No. 4 to No. 10 (4.75 mm to 2.0 mm) sieve
Medium	No. 10 to No. 40 (2.0 mm to 0.42 mm) sieve
Fine	No. 40 to No. 200 (0.42 mm to 0.075 mm) sieve
Silt	1. Lumps are easily crumbled when are-dried. 2. Feels gritty between the teeth. 3. A moist pat when shaken in the palm of the hand will appear shiny and wet. When squeezed it will appear dry and dull.
Clay	1. Lumps are comparatively hard when air-dried. 2. Threads (1/8" diameter) of considerable length will support their own weight when held by one end. 3. A moist pat will appear the same whether shaken in the palm of the hand or squeezed.

Order of Description

1. Soil Density (or consistency) – see table below
2. Color
3. Major Grain Size – Composes more than 50% of the sample
4. Modifying Term – "and" : 40% to 50% of the minor grain size
   "some" : 30% to 40%
   "little" : 10% to 30%
   "trace" : 10% or less
5. Minor Grain Size(s)
6. Other (plasticity, etc.)

7. Moisture Content (by field test) – "dry" : Absence of moisture, dusty, dry to the touch
"moist" : Damp but no visible water
"wet" : Visible free water, usually soil is below water table
8. General Classification – Fill, Residual Soil, Weathered Rock

SOIL DENSITY (OR CONSISTENCY) TABLE			
Coarse-Grained Soil (Gravel, Sand)		**Fine-Grained Soil (Clay, Silt)**	
Apparent Density	SPT (# blows / ft)	Consistency	SPT (# blows / ft)
Very loose	0-4	Very soft	0-2
Loose	5-10	Soft	3-4
Medium dense	11-30	Medium stiff	5-8
Dense	31-50	Stiff	9-15
Very dense	>50	Very stiff	16-30
		Hard	>30

Examples:

1. Dense to very dense, brown to light brown, **SILTY SAND**, some gravel [A-7-6(10)]
(Moist)

-FILL-

Criteria for Describing Soil Structure

Description	Criteria
Bed	A sedimentary layer bounded by depositional surfaces.
Blocky	A characteristic in which cohesive soil can be broken down into small angular lumps which resist further breakdown.
Bonded	Attached or adhering.
Fissured	Broken along definite planes of fracture.
Foliated	Planar arrangement of textural or structural features.
Frequent	More than one per foot of thickness.
Homogeneous	Same color and appearance throughout.
Interbedded	Alternating soil layers of different composition.
Laminae	A very thin cohesive layer.
Layer	A general term for material lying essentially parallel to the surfaces against which it was formed.
Lens	A lenticular deposit, larger than a pocket.
Occasional	One or less per foot of thickness.
Parting	A very thin granular layer.
Pocket	Small erratic deposits less than 12" in thickness.
Seam	A thin layer separating two distinctive layers of different composition or greater magnitude.
Stratified	Alternating layers of varying material or color.
Stratum	A stratigraphic unit.
Varve	A cyclic sedimentary couplet consisting of a coarser and a finer layer representing the variation in depositional energy resulting from the annual freeze-thaw cycle typically found in glaciolacustrine environments.

ROCK CORING GENERAL NOTES

Depth and Elevation: Use large marks as 1' (300mm) increments. Record proper elevations.

Core: Draw sketch of core breaks as it is oriented in the core box (align all core breaks so they fit together properly before drawing sketch). Starting at the top of core, measure each piece of core down its centerline to 1/100 of a foot. Record this measurement along the left side of the core sketch at the break.

VISUAL METHODS FOR ROCK IDENTIFICATION

Description:

1. Draw a heavy line through description at depth to which core run penetrated.
2. Describe the rock type.
3. Note the condition of the core break on the right side of the core sketch
   Mud seam (MS); Sand seam (SS); Weathered surface (WS); Fresh break (FB)
4. Record coring time in minutes.
5. Record to nearest 1/100 foot the core recovered (after alignment in core box). Discard any debris at top of core, which obviously fill into the core hole.
6. Calculate per cent core recovery and record: $CR = \frac{\text{feet of core recovered}}{\text{feet cored}}$
7. Rock Quality Designation (RQD)

$$(RQD) = \frac{\Sigma[\text{Lengths of all pieces of the core} \geq 4\text{" (100mm)}]}{\text{Total length of core run}} \times 100$$

Hardness:	Very Soft (VS)	Can be deformed or crumbled by hand;
	Soft (S)	Can be scratched with a fingernail
	Moderately Hard (MH)	Can be scratched easily with a knife;
	Hard (H)	Can be scratched with difficulty with a knife;
	Very hard (VH)	Cannot be scratched with a knife

Color: Wet the rock with water and describe the color including the color of any unusual or reoccurring markings on the core (i.e. light green with dark green bands, foliation lines).

Soundness: Use the proper number 1 through 4

1.	Weathered	RQD = 0% to 25%
2.	Highly jointed to Jointed	RQD = 25% to 50%
3.	Jointed to Relatively sound	RQD = 50% to 75%
4.	Relatively sound to Sound	RQD = 75% to 100%

Main Rock Formation Name

Texture
Very Fine (VF),
Fine (F),
Medium (M),
Course (C)

Modifying Term	"and"	40% to 50% of the core run
	"some"	30% to 40%
	"little"	10% to 30%
	"trace"	10% or less

Minor Rock Type(s)

Other

Foliation: Foliation planes are parallel planes of different minerals forming a banded appearance on the rock. The foliation planes are usually of a different color than the surrounding rock. Also the rock shears along the foliation planes if struck with a hammer. Record the following:

Close spaced (CS) – 1/8" (3mm) or closer; Medium spaced (MS) – 1/8" to 1/4" (3mm to 6mm); Open spaced (OS) – 1/4" (6mm) or larger

The angle to the horizontal should be measured (with a protractor) and recorded for the rock core. (Several different angles can be found in each 5' to 10' core.)

Weathering: Use the proper number 1 through 5.

1. Unweathered: No evidence of any mechanical or chemical alteration along discoloration evidenced.
2. Slightly weathered: Discoloration is evident, on surface, slight alteration no discontinuities, less than 10% of the volume is altered, strength is substantially unaffected.
3. Moderately weathered: Discoloring is evident, surface is pitted and altered with alteration penetrating will below rock surfaces, weathering "halos" evident, 10% to 50% of the rock is altered, strength is noticeably less than fresh rock.
4. Highly weathered: Entire mass is discolored; alteration pervades nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away, retains only a fraction of original strength (with wet strength usually lower than dry strength).
5. Decomposed: Rock is reduced to a soil with relict rock structure (saprolite), can be generally molded and crumbled by hand.

Recovery Core Recovery

Rock Quality: Use the proper number 1 through 5

1.	Very Poor	RQD = 0% to 25%
2.	Poor	RQD = 25% to 50%
3.	Fair	RQD = 50% to 75%
4.	Good	RQD = 75% to 90%
5.	Excellent	RQD = 90% to 100%

Examples:

1. Moderately hard, blue-gray to gray, weathered **BIOTITE GNEISS BOULDER**, medium texture

   Recovery = 24%
   RQD = 17%

2. Very hard, gray and white, relatively sound to sound **BIOTITE GNEISS**, medium to fine texture, some quartz veins, foliation angle = 20 degrees

   Recovery = 100%
   RQD = 100%

   -Fresh break @ approximately 47'

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-1 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound Grass Shoulder, Northern Boring.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/25/90	Completed: 7/25/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Amenta
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Seagle
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
999.0		1.0	**TOPSOIL**, grass and weeds, moist.						
			Loose to medium dense, brown **SAND**, some silt, some mica, trace gravel, trace clay, moist.	5					
				10			1.2	2-7-4-3	●
			- Hard layer at 10.5-ft						
				15			1.2	2-3-6-9	●
			- Some rock fragments from 18.5-ft to 20.5-ft	20			1.5	3-4-3-4	●
				25					
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 41.7-ft.
2. Hole dry on completion.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-1 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound Grass Shoulder, Northern Boring.

Groundwater Depth:
Encountered at: ▽
At Completion: ▼
After ____ hrs ▼

Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: 140 lbs/AUTO
Hammer Drop: 30 in.

Boring Began: 7/25/90 | Completed: 7/25/90
Boring Method: HSA | Inspector: Amenta
Hole Diameter: 3 3/8 I.D. | Operator: Seagle
Rock Core Diam: N/A | Weather: cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.
			Loose to medium dense, brown **SAND**, some silt, some mica, trace gravel, trace clay, moist. *(Continued)*					
				35				
			- Augering through hard layers beginning at 39-ft.	40				
958.3		41.7						
			Boring Terminated @ 41.7-ft. Auger Refusal.					
				45				
				50				
				55				
				60				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 41.7-ft.
2. Hole dry on completion.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-2 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder, Westernmost Boring.

Groundwater Depth:
Encountered at: 15.0 ft
At Completion:
After ____ hrs

Surface Elevation: 1002.0 ft
Caved at:
Hammer Wt. & Type: 140 lbs/AUTO
Hammer Drop: 30 in.

Boring Began: 7/24/90 | Completed: 7/24/90
Boring Method: HSA | Inspector: Amenta
Hole Diameter: 3 3/8 I.D. | Operator: Seagle
Rock Core Diam: N/A | Weather: partly cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.
1001.0		1.0	**TOPSOIL**, grass and weeds					
			Loose to medium dense, brown **SAND**, some silt, some mica, some gravel, trace of clay, moist.	5				
996.0		6.0				J-1	1.8	4-6-6-6
			Loose to medium dense, brownish gray **SILT**, some fine sand, trace mica, trace clay, trace black organic silt - Hard layer at 9-ft.					
992.0		10.0		10				
			Loose, grayish brown medium to coarse **SAND**, some gravel, trace silt trace clay, moist.			J-2	2.0	4-5-3-6
987.0		15.0		15 ▽				
			Soft to stiff, brown **CLAY**, some silt, some mica, trace fine sand, wet.			J-3	0.8	1-2-2-2
				20				
980.5		21.5				J-4	1.9	3-4-7-14
			Brown Weathered **SAPROLITE**, trace clay, trace silt, trace fine sand, moist. - Hard layer to auger.					
977.0		25.0		25				
			Boring Terminated @ 25-ft.					
				30				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Observation well installed 7/24/90.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-3 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound, Grass Shoulder.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/24/90	Completed: 7/25/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Amenta
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Seagle
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: 2 1/8 NQ	Weather: cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	Water Content % / Plastic Limit — Liquid Limit / Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
999.5		0.5	**TOPSOIL**, grass and weeds.						
			Brown **SAND**, some silt, some mica, some gravel, trace clay, moist.						
995.0		5.0		5					
			Very loose to medium dense, grayish brown **SILT**, some fine sand, some mica, trace clay, moist.		SPT	J-1	1.0	1-1-2-2	●
			- Hard augering from 7.5-ft to 9.5-ft.						
				10	SPT	J-2	0.5	1-2-2-2	●
					SPT	J-3	0.5	3-2-2-2	●
				15	SPT	J-4	0.3	6-9-9-10	●
984.0		16.0							
			Stiff to very stiff, brown **SILT**, some clay, trace fine sand, trace quartz, moist		SPT	J-5	0.4	3-5-5-10	●
					SPT	J-6	0.7	8-5-5-8	●
			- Trace black organic silt from 20-ft to 22-ft.	20	SPT	J-7	1.2	6-14-7-7	●
				25					
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 43.5-ft.
2. Hole dry on completion.
3. Slope Indicator installed to 46.4-ft on 7/25/90.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-3 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound, Grass Shoulder.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/24/90	Completed: 7/25/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Amenta
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Seagle
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: 2 1/8 NQ	Weather: cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Stiff to very stiff, brown **SILT**, some clay, trace fine sand, trace quartz, moist *(Continued)*	35					
				40					
956.5		43.5	- Auger refusal at 43.5-ft.						
			Light brown, Moderately Weathered Micacious **SANDSTONE** Foliation Angle: Not measured Texture: Medium	45					
953.7		46.3	Hardness: Moderately Hard Core Recovery = 84%, RQD = 68% No water return. Coring time = 8 minutes.						
			Light brown, Slightly to Moderately Weathered Micacious **SANDSTONE**, some hornblend.	50					
948.7		51.3	Foliation Angle: Not measured Texture: Medium Hardness: Moderately Hard Core Recovery = 100%, RQD = 82% No water return. Coring time = 16 minutes.	55					
			Boring Terminated @ 51.3-ft.	60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 43.5-ft.
2. Hole dry on completion.
3. Slope Indicator installed to 46.4-ft on 7/25/90.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-4 | Sheet: 1 of 3

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/27/90	Completed: 7/27/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Seagle
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Thornton
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: 2 1/8 NQ	Weather: partly cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
999.0		1.0	**TOPSOIL**, grass and weeds.						
			Very loose to medium dense, brown **SILT**, some sand, some gravel, some mica, trace clay, moist.	5	SPT	J-1	1.5	4-7-7-7	●
				10	SPT	J-2	1.2	2-2-2-2	●
				15	SPT	J-3	0.3	8-2-2-2	●
				20	SPT	J-4	1.0	4-8-6-21	●
978.5		21.5	Brown **SILT**, some sand, some clay, some mica, moist **(Saprolite)** - Harder to auger than from 0-ft to 21-ft.	25					
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 65.5-ft.
2. Hole dry on completion.
3. Slope indicator pipe installed to 67-ft on 7/27/90.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-4 | Sheet: 2 of 3

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/27/90	Completed: 7/27/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Seagle
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Thornton
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: 2 1/8 NQ	Weather: partly cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Brown **SILT**, some sand, some clay, some mica, moist **(Saprolite)**						
			- Harder to auger than from 0-ft to 21-ft. *(Continued)*						
				35					
				40					
			- Hard layer at 43-ft.						
				45					
				50					
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 65.5-ft.
2. Hole dry on completion.
3. Slope indicator pipe installed to 67-ft on 7/27/90.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-4 | Sheet: 3 of 3

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/27/90	Completed: 7/27/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Seagle
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Thornton
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: 2 1/8 NQ	Weather: partly cloudy

Elevation (feet)	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)
		Brown **SILT**, some sand, some clay, some mica, moist **(Saprolite)**	
		- Harder to auger than from 0-ft to 21-ft. *(Continued)*	
			65
934.5	65.5	- Auger refusal at 65.5-ft.	
		Gray, Slightly Weathered to Moderately Weathered **SANDSTONE** and Micacious Sandstone, traces of quartz.	
		Foliation Angle: 35 to 55 degrees	
		Texture: Fine to Medium	
		Hardness: Hard	
		Core Recovery = 97%, RQD = 51%	
			70
929.5	70.5	No water return.	
		Coring time = 18 minutes.	
		Gray, Unweathered **SANDSTONE**, some mica, trace quartz seams.	
		Foliation Angle: 20 to 45 degrees	
		Texture: Fine	
		Hardness: Hard	
			75
924.5	75.5	Core Recovery = 100%, RQD = 100%	
		Coring time = 15 minutes.	
		Boring Terminated @ 75.5-ft.	
			80
			85
			90

SAMPLE: Type | No. | Rec. | Blows per 6 in.

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 65.5-ft.
2. Hole dry on completion.
3. Slope indicator pipe installed to 67-ft on 7/27/90.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-5 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound Grass Shoulder, Southern Boring.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/28/90	Completed: 7/28/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Seagle
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Thornton
After ___ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: cloudy, light rain

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
999.5		0.5	**TOPSOIL**, grass and weeds, moist						
			Loose, brown **SILT**, some sand, trace to some gravel, some mica, trace clay, moist						
				5			1.3	3-4-4-6	●
				10					
			- Could not sample at 10-ft, hit boulder.						
				15			1.0	2-2-3-3	●
				20			1.3	2-4-3-4	●
			- No gravel in sample from 20-ft to 22-ft.						
			- Hard layer from 22.5-ft to 23.5-ft.						
				25					
			- Hard layer from 27.1-ft to 28.5-ft.						
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 53.3-ft.
2. Hole dry on completion.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: C-5 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound Grass Shoulder, Southern Boring.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/28/90	Completed: 7/28/90
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Seagle
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 3 3/8 I.D.	Operator: Thornton
After ____ hrs ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: cloudy, light rain

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Loose, brown **SILT**, some sand, trace to some gravel, some mica, trace clay, moist *(Continued)*						
			- Hard layer from 32-ft to 34-ft.	35					
			- Hard layer from 41-ft to 44-ft.	40					
				45					
				50					
946.7		53.3	Boring Terminated at 53.3-ft. Auger Refusal.						
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 53.3-ft.
2. Hole dry on completion.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-1 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound Grass Shoulder, Northern Boring.

Groundwater Depth:	Surface Elevation: 998.0 ft	Boring Began: 2/7/91	Completed: 2/7/91
Encountered at: ▽	Caved at:	Boring Method: Unknown	Inspector: Oliveira
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown	Hole Diameter: Unknown	Operator: Oliveira
After ____ hrs ▽	Hammer Drop: Unknown	Rock Core Diam: N/A	Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			No soil descriptions provided.						
						1		7-6-5	●
				5					
						2		2-2-2	●
				10					
						3		2-4-3	●
				15					
980.0		18.0				4		7-6-7	●
			Small rock between 18-ft and 22-ft.	20					
976.0		22.0							
			No soil descriptions provided.			5		5-5-8	●
				25					
						6		9-7-6	●
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Hole dry on completion.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-1 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound Grass Shoulder, Northern Boring.

Groundwater Depth:		Surface Elevation: 998.0 ft	Boring Began: 2/7/91	Completed: 2/7/91	
Encountered at:	▽	Caved at:	Boring Method: Unknown	Inspector: Oliveira	
At Completion:	▼	Hammer Wt. & Type: Unknown/Unknown	Hole Diameter: Unknown	Operator: Oliveira	
After ____ hrs	▽	Hammer Drop: Unknown	Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			No soil descriptions provided. *(Continued)*						
						7		14-14-10	●
				35					
961.0		37.0				8		50/2"	● 2"
			Boring Terminated @ 37-ft.						
				40					
				45					
				50					
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Hole dry on completion.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-4 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder, Northernmost Boring.

Groundwater Depth:
Encountered at: 34.0 ft
At Completion:
After ____ hrs

Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: Unknown/Unknown
Hammer Drop: Unknown

Boring Began: 2/7/91 | Completed: 2/7/91
Boring Method: Unknown | Inspector: Oliveira
Hole Diameter: Unknown | Operator: Oliveira
Rock Core Diam: N/A | Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	Water Content % / Plastic Limit — Liquid Limit / Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
999.4		0.6	**TOPSOIL**, grass.						
			Very loose to loose, brown **SILT**.	5		1		2-2-4	
				10					
				15		2		3-4-4	
						3		3-3-1	
980.5		19.5		20		4		3-7-12	
			Medium dense to very dense, tan **SILT**, some sand.						
				25					
			- Small rock from 28-ft to 38-ft.						
				30		5	0.0	7-9-14	

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-4 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder, Northernmost Boring.

Groundwater Depth:
Encountered at: 34.0 ft ▽ | Caved at:
At Completion: ▼ | Hammer Wt. & Type: Unknown/Unknown
After ___ hrs ▼ | Hammer Drop: Unknown

Surface Elevation: 1000.0 ft
Boring Began: 2/7/91 | Completed: 2/7/91
Boring Method: Unknown | Inspector: Oliveira
Hole Diameter: Unknown | Operator: Oliveira
Rock Core Diam: N/A | Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % / Plastic Limit — Liquid Limit / ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Medium dense to very dense, tan **SILT**, some sand. *(Continued)*						
					⊠	6		50/5"	5"
				35					
962.0		38.0	**ROCK**			7		50/1"	1"
960.0		40.0		40					
			Boring Terminated at 40-ft.						
				45					
				50					
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-5 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:	Surface Elevation: 1002.0 ft	Boring Began: 2/6/91	Completed: 2/6/91
Encountered at: ▽	Caved at:	Boring Method: Unknown	Inspector: Oliveira
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown	Hole Diameter: Unknown	Operator: Oliveira
After ___ hrs ▼	Hammer Drop: Unknown	Rock Core Diam: N/A	Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
1001.4		0.6	**TOPSOIL**, grass						
			Loose to very dense, tan **SILT**, some sand	5	SPT	1		11-12-14	●
				10	SPT	2		4-4-5	●
987.0		15.0		15	SPT	3		9-28-31	●
			ROCK						
984.0		18.0							
			Boring Terminated @ 18-ft. Auger Refusal.	20					
				25					
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Hole dry on completion.
3. Auger refusal at 18-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-6 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation: 1002.0 ft	Boring Began: 2/7/91	Completed: 2/7/91	
Encountered at: 16.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira	
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown		Hole Diameter: Unknown	Operator: Oliveira	
After ___ hrs ▼	Hammer Drop: Unknown		Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
1001.4		0.6	**TOPSOIL**, grass						
			Loose to very dense, tan **SILT**, some sand, some small rocks						
			- Lab Testing for 9-ft to 10.5-ft **A-2-4(0)** **-#40 = 45%** **-#200 = 17%** **PI = NP** **LL = 35**	5		1		14-12-11	
			- Lab Testing for 14-ft to 15.5-ft **A-2-4(0)** **-#40 = 61%** **-#200 = 12%** **PI = NP** **LL = 40**	10		2		3-3-4	0
			- Lab Testing for 19-ft to 20.5-ft **A-2-5(0)** **-#40 = 50%** **-#200 = 9%** **PI = NP** **LL = 44**	15		3		9-8-5	0
			- Lab Testing for 29-ft to 30.5-ft ▽ **A-1-b(1)** **-#40 = 43%** **-#200 = 10%** **PI = NP**	20		4		14-28-50	0
				25		5	0.0	50/6"	6"
				30		6		50/6"	6"

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 37-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-6 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation: 1002.0 ft	Boring Began: 2/7/91	Completed: 2/7/91
Encountered at: 16.0 ft	▽	Caved at:	Boring Method: Unknown	Inspector: Oliveira
At Completion:	▼	Hammer Wt. & Type: Unknown/Unknown	Hole Diameter: Unknown	Operator: Oliveira
After ___ hrs	▼	Hammer Drop: Unknown	Rock Core Diam: N/A	Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			- Lab Testing for 34-ft to 35.5-ft **A-2-4(0)** **-#40 = 66%** **-#200 = 18%** **PI = NP** **LL = 35**						
967.0		35.0		35	☒	7		50/6"	0 — ▼ — 6" ●
			ROCK						
965.0		37.0							
			Boring Terminated @ 37-ft. Auger Refusal.						
				40					
				45					
				50					
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 37-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

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FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-7 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation: 1004.0 ft	Boring Began: 2/6/91	Completed: 2/6/91	
Encountered at: 14.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira	
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown		Hole Diameter: Unknown	Operator: Oliveira	
After ____ hrs ▼	Hammer Drop: Unknown		Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
1003.4		0.6	**TOPSOIL**, grass						
			No soil descriptions provided. - Lab Testing from 4.5-ft to 6-ft **-#40 = 57%** **-#200 = 25%** - Lab Testing from 9-ft to 10.5-ft **-#40 = 48%** **-#200 = 25%** - Lab Testing from 14-ft to 15.5-ft **A-2-4(0)** **-#40 = 88%** **-#200 = 18%** **PI = NP** **LL = 39**	5		1		3-3-3	●
				10		2		2-2-2	●
				15		3	0.0	25-11-8	0 ● ▼ ⊢—⊣
				20		4		5-8-12	●
982.0		22.0							
981.0		23.0	**ROCK** Boring Terminated @ 23-ft. Auger Refusal.			5	0.0	50/2"	2"
				25					
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 23-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-8 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation: 1004.0 ft	Boring Began: 2/6/91	Completed: 2/6/91	
Encountered at: 16.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira	
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown		Hole Diameter: Unknown	Operator: Oliveira	
After ____ hrs ▼	Hammer Drop: Unknown		Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
1003.4		0.6	**TOPSOIL**, grass						
			Very loose to medium dense, tan **SILT**, some sand, some small rocks.						
			- Lab Testing from 4.5-ft to 6.0-ft **A-5(2)** **-#40 = 78%** **-#200 = 46%** **PI = 8** **LL = 36**	5		1		2-2-2	
			- Lab Testing from 9-ft to 10.5-ft **A-2-4(0)** **-#40 = 39%** **-#200 = 12%** **PI = NP** **LL = 31**	10		2		7-7-9	
			- Lab Testing from 14-ft to 15.5-ft **A-2-5(0)** **-#40 = 70%** **-#200 = 24%** **PI = NP** **LL = 42**	15		3		4-3-4	
			- Lab Testing from 19-ft to 20.5-ft ▽ **A-2-4(0)** **-#40 = 70%** **-#200 = 18%** **PI = NP** **LL = 36**	20		4		8-11-12	
980.0		24.0				5	0.0	50/1"	1"
979.0		25.0	**ROCK**	25					
			Boring Terminated @ 25-ft. Auger Refusal.	30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 25-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-9 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation: 1004.0 ft	Boring Began: 2/6/91	Completed: 2/6/91	
Encountered at: 15.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira	
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown		Hole Diameter: Unknown	Operator: Oliveira	
After ____ hrs ▼	Hammer Drop: Unknown		Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	Water Content % / Plastic Limit — Liquid Limit / Standard Penetration Test Data (Blows / ft)
1003.4		0.6	**TOPSOIL**, grass						
			Medium dense, tan **SILT**, some sand.						
			- Lab Testing from 4.5-ft to 6-ft **-#40 = 55%** **-#200 = 23%**						
			- Lab Testing from 9-ft to 10.5-ft **-#40 = 35%** **-#200 = 10%**	5	SPT	1		3-9-8	
				10	SPT	2		4-5-8	
990.0		14.0				3	0.0	50/1"	1"
			ROCK ▽	15					
988.0		16.0							
			Boring Terminated @ 16-ft. Auger Refusal.	20					
				25					
				30					

Water Content % ▼ | Plastic Limit — Liquid Limit | Standard Penetration Test Data (Blows / ft) ●
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 16-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-10 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shouldeer

Groundwater Depth:		Surface Elevation: 1002.0 ft	Boring Began: 2/6/91	Completed: 2/6/91	
Encountered at: 27.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira	
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown		Hole Diameter: Unknown	Operator: Oliveira	
After ____ hrs ▼	Hammer Drop: Unknown		Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
1001.4		0.6	**TOPSOIL**, grass						
			Loose to very dense, brown, tan and white **SILT**, some sand, some small rock.						
			- Lab Testing from 4.5-ft to 6-ft **A-4(0)** **-#40 = 78%** **-#200 = 37%** **PI = 3** **LL = 44**	5		1		5-3-3	● H▼
			- Lab Testing from 9-ft to 10.5-ft **-#40 = 84%** **-#200 = 28%**	10		2		5-9-9	▼●
			- Lab Testing from 14-ft to 15.5-ft **-#40 = 95%** **-#200 = 40%**	15		3		3-4-5	● ▼
			- Lab Testing from 19-ft to 20.5-ft **-#40 = 71%** **-#200 = 23%**	20		4		7-23-21	▼ ●
			- Lab Testing from 24-ft to 25.5-ft **A-4(0)** **-#40 = 83%** **-#200 = 51%** **PI = NP** **LL = 37** ▽	25		5		12-15-17	0 ▼ ●
973.0		29.0				6		50/6"	▼ ● 6"
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-10 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shouldeer

Groundwater Depth:
Encountered at: 27.0 ft
At Completion:
After ____ hrs

Surface Elevation: 1002.0 ft
Caved at:
Hammer Wt. & Type: Unknown/Unknown
Hammer Drop: Unknown

Boring Began: 2/6/91 | Completed: 2/6/91
Boring Method: Unknown | Inspector: Oliveira
Hole Diameter: Unknown | Operator: Oliveira
Rock Core Diam: N/A | Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.
			Dense, gray **SAND**, some small rock. - Lab Testing from 29-ft to 30.5-ft **-#40 = 55%** **-#200 = 33%***(Continued)*					
968.0		34.0	Boring Terminated @ 34-ft.	35		7	0.0	50/6"
				40				
				45				
				50				
				55				
				60				

▼ Water Content %
Plastic Limit ——— Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-11 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation: 1002.0 ft	Boring Began: 2/5/91	Completed: 2/5/91	
Encountered at: 15.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira	
At Completion: ▼	Hammer Wt. & Type: Unknown/Unknown		Hole Diameter: Unknown	Operator: Oliveira	
After ____ hrs ▽	Hammer Drop: Unknown		Rock Core Diam: N/A	Weather: Unknown	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	Water Content % / Plastic Limit — Liquid Limit / Standard Penetration Test Data (Blows / ft)
1001.4		0.6	**TOPSOIL**, grass						
			Loose, tan **SILT**, some sand, some small rock.						
			- Lab Testing from 4.5-ft to 6-ft **A-2-5(0)** **-#40 = 78%** **-#200 = 27%** **PI = NP** **LL = 46**	5		1		4-3-5	0
			- Lab Testing from 9-ft to 10.5-ft **A-2-4(0)** **-#40 = 58%** **-#200 = 18%** **PI = NP** **LL = 36**	10		2		4-5-4	0
988.0		14.0	**ROCK**	15		3		50/6"	6"
986.0		16.0	- Lab Testing from 14-ft to 15.5-ft **-#40 = 36%** **-#200 = 16%**						
			Boring Terminated @ 16-ft. Auger Refusal.	20					
				25					
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 16-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

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FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-12 | Sheet: 1 of 1

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder, Southernmost Boring.

Groundwater Depth: | Surface Elevation: 1000.0 ft | Boring Began: | Completed:
Encountered at: ▽ | Caved at: | Boring Method: Unknown | Inspector: Oliveira
At Completion: ▼ | Hammer Wt. & Type: Unknown/Unknown | Hole Diameter: Unknown | Operator: Oliveira
After ____ hrs ▼ | Hammer Drop: Unknown | Rock Core Diam: N/A | Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.
999.4		0.6	**TOPSOIL**, grass.					
			Brown **SILT**, some sand, some small rock.	5				
				10				
				15				
				20				
				25				
974.0		26.0						
			ROCK					
973.0		27.0						
			Boring Terminated @ 27-ft. Auger Refusal.	30				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Hole dry on completion.
3. Auger refusal at 27-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-13 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:		Surface Elevation:	1000.0 ft	Boring Began:	Completed:
Encountered at:	24.0 ft ▽	Caved at:		Boring Method: Unknown	Inspector: Oliveira
At Completion:	▼	Hammer Wt. & Type:	Unknown/Unknown	Hole Diameter: Unknown	Operator: Oliveira
After ____ hrs	▼	Hammer Drop:	Unknown	Rock Core Diam: N/A	Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.
			No soil descriptions provided.	5		1		6-7-6
						2	0.0	50/6"
				10				
				15		3		3-4-5
				20		4		23-50/4"
			- Rock from 21-ft to 25-ft	▽				
				25		5		28-6-6
				30		6		4-5-7

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

6" 4"

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 40-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-13 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:
Encountered at: 24.0 ft
At Completion:
After ____ hrs

Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: Unknown/Unknown
Hammer Drop: Unknown

Boring Began:
Boring Method: Unknown
Hole Diameter: Unknown
Rock Core Diam: N/A

Completed:
Inspector: Oliveira
Operator: Oliveira
Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	Water Content % / Standard Penetration Test Data (Blows / ft)
			No soil descriptions provided. *(Continued)*						
				35		7		10-10-14	
961.0		39.0				8		50/1"	
960.0		40.0	**ROCK**	40					
			Boring Terminated @ 40-ft. Auger Refusal.						
				45					
				50					
				55					
				60					

Plastic Limit ⊢——⊣ Liquid Limit
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 40-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-14 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:
Encountered at: 26.0 ft ▽
At Completion: ▼
After ____ hrs ▼

Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: Unknown/Unknown
Hammer Drop: Unknown

Boring Began: 2/7/91 | Completed: 2/7/91
Boring Method: Unknown | Inspector: Oliveira
Hole Diameter: Unknown | Operator: Oliveira
Rock Core Diam: N/A | Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Tan **SILT**, some sand, some small rock.	5					
				10					
				15					
				20					
975.0		25.0		25					
			Tan **SILT**, some sand, soft material. ▽	30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 43-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: FD-14 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound Grass Shoulder

Groundwater Depth:
Encountered at: 26.0 ft
At Completion:
After ____ hrs

Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: Unknown/Unknown
Hammer Drop: Unknown

Boring Began: 2/7/91 | Completed: 2/7/91
Boring Method: Unknown | Inspector: Oliveira
Hole Diameter: Unknown | Operator: Oliveira
Rock Core Diam: N/A | Weather: Unknown

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.
			Tan **SILT**, some sand, soft material. *(Continued)*	35				
960.0		40.0		40				
			ROCK					
957.0		43.0						
			Boring Terminated @ 43-ft. Auger Refusal.	45				
				50				
				55				
				60				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Boring completed by Froehling & Robertson, INC.
2. Auger refusal at 43-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-1 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound, Grass Shoulder, Southern Edge.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/18/97	Completed: 7/21/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 39 hrs 24.0 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Medium dense, brown and gray **SAND**, some silt, some mica, trace of gravel, dry to moist. **(FILL)**			J-1	1.4	5-7-6-5	●
			- Hit small bolder's down to 10-ft.	5		J-2	1.3	4-10-3-3	●
				10		J-3	1.2	3-6-3-5	●
985.0		15.0		15					
			Loose, light brown **SAND**, dry. **(FILL)**			J-4	0.8	1-5-4-5	●
983.0		17.0							
			Loose, brown **SAND**, some silt, some mica, trace of red clay, moist. **(FILL)**	20		J-5	0.8	2-4-5-5	●
				▼ 25		J-6	1.5	2-1-2-3	●
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 42.2-ft.
2. Hole dry on completion.
3. Observation well installed 7/21/97. Monitored to 8/5/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-1 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound, Grass Shoulder, Southern Edge.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/18/97	Completed: 7/21/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 39 hrs 24.0 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Loose, brown **SAND**, some silt, some mica, trace of red clay, moist. **(FILL)** *(Continued)*			J-7	0.8	7-5-10-7	●
965.0		35.0		35					
			0.3-ft: Loose, brown to black **SAND**, some silt, some mica, dry to moist. **(Colluvium/Residuum)** 1.0-ft: Loose, light brown **SAND**, some mica, dry to moist. **(Colluvium/Residuum)**			J-8	1.4	5-4-3-5	●
960.0		40.0		40					
958.7		41.3	Weathered **SANDSTONE**, moist to wet.			J-9	0.4	3-6-50/3"	● 9"
957.8		42.2	Augered from 41.3-ft to 42.2-ft.						
			Boring Terminated @ 42.2-ft. Auger Refusal.	45					
				50					
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 42.2-ft.
2. Hole dry on completion.
3. Observation well installed 7/21/97. Monitored to 8/5/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-2 | Sheet: 1 of 3

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/31/97	Completed: 7/31/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 120 hrs 59.5 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Loose, brown **SAND**, some silt, some mica, trace of gravel, dry to moist. **(FILL)**			J-1	0.8	2-2-5-5	
				5		J-2	0.6	3-3-9-50/5"	
			- boulder in bottom of split spoon at 6.8-ft. - small boulders from 7.0-ft to 9.2-ft.						
				10		J-3	1.6	2-3-3-9	
				15		J-4	0.7	3-4-4-2	
980.0		20.0		20					
			Loose to medium dense, brown **SAND**, some silt, some mica, moist to wet. **(FILL)**			J-5	1.3	3-1-1-1	
						J-6	1.3	3-3-3-4	
				25		J-7	1.3	3-2-5-5	
						J-8	1.6	1-2-2-2	
						J-9	1.8	1-1-1-5	
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 61.7-ft.
2. Hole dry on completion.
3. Slotted slope indicator pipe installed 7/31/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-2 | Sheet: 2 of 3

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder

Groundwater Depth:
Encountered at: ▽
At Completion: ▼
After 120 hrs 59.5 ft ▼
Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: 140 lbs/AUTO
Hammer Drop: 30 in.
Boring Began: 7/31/97 Completed: 7/31/97
Boring Method: HSA Inspector: Thornton
Hole Diameter: 8 O.D. Operator: Kingsley
Rock Core Diam: N/A Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION (Density, Color, Plasticity, Size, Proportions, Moisture)	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.
			Loose to medium dense, brown **SAND**, some silt, some mica, moist to wet. **(FILL)** *(Continued)*			J-10	0.8	3-4-9-10
968.0		32.0						
			Loose to medium dense, brown **SAND**, some silt, some mica, some organics, dry to moist. **(Colluvium/Residuum)**			J-11	2.0	3-4-3-5
				35		J-12	1.6	3-3-4-8
						J-13	1.8	2-5-6-5
961.6		38.4						
			Medium dense to dense, brown **SAND**, some silt, some mica, and **Weathered SANDSTONE**, dry to wet. **(Colluvium/Residuum)**	40		J-14	1.8	11-18-31-32
						J-15	1.1	9-6-10-10
						J-16	1.6	4-7-16-43
				45		J-17	0.8	25-22-10-6
954.0		46.0						
			Loose to medium dense, light brown to reddish brown **SAND**, some silt, some mica, moist to wet. **(Colluvium/Residuum)**			J-18	2.0	2-5-6-8
						J-19	2.0	5-5-6-12
				50		J-20	1.6	6-5-5-10
						J-21	1.6	0-4-7-5
945.4		54.6						
			Very dense, brown Weathered **SANDSTONE**, dry to moist.	55		J-22	1.5	8-33-50
						J-23	1.0	34-25-50
941.5		58.5				J-24	0.4	50/7"
			Augered from 58.5-ft to 61.7-ft. ▽	60				

Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 61.7-ft.
2. Hole dry on completion.
3. Slotted slope indicator pipe installed 7/31/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-2 | Sheet: 3 of 3

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder

Groundwater Depth:
Encountered at: ▽
At Completion: ▼
After 120 hrs 59.5 ft ▼

Surface Elevation: 1000.0 ft
Caved at:
Hammer Wt. & Type: 140 lbs/AUTO
Hammer Drop: 30 in.

Boring Began: 7/31/97 | Completed: 7/31/97
Boring Method: HSA | Inspector: Thornton
Hole Diameter: 8 O.D. | Operator: Kingsley
Rock Core Diam: N/A | Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	SAMPLE No.	SAMPLE Rec.	SAMPLE Blows per 6 in.
			Augered from 58.5-ft to 61.7-ft. *(Continued)*					
938.3		61.7	Boring Terminated @ 61.7-ft. Auger Refusal.					
				65				
				70				
				75				
				80				
				85				
				90				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 61.7-ft.
2. Hole dry on completion.
3. Slotted slope indicator pipe installed 7/31/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-3 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound, Grass Shoulder, Northern Edge.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/21/97	Completed: 7/21/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 77 hrs 39.2 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			TOPSOIL for top 3-inches.						
998.0		2.0	Loose, brown **SAND**, some silt, some fine gravel, dry. **(FILL)**			J-1	0.8	4-4-4-5	●
			Very loose to loose, brown **SAND**, some silt, some mica, trace of small gravel, moist. **(FILL)**	5		J-2	0.7	1-1-1-1	●
				10		J-3	0.7	1-1-3-3	●
			- small boulders between 12.5-ft and 14-ft.						
				15		J-4	0.8	1-3-4-4	●
980.0		20.0		20					
			Black **TOPSOIL**, fine gravel in bottom of split spoon, moist. **(Colluvium/Residuum)**			J-5	0.7	8-3-3-4	●
978.0		22.0	Loose, brown **SAND**, some silt, some mica, moist. **(Colluvium/Residuum)**						
				25		J-6	1.3	1-3-4-4	●
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 45.8-ft.
2. Hole dry on completion.
3. Observation well installed 7/22/97. Monitored to 8/5/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-3 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Southbound, Grass Shoulder, Northern Edge.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/21/97	Completed: 7/21/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 77 hrs 39.2 ft ▽	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.
969.7		30.3	White Weathered **SANDSTONE**, dry to moist. **(Colluvium/Residuum)**			J-7	1.6	10-28-21-16
965.0		35.0		35				
964.7		35.3	Brown **SAND**, some silt, some mica, dry to moist. **(Colluvium/Residuum)**			J-8	1.5	1-5-7-10
			White Weathered **SANDSTONE**, dry to moist. **(Colluvium/Residuum)**					
960.0		40.0		40				
			Loose, reddish brown **SAND**, some silt, some mica. **(Colluvium/Residuum)**			J-9	2.0	4-3-5-10
958.0		42.0						
			Weathered **SANDSTONE**					
954.6		45.4		45		J-10	0.4	50/2"
954.2		45.8	Augered from 45.4-ft to 45.8-ft.					
			Boring Terminated @ 45.8-ft. Auger Refusal.					
				50				
				55				
				60				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 45.8-ft.
2. Hole dry on completion.
3. Observation well installed 7/22/97. Monitored to 8/5/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-4 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder, Northern Edge.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/22/97	Completed: 7/22/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 98 hrs 40.8 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢——⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			TOPSOIL for top 5-inches.						
			Loose, brown and gray **SAND**, some silt, some mica, trace of fine gravel, dry to moist. **(FILL)**			J-1	1.0	3-2-4-5	●
			- trace of fine gravel from 5-ft to 7-ft.	5		J-2	1.4	2-2-5-5	●
993.0		7.0							
			Very loose to medium dense, reddish brown **SAND**, some silt, some mica, dry to moist. **(FILL)**	10		J-3	1.1	3-2-2-10	●
			- rock in end of split spoon from 15-ft to 17-ft.	15		J-4	1.0	4-6-10-9	●
			- trace of fine gravel from 20-ft to 22-ft.	20		J-5	0.8	3-4-7-6	●
978.0		22.0							
			Very loose, reddish brown and brown **SAND**, some silt, some mica, trace of fine gravel, moist to wet. **(FILL)**						
			- Weight of rod and hammer from 30-ft to 30.7-ft	25		J-6	0.3	1-1-1-1	●
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 56.0-ft.
2. Hole dry on completion.
3. Observation well installed 7/22/97. Monitored to 8/5/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B270-4 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Northbound, Grass Shoulder, Northern Edge.

Groundwater Depth:	Surface Elevation: 1000.0 ft	Boring Began: 7/22/97	Completed: 7/22/97
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 98 hrs 40.8 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: N/A	Weather: cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.
			Very loose, reddish brown and brown **SAND**, some silt, some mica, trace of fine gravel, moist to wet. **(FILL)**			J-7	1.6	0-1-2-3
			- Weight of rod and hammer from 30-ft to 30.7-ft *(Continued)*					
965.0		35.0		35				
964.7		35.3	**TOPSOIL (Colluvium/Residuum)**					
			Medium dense, brown and gray Weathered **SANDSTONE**, dry to moist. **(Colluvium/Residuum)**			J-8	1.0	2-8-13-8
				40				
			▼			J-9	1.8	8-16-12-8
958.0		42.0						
			Loose to medium dense, brown **SAND**, some silt, some mica, moist to wet. **(Colluvium/Residuum)**					
			- Slow, tight augering from 47-ft to 52-ft.	45		J-10	1.0	3-4-6-7
				50		J-11	1.0	
948.0		52.0						
			Very dense, gray and white Weathered **SANDSTONE**, wet.	55				
944.4		55.6				J-12	0.5	15-50/1"
944.0		56.0	Augered from 55.6-ft to 56-ft.					
			Boring Terminated @ 56-ft. Auger Refusal.	60				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Auger refusal at 56.0-ft.
2. Hole dry on completion.
3. Observation well installed 7/22/97. Monitored to 8/5/97.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B-1 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Toe of slope, southern most boring.

Groundwater Depth:	Surface Elevation: 946.0 ft	Boring Began: 5/28/03	Completed: 5/28/03
Encountered at: ▽	Caved at:	Boring Method: HSA	Inspector: Thornton
At Completion: ▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley
After 24 hrs 28.0 ft ▼	Hammer Drop: 30 in.	Rock Core Diam: 3-3/4" NQ	Weather: clear

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			FILL and **COLLUVIUM** (includes cobbles and boulders)						
941.0		5.0		5					
			Loose to medium dense, brown **SILT**, some sand, trace of mica, moist.			J-1	1.0	3-4-7-5	●
				10		J-2	1.5	3-4-5-6	●
934.0		12.0							
			Medium dense, brown **SILT** and **SAND**, trace of mica, moist.			J-3	1.8	4-9-10-8	●
				15		J-4	1.7	6-11-7-8	●
						J-5	1.6	3-6-11-37	●
						J-6	2.0	5-6-9-14	●
				20		J-7	1.6	6-11-12-24	●
			- Dense below 22-ft.			J-8	1.5	5-22-23-26	●
			- Wet @ 24-ft.	25		J-9	1.1	2-3-32-42	●
920.0		26.0							
			Very dense, brown, highly weathered **MICA SCHIST**, dry to moist.			J-10	0.6	11-50/2"	● 2"
			▽			J-11	1.1	8-17-50	●
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B-1 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Toe of slope, southern most boring.

Groundwater Depth:		Surface Elevation: 946.0 ft	Boring Began: 5/28/03	Completed: 5/28/03	
Encountered at:	▽	Caved at:	Boring Method: HSA	Inspector: Thornton	
At Completion:	▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley	
After 24 hrs	28.0 ft ▽	Hammer Drop: 30 in.	Rock Core Diam: 3-3/4" NQ	Weather: clear	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Very dense, brown, highly weathered **MICA SCHIST**, dry to moist. *(Continued)* - White from 30 ft. to 34 ft.		⊠	J-12	0.2	50/4"	4"
					⊠	J-13	0.2	50/2"	2"
				35	⊠	J-14	0.5	41-50/2"	2"
					⊠	J-15	0.2	50/3"	3"
					⊠	J-16	0.2	50/6"	6"
				40	⊠	J-17	0.0	50/2"	2"
904.0		42.0							
			Gray Unweathered **MICA SCHIST** Foliation Angle: 40 degrees Texture: Fine Hardness: Very Hard Core Recovery: 100%, RQD = 100%	45			5.0		
899.0		47.0							
			Boring Terminated @ 47.0 ft.						
				50					
				55					
				60					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B-2 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Toe of slope, middle boring.

Groundwater Depth:		Surface Elevation: 940.0 ft	Boring Began: 5/15/03	Completed: 5/20/03	
Encountered at:	▽	Caved at:	Boring Method: HSA	Inspector: Thornton	
At Completion:	▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley	
After ____ hrs	▼	Hammer Drop: 30 in.	Rock Core Diam: 3-3/4" NQ	Weather: cloudy/rain	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			FILL and **COLLUVIUM** (includes cobbles and boulders)	5					
930.0		10.0		10					
			Loose to medium dense, brown **SILT** and **SAND**, trace of mica, dry to moist.			J-1	1.9	2-5-14-14	●
						J-2	1.4	3-4-14-9	●
				15		J-3	1.6	5-6-11-9	●
						J-4	1.5	3-7-9-11	●
						J-5	1.8	4-7-8-11	●
				20		J-6	1.8	3-5-9-12	●
			- White and moist to wet below 22 ft.			J-7	1.4	4-6-6-8	●
				25		J-8	1.9	3-5-6-5	●
						J-9	1.8	2-2-4-5	●
						J-10	1.9	3-4-6-6	●
910.0		30.0		30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Slope indicator installed to 55-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B-2 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Toe of slope, middle boring.

Groundwater Depth:		Surface Elevation: 940.0 ft	Boring Began: 5/15/03	Completed: 5/20/03	
Encountered at:	▽	Caved at:	Boring Method: HSA	Inspector: Thornton	
At Completion:	▼	Hammer Wt. & Type: 140 lbs/AUTO	Hole Diameter: 8 O.D.	Operator: Kingsley	
After ____ hrs	▼	Hammer Drop: 30 in.	Rock Core Diam: 3-3/4" NQ	Weather: cloudy/rain	

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.
			Very dense, brown, highly weathered **MICA SCHIST**, wet.		SPT	J-11	0.9	5-50/4"
					SPT	J-12	1.8	18-26-28-50/4"
					SPT	J-13	0.2	50/3"
				35				
904.0		36.0						
			Medium dense, brown **SILT** and **SAND**, trace of mica, wet.		SPT	J-14	0.6	6-14-8-10
902.0		38.0						
			Very dense, brown, highly weathered **MICA SCHIST**, moist.		SPT	J-15	0.8	4-50/3"
900.0		40.0		40				
			Medium dense, brown **SILT** and **SAND**, trace of mica, moist.		SPT	J-16	0.8	11-9-15-23
898.0		42.0						
			Very dense, brown, highly weathered **MICA SCHIST**, moist.		SPT	J-17	1.2	6-14-50/2"
					SPT	J-18	0.8	28-50/3"
				45				
894.0		46.0						
			Gray Unweathered to Slightly Weathered **MICA SCHIST** Foliation Angle: 60 degrees Texture: Fine Hardness: Very Hard Core Recovery = 95%, RQD = 92%				3.8	
890.0		50.0		50				
			Gray and white Unweathered **MICA SCHIST** Foliation Angle: 60 degrees Texture: Fine Hardness: Very Hard Core Recovery = 100%, RQD = 100%				5.0	
885.0		55.0		55				
			Gray Unweathered **MICA SCHIST** Foliation Angle: Not measured Texture: Fine				2.2	
882.8		57.2	Hardness: Very Hard Core Recovery = 100%, RQD = 100%					
			Boring Terminated @ 57.2 ft.	60				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)

10 20 40 60 80

4" 3" 3" 8" 3"

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. Slope indicator installed to 55-ft.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B-3 | Sheet: 1 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Toe of slope, northern most boring.

Groundwater Depth:		Surface Elevation:	938.0 ft	Boring Began:	5/14/03
Encountered at:	▽	Caved at:	30.0 ft	Boring Method:	HSA
At Completion:	▼	Hammer Wt. & Type:	140 lbs/AUTO	Hole Diameter:	8 O.D.
After 24 hrs	28.0 ft ▼	Hammer Drop:	30 in.	Rock Core Diam:	3-3/4" NQ

Completed:	5/14/03
Inspector:	Thornton
Operator:	Kingsley
Weather:	cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.	▼ Water Content % Plastic Limit ⊢—⊣ Liquid Limit ● Standard Penetration Test Data (Blows / ft) 10 20 40 60 80
			Loose, brown **SILT**, some sand, trace of mica, moist. **(FILL)**			J-1	1.3	2-3-4-4	●
				5		J-2	0.4	4-9-1-1	●
931.0		7.0							
			FILL and COLLUVIUM(includes cobbles and boulders)	10		J-3	0.9	5-26-36-22	●
926.0		12.0							
			Medium dense, brown **SILT** and **SAND**, trace of mica (dry)			J-4	1.1	2-9-21-17	●
				15		J-5	1.3	5-11-12-14	●
			- Dense to very dense from 16-ft. to 20-ft.			J-6	0.8	3-21-28-15	●
						J-7	0.4	4-50/2"	● 2"
				20		J-8	1.9	8-18-19-22	●
			- Moist below 21-ft.						
			- White from 22-ft. to 25.5-ft.			J-9	2.0	8-8-12-15	●
				25		J-10	2.0	5-8-10-12	●
						J-11	2.0	4-8-10-10	●
			▼						
						J-12	2.0	3-6-5-10	●
				30					

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. The water level 48 and 72 hours after drilling was 28.0.

BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

BORING LOG

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION

Project Name: PRA-BLRI 2E15, Blue Ridge Parkway | Boring No.: B-3 | Sheet: 2 of 2

Project Location: MP 270.3, Deep Gap, NC | Boring Location: Toe of slope, northern most boring.

Groundwater Depth:		Surface Elevation:	938.0 ft	Boring Began:	5/14/03
Encountered at:	▽	Caved at:	30.0 ft	Boring Method:	HSA
At Completion:	▼	Hammer Wt. & Type:	140 lbs/AUTO	Hole Diameter:	8 O.D.
After 24 hrs	28.0 ft ▼	Hammer Drop:	30 in.	Rock Core Diam:	3-3/4" NQ

Completed:	5/14/03
Inspector:	Thornton
Operator:	Kingsley
Weather:	cloudy

Elevation (feet)	Graphic Log	Layer Depth (ft)	MATERIAL DESCRIPTION Density, Color, Plasticity, Size, Proportions, Moisture	Depth Scale (ft)	SAMPLE Type	No.	Rec.	Blows per 6 in.
			Medium dense, brown **SILT** and **SAND**, trace of mica (dry) *(Continued)*		J	-13	1.8	3-4-5-8
			- Loose from 30-ft to 34-ft.		J	-14	2.0	2-3-4-32
			- Very dense from 34-ft. to 36-ft.					
			- Wet from 34-ft. to 40-ft.	35	J	-15	1.1	22-43-21-21
					J	-16	1.3	5-10-19-19
					J	-17	1.2	10-9-14-11
				40	J	-18	1.5	9-9-11-37
					J	-19	1.6	12-3-6-9
894.0		44.0						
			Very dense, gray, highly weathered **MICA SCHIST** (moist)	45	J	-20	0.8	3-50/4"
					J	-21	0.1	50/1"
890.5		47.5						
			Boring Terminated @ 47.5-ft.					
				50				
				55				
				60				

▼ Water Content %
Plastic Limit ⊢——⊣ Liquid Limit
● Standard Penetration Test Data (Blows / ft)
10 20 40 60 80

Sample Types:
- Auger Cuttings
- Vane Shear
- SPT
- UD
- Penetrometer
- Rock Core

Remarks:
1. The water level 48 and 72 hours after drilling was 28.0.

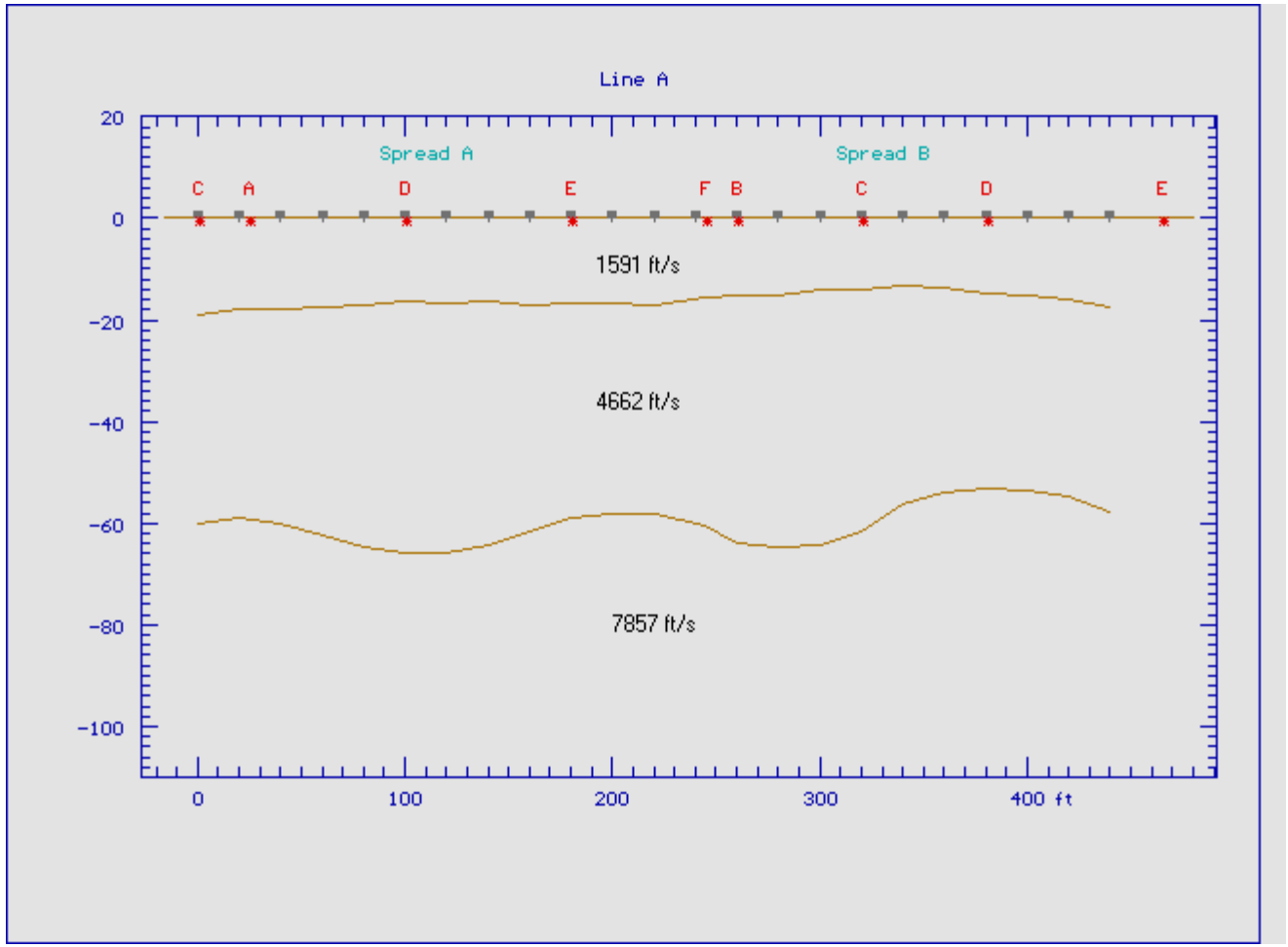
BORING LOG BLRI2E15_BORINGS.GPJ FHWA_VA.GDT 10/12/07

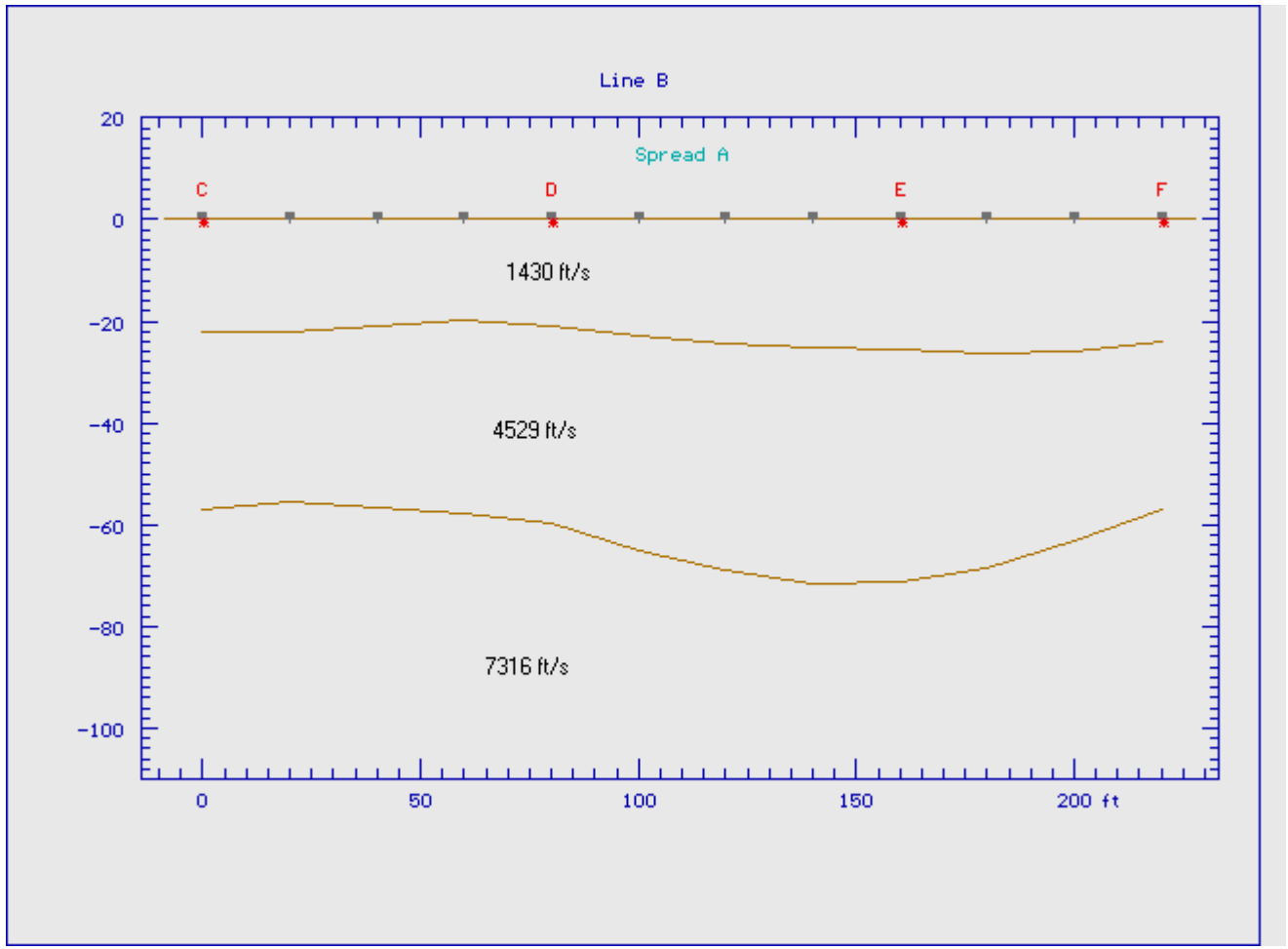
Water level measurements
BLRI 2E15
Landslide, Milepost 270.3

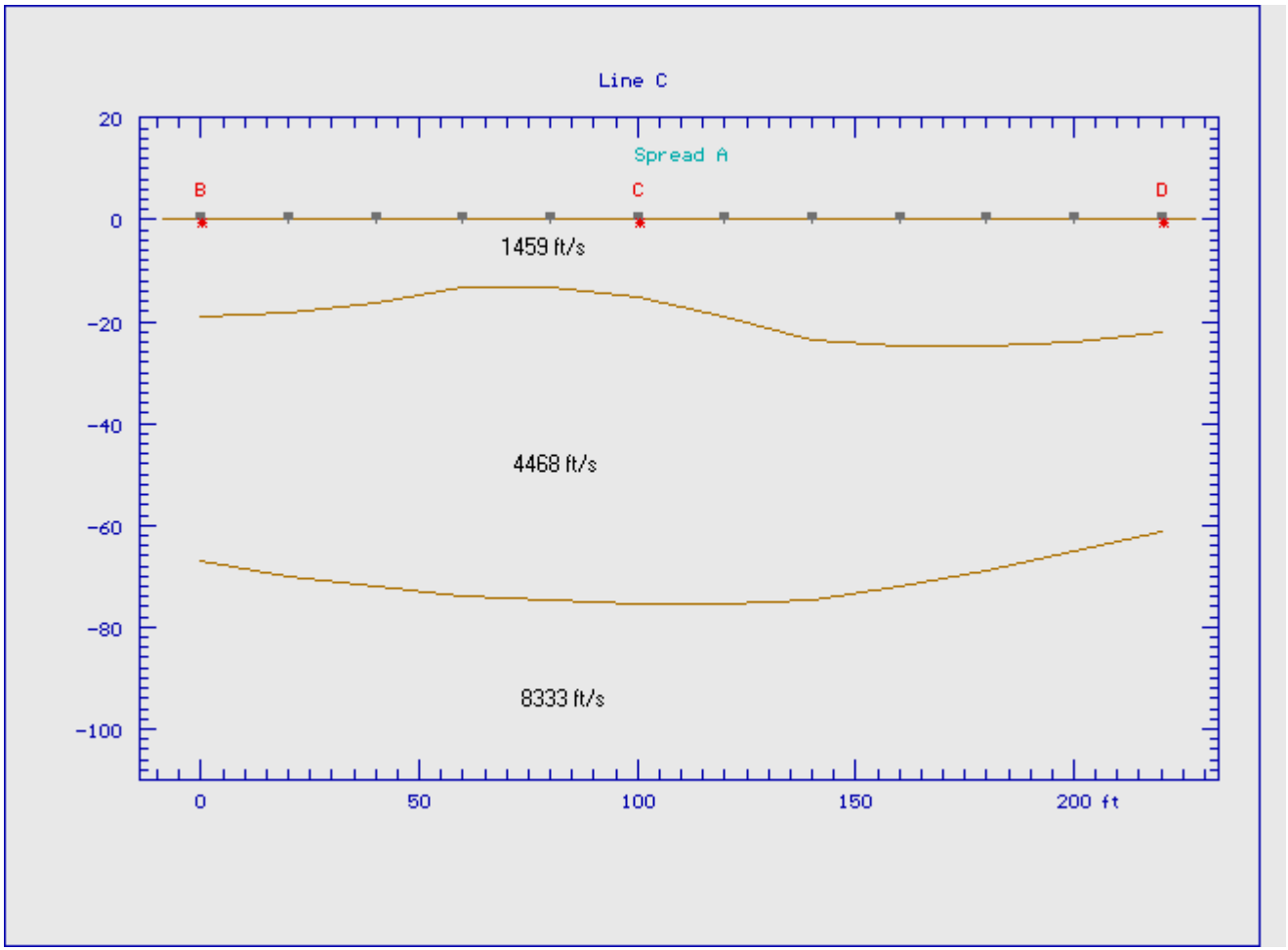
Water Depth (ft)	**Date**								
Well	7/21/1997	7/22/1997	7/23/1997	7/24/1997	7/30/1997	7/31/1997	8/1/1997	8/5/1997	3/17/1999
WW-1 (FD-13)	30.4	30.4	30.3	30.4	30.5	30.4	29.5	30.6	31.1
WW-2 (C-2)	20	19.7	19.7	20	19.8	dry	dry	dry	dry
WW-3 (FD-6)	dry	dry	dry	dry	dry	dry	dry	dry	dry
WW-4				10.6	10.5	10.6	10.8	10.7	
B270-1	39	40.3	39.9	39.7	40	40.2	40	40	broken
B270-2						dry	dry	59.5	56.3
B270-3		39	39	39	39.2	39.3	39.2	40.6	40.6
B270-4			47.6	47.7	47.8	47.6	47.7	40.8	49.3

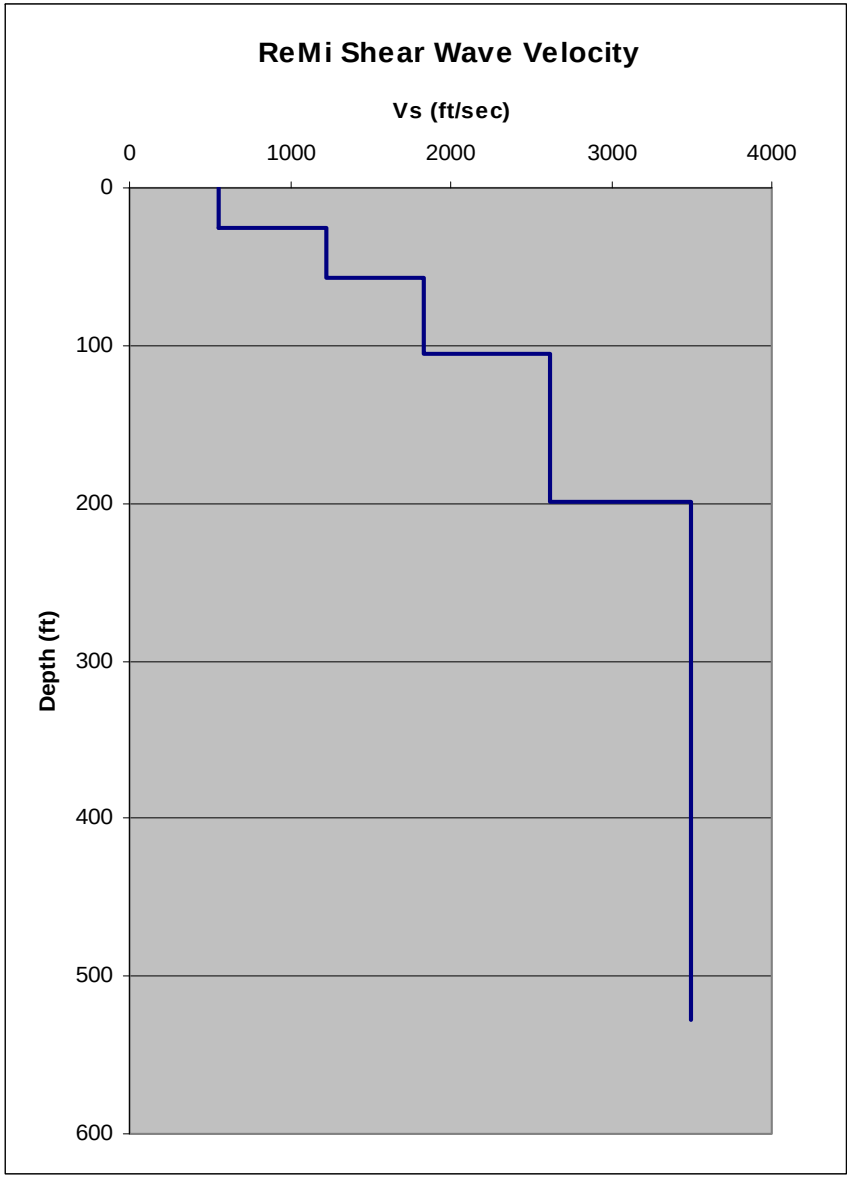
Location of B270-1 and B270-2 are unknown
Location of WW-4 is unknown

APPENDIX D
Geophysics


Line A
Spread A
Spread B
C
A
D
E
F
B
C
D
E
20
0
-20
-40
-60
-80
-100
1591 ft/s
4662 ft/s
7857 ft/s
0
100
200
300
400 ft


Line B
Spread A
C
D
E
F
20
0
-20
-40
-60
-80
-100
1430 ft/s
4529 ft/s
7316 ft/s
0
50
100
150
200 ft


Line C
Spread A
B
C
D
20
0
-20
-40
-60
-80
-100
1459 ft/s
4468 ft/s
8333 ft/s
0
50
100
150
200 ft


ReMi Shear Wave Velocity
Vs (ft/sec)
0
1000
2000
3000
4000
Depth (ft)
0
100
200
300
400
500
600

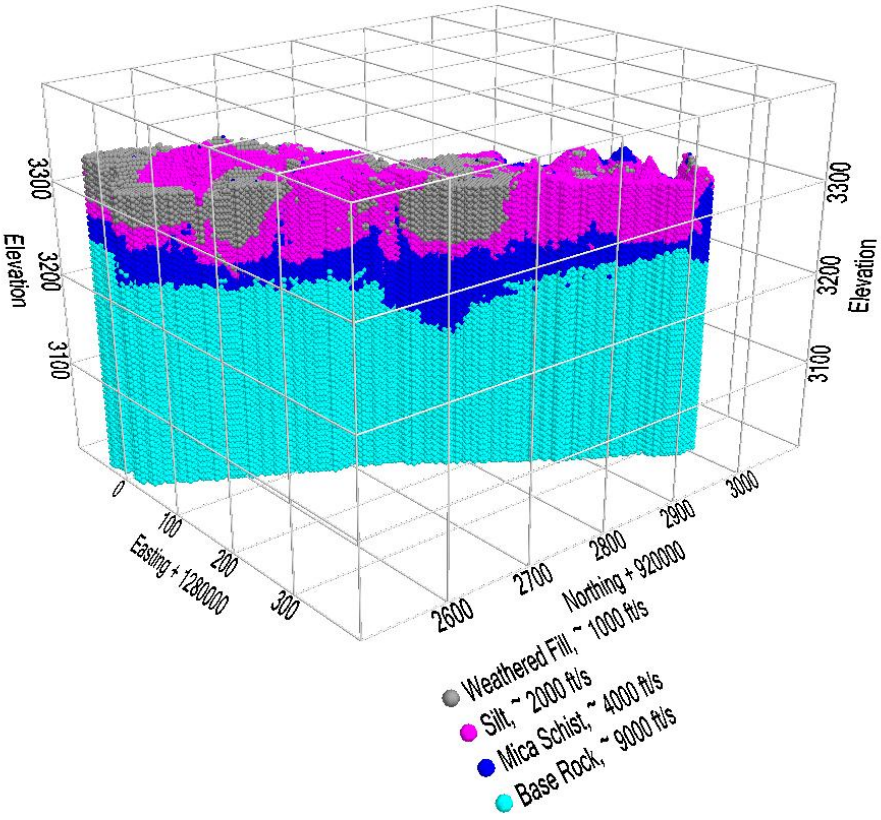


Figure 3. Refraction Tomogram Material Model

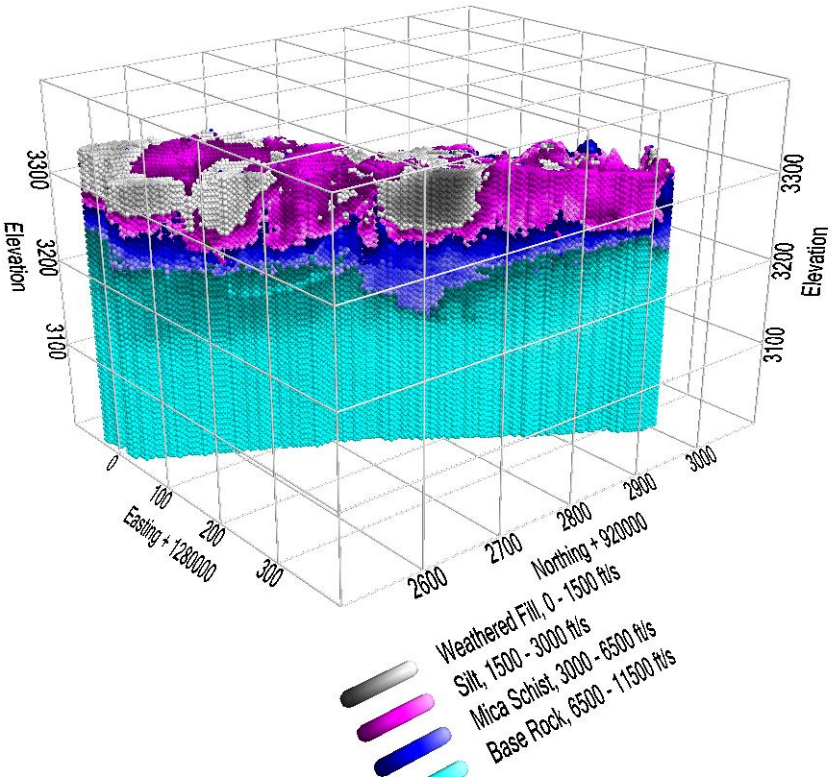


Figure 4. Velocity Variations within Layers

October 24, 2007

Khalid Mohamed, P.E.
FHWA-EFLHD
2400 Ridgetop
Sterling, Virginia 20166
(703) 404-6347

Re: Summary of Seismic Refraction Data Processing for the Blue Ridge Parkway, Deep Gap, North Caroline. (BH #5100).

The following letter provides a brief report on the data processing for the seismic refraction data sets collected by Eastern Federal Lands Highway Division (EFLHD). The data includes 3 lines with a total of 3 seismic refraction spreads. Data were collected using a 24-channel receiver array on Lines 1 and 2 and a 12-channel receiver array on Line 3. The array geometry is outlined in the observer's notes provided by EFLHD. Additional information including seismograph, geophones, etc. was not provided, but is typically not critical for data processing.

ZAPATAENGINEERING, Blackhawk Division (Blackhawk) performed the data reduction and processing only and did not collect the data or oversee data collection. The field notes, seismic data, and land survey data were provided by EFLHD.

Data Processing:
The seismic data were processed using the Generalized Reciprocal Method (GRM) and the refraction tomography method. The standard refraction processing (GRM) was performed using Gremix written by Interpex, Ltd and the refraction tomography processing was performed using SeisImager written by Oyo Geospace, Inc.

The general data processing flow is outlined below:

- Import each shot record into Pickwin95 (Oyo SeisImager software)
- Apply 2D geometry corrections and save file (SeisImager internal format)
- Pick first arrival data for each shot record
- Create ASCII elevation file in appropriate format
- Import first break pick file and elevation file into Plotrefa (Oyo SeisImager software)
- Create initial tomography model

- Run refraction tomography inversion
- Trim and rescale image based on raypath data
- Screen capture and export velocity tomogram
- Import tomograms into CorelDraw to create figures
- Convert original FBT files into Interprex format
- Import data into Gremix
- Process and interpret data using GRM and/or Time Delay method
- Export DXF plots
- Incorporate tomography results into DXF plots

General Data Considerations:
In general, the overall data quality was fair for near offset traces and poor for long offset traces. The signal-to-noise ratios were generally low on traces representing longer source-receiver offsets and first break times often could not be accurately determined on the longest offsets. Band pass filtering was applied to the data sets during picking and provided marginal data improvement on some of the data records.

Individual Seismic Refraction Lines

Each seismic line is shown as a separate figure. Each figure contains a plot of the standard refraction processing results (line drawing) with the velocity tomogram incorporated into the cross section plot. The plots are divided into three windows. The upper window shows the first break time picks for each shot record with the layer assignments. The middle window shows the interpreted cross section with the ground surface layer and the refractor horizon derived from the GRM results with the velocity tomogram superimposed. The lower window shows the variation in velocity across the line for V1 (overburden velocity) and V2 (refractor velocity). The dashed lines of the GRM refractor horizon indicate areas where there was insufficient source offset on the off-end shots to accurately image the refractor. The range of error for the interpreted depths and velocities may be significantly higher in these regions.

In general, the GRM results should be considered the most representative of absolute depth to the refractor and for the refractor velocity. The velocity tomogram generally identifies lateral velocity variation better than the GRM method, but tends to underestimate the refractor velocity and poorly define the depth to the refractor horizon.

Limitations and Recommendations

The accuracy of the results from the data processing of these datasets are limited by the low signal-to-noise ratios recorded on the longer offsets which limit the data redundancy used to improve accuracy. Some suggestions for improving signal-to-noise ratio include increasing the number of source stacks (vertical stacking) or increasing the signal-to-noise ratio by using a larger source. For a sledgehammer source, this can be accomplished by using a sledgehammer with a heavier head weight. Sledgehammers are available up to 20 pounds. Vertical stacking can be useful, but has limitations based on

the type, frequency and amplitude of the ambient noise and by the precision (repeatability) of the trigger timing mechanism.

Additional suggestions for future work include the following general rules of thumb for designing acquisition parameters:

- Source array length equal to 3 to 5 times the target depth
- Source offset for off-end shots ≥ the crossover distance (~ 100 ft for Line 1)
- Increase the number of source locations internal to the spread

The general source location layout for refraction includes seven source locations: a source location at each end of a spread, an off-end location at each end of the spread at a distance greater than the crossover distance, and three source locations internal to the spread. The internal source locations are distributed symmetrically across the spread halfway between the geophone stations. For a 24 channel spread the general source location layout would be between geophone channels 6 and 7, geophone channels 12 and 13, and geophone channels 18 and 19. Increasing the number of source locations internal to the spread improves the tomography solution and also provides improved V1 velocity control for the GRM processing.

Blackhawk appreciates this opportunity to be of service to EFLHD. If you have any questions, please feel free to contact me at (303) 278-8700.

Sincerely,

Jim Pfeiffer
Associate Geophysicist

Jim Hild
Manager/Sr. Geophysicist

All geophysical data analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by ZAPATA ENGINEERING P.A. Blackhawk Division, Senior Geophysicists, and Engineers.

A geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations, or ordinances.

North

South

TIME (MILLISECONDS)

ELEVATION (feet)

Ground Surface

Interpreted Top of Bedrock

Tomography Velocity (ft/s)

8500
7500
6500
5500
4500
3500
2500
1500
500

Elevation in Feet

Distance in Feet

VELOCITY (Feet/SEC) x 1000

Overburden Velocity

Bedrock Velocity

1700 1200 1180 1090

12800 12800 12800 11000

Line 2

Line 3

DISTANCE (feet)

NOTE:
Dashed Line = Greater Uncertainty
Due to Limited Data Coverage

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A DIVISION OF ZAPATA ENGINEERING

301 Commercial Road,
Suite B
Golden, Colorado 80401

Phone: (303) 278-8700
Fax: (303) 278-0789
Web: www.blackhawkgeo.com

FHWA-EFLHD
Eastern Federal Lands Highway Division
Sterling, Virginia

Line 1
Seismic Refraction GRM & Tomography Survey
Deep Gap
North Carolina

Project No:	Date:	Drawn By:	Checked By:	Scale:	Figure:
5100	October, 2007	HJV	JP	H40' - V100'	1

East

West

TIME (MILLISECONDS)

ELEVATION (feet)

Ground Surface

B3

B2

B1

D

S

Interpreted Top of Bedrock

VELOCITY (feet/SEC) x 1000

1200

1130

1250

1490

4400

7900

11900

11300

Overburden Velocity

Bedrock Velocity

Line 1

DISTANCE (feet)

Tomography Velocity (ft/s)

8500
7500
6500
5500
4500
3500
2500
1500
500

Elevation in Feet

Distance in Feet

NOTE:

Dashed Line = Greater Uncertainty
Due to Limited Data Coverage

Data from Borehole Logs

D = Dense Layer
S = Mica Schist

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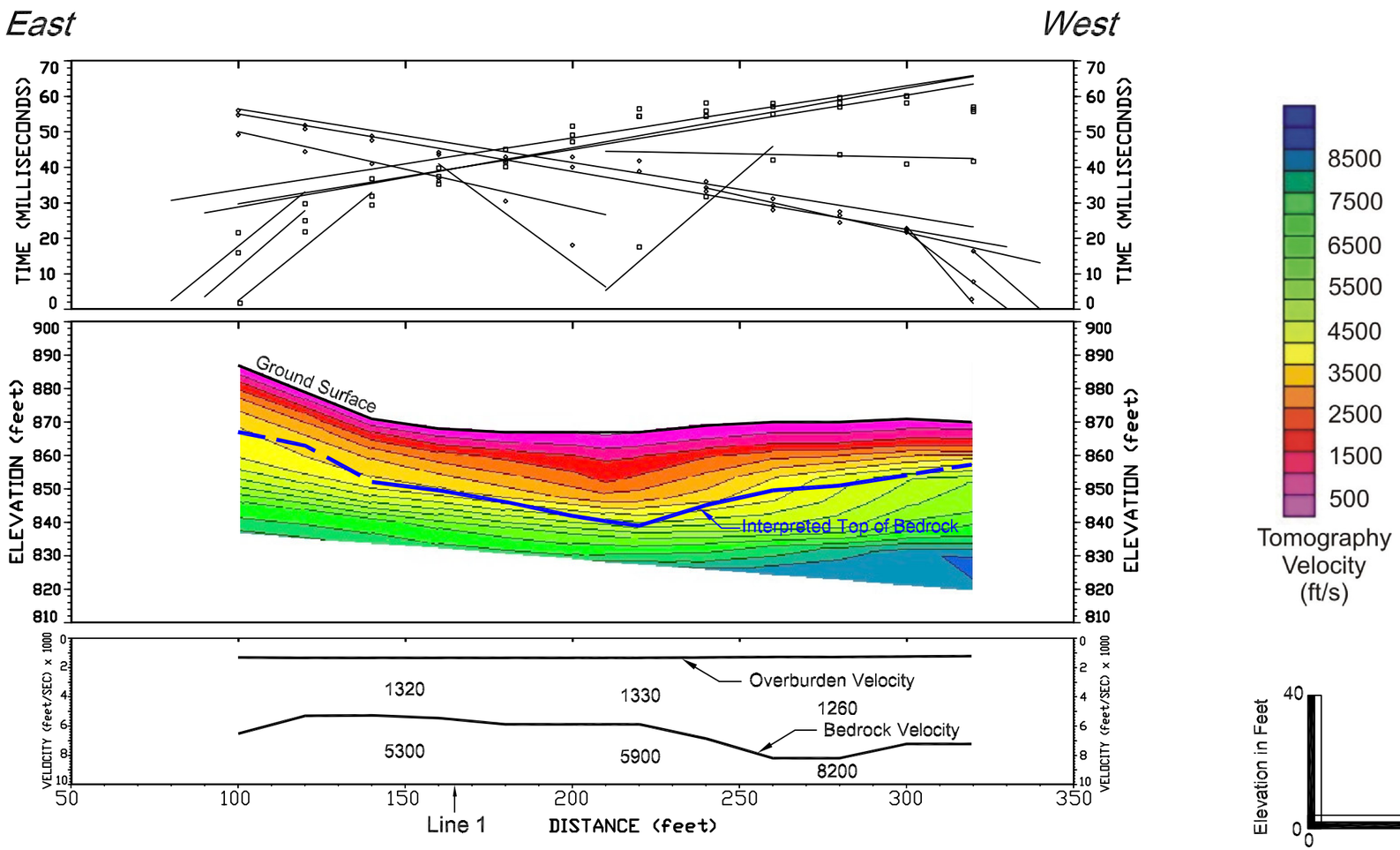
FHWA-EFLHD
Eastern Federal Lands Highway Division
Sterling, Virginia

Line 2
Seismic Refraction GRM & Tomography Survey
Deep Gap
North Carolina

Project No:	Date:	Drawn By:	Checked By:	Scale:	Figure:
5100	October, 2007	HJV	JP	H40' - V40'	2



NOTE:
Dashed Line = Greater Uncertainty
Due to Limited Data Coverage

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FHWA-EFLHD
Eastern Federal Lands Highway Division
Sterling, Virginia

Line 3
Seismic Refraction GRM & Tomography Survey
Deep Gap
North Carolina

Project No:	Date:	Drawn By:	Checked By:	Scale:	Figure:
5100	October, 2007	HJV	JP	H40' - V40'	3

APPENDIX E

Laboratory Testing

U.S. Department of Transportation
Federal Highway Administration
Federal Lands Highway Office

Eastern Federal Lands Highway Division
Materials Testing Laboratory
112 Industrial Park, Sevierville, TN 37862

Project Name:	Blue Ridge Parkway MP 270.3 Slide	**State:**	NC
Project Number:	BLRI 2E15		
Sampled By:	Geotech		
Field Sample No:	B-1		
Submitted By:	B. Lawrence		
Boring No:	B-1	**Depth:**	44.0 - 44.4

Unconfined Compressive Strength of Intact Rock Core (ASTM 2938)

Unconfined Compressive Strength, psi	6220

Charles W. McCown, Jr. - Laboratory Team Leader

Date

U.S. Department of Transportation
Federal Highway Administration
Federal Lands Highway Office

Eastern Federal Lands Highway Division
Materials Testing Laboratory
112 Industrial Park, Sevierville, TN 37862

Project Name:	Blue Ridge Parkway MP 270.3 Slide		**State:** NC
Project Number:	BLRI 2E15		
Sampled By:	Geotech		
Field Sample No:	B-1/ 1		
Submitted By:	B. Lawrence		
Boring No:	B-1	**Sample No:** 1	**Depth:** 46.3 - 46.7

Unconfined Compressive Strength of Intact Rock Core (ASTM 2938)

Unconfined Compressive Strength, psi	2470

Charles W. McCown, Jr. - Laboratory Team Leader

Date

U.S. Department of Transportation
Federal Highway Administration
Federal Lands Highway Office

Eastern Federal Lands Highway Division
Materials Testing Laboratory
112 Industrial Park, Sevierville, TN 37862

Project Name:	Blue Ridge Parkway MP 270.3 Slide		**State:** NC
Project Number:	BLRI 2E15		
Sampled By:	Geotech		
Field Sample No:	B-2/ 2		
Submitted By:	B. Lawrence		
Boring No:	B-2	**Sample No:** 2	**Depth:** 50.2 - 50.7

Unconfined Compressive Strength of Intact Rock Core (ASTM 2938)

Unconfined Compressive Strength, psi	5180

Charles W. McCown, Jr. - Laboratory Team Leader — Date

U.S. Department of Transportation
Federal Highway Administration
Federal Lands Highway Office

Eastern Federal Lands Highway Division
Materials Testing Laboratory
112 Industrial Park, Sevierville, TN 37862

Project Name:	Blue Ridge Parkway MP 270.3 Slide		**State:** NC
Project Number:	BLRI 2E15		
Sampled By:	Geotech		
Field Sample No:	B-2/ 1		
Submitted By:	B. Lawrence		
Boring No:	B-2	**Sample No:** 1	**Depth:** 53.6 - 53.9

Unconfined Compressive Strength of Intact Rock Core (ASTM 2938)

Unconfined Compressive Strength, psi	4980

Charles W. McCown, Jr. - Laboratory Team Leader

Date

U.S. Department of Transportation
Federal Highway Administration
Federal Lands Highway Office

Eastern Federal Lands Highway Division
Materials Testing Laboratory
112 Industrial Park, Sevierville, TN 37862

Project Name:	Blue Ridge Parkway MP 270.3 Slide	**State:**	NC
Project Number:	BLRI 2E15		
Sampled By:	Geotech		
Field Sample No:	B-2		
Submitted By:	B. Lawrence		
Boring No:	B-2	**Depth:**	56.7 - 57.1

Unconfined Compressive Strength of Intact Rock Core (ASTM 2938)

Unconfined Compressive Strength, psi	1560

Charles W. McCown, Jr. - Laboratory Team Leader

Date

APPENDIX F
Design Calculations

BLRI 2E15
Ground Anchor Design
Landslide, MP 270.3

GEC 4

5.3 - Anchor bond zone must be located sufficiently behind the critical potential failure surface so that load is not transferred from the anchor bond zone into the "no-load" zone.

No Load - unbonded length: Typically a distance of H/5 or 1.5 meters behind critical potential failure surface

5.7 - Anchored slopes and landslide stabilization systems

Use Limit Equilibrium analysis

5.7.3 - Limit equilibrium methods

* Use one or both of two methods - both highly localized
  - apply surcharge or concentrated load to slope face
  - apply concentrated force to slice base where anchor crosses
* plus hand calculation check

Anchor Design:

5.3.4 Design of Unbonded length

$min_{strand} := 15ft$ Minimum lengths of unbonded zones for strand and bar anchors

$min_{bar} := 10ft$

$L_{unbond\_crit} := 5ft$ Minimum length of unbonded zone beyond critical failure zone (or H/5)

5.3.6 Design of the anchor bond length

Typical Anchor characteristics:

1. Design Load between 260 and 1160 kN (58 to 260 kips)
2. Total anchor length between 30 and 60 ft.
3. Anchors installed between 10 and 45 degrees from horizontal, 15 to 30 degrees common

First step: Assume maximum anchor bond length of 25 ft. for rock and 15 degree inclination

$kips := 1000lbf$

Calculation of Bond Length:

Rock-grout length:

$d_0 := 3in$ $d_1 := 4in$ $d_2 := 5in$ $d_3 := 6in$ Possible drill hole diameters

$Q := 300kips$ Load per anchor

From GEC-4 (Table 7 assumes competent rock):

Table 7. Presumptive average ultimate bond stress for ground/grout interface along anchor bond zone (after PTI, 1996).

Rock		Cohesive Soil		Cohesionless Soil	
Rock type	Average ultimate bond stress (MPa)	Anchor type	Average ultimate bond stress (MPa)	Anchor type	Average ultimate bond stress (MPa)
Granite and basalt	1.7 - 3.1	Gravity-grouted anchors (straight shaft)	0.03 - 0.07	Gravity-grouted anchors (straight shaft)	0.07 - 0.14
Dolomitic limestone	1.4 - 2.1	Pressure-grouted anchors (straight shaft)		Pressure-grouted anchors (straight shaft)	
Soft limestone	1.0 - 1.4	• Soft silty clay	0.03 - 0.07	• Fine-med. sand, med. dense – dense	0.08 - 0.38
Slates and hard shales	0.8 - 1.4	• Silty clay	0.03 - 0.07	• Med.–coarse sand (w/gravel), med. dense	0.11 - 0.66
Soft shales	0.2 - 0.8	• Stiff clay, med. to high plasticity	0.03 - 0.10	• Med.–coarse sand (w/gravel), dense - very dense	0.25 - 0.97
Sandstones	0.8 - 1.7	• Very stiff clay, med. to high plasticity	0.07 - 0.17	• Silty sands	0.17 - 0.41
Weathered Sandstones	0.7 - 0.8	• Stiff clay, med. plasticity	0.10 - 0.25	• Dense glacial till	0.30 - 0.52
Chalk	0.2 - 1.1	• Very stiff clay, med. plasticity	0.14 - 0.35	• Sandy gravel, med. dense-dense	0.21 - 1.38
Weathered Marl	0.15 - 0.25	• Very stiff sandy silt, med. plasticity	0.28 - 0.38	• Sandy gravel, dense-very dense	0.28 - 1.38
Concrete	1.4 - 2.8				

Note: Actual values for pressure-grouted anchors depend on the ability to develop pressures in each soil type.

Table 8. Presumptive ultimate values of load transfer for preliminary design of ground anchors in rock.

Rock type	Estimated ultimate transfer load (kN/m)
Granite or Basalt	730
Dolomitic Limestone	580
Soft Limestone	440
Sandstone	440
Slates and Hard Shales	360
Soft Shales	150

Typical ranges of ultimate bond stress values for the rock/grout interface which have been measured are provided in table 7. Alternatively, PTI (1996) suggests that the ultimate bond stress between rock and grout can be approximated as 10 percent of the unconfined compressive strength of the rock up to a maximum value for ultimate bond stress of 3.1 MPa.

GEC refers to PTI (1996) recommendation that ultimate bond stress between rock and grout can be approximated as 10 percent of the unconfined compressive strength of the rock up to a maximum value of 3.1 MPa (450 psi).

LAB TESTING

$$UCRock := \begin{pmatrix} 1560 \\ 4980 \\ 5180 \\ 2470 \\ 6220 \end{pmatrix} psi$$

Results of Laboratory Unconfined Compression Strength Tests

$\mu_{UCRock} := mean(UCRock)$ $\quad \mu_{UCRock} = 4082\,psi$ Mean Strength of sample

$\sigma_{UCRock} := Stdev(UCRock)$ $\quad \sigma_{UCRock} = 1971\,psi$ Standard Deviation of sample

Approximately 90% confidence that strength of intact rock is greater than:

$StrengthIntRock := \mu_{UCRock} - 1.28 \cdot \sigma_{UCRock}$ $\quad StrengthIntRock = 1559\,psi$

Multiply by 10 percent :

$UltStrRockGrout := if(StrengthIntRock \cdot 0.10 < 450psi, StrengthIntRock \cdot 0.10, 450psi)$

$UltStrRockGrout = 156\,psi$

Allowable Rock-Grout Bond:

$$\tau_{a\_calc} := \frac{UltStrRockGrout}{3} \qquad \tau_{a\_calc} = 52\,psi$$

Allowable/working bond stress (includes FS = 3) as recommended by Wyllie and by GEC-4

Check: From Table 9.2 (Wyllie), sandstone working bond stress is 40 to 80 psi. Site is part sandstone and part mica schist. Estimate mica schist is 50 psi based on AASHTO typical range of compressive strengths for schist divided by 30 (per Wyllie eq. 9.9) and assuming weaker because of mica content.

Use design bond of:

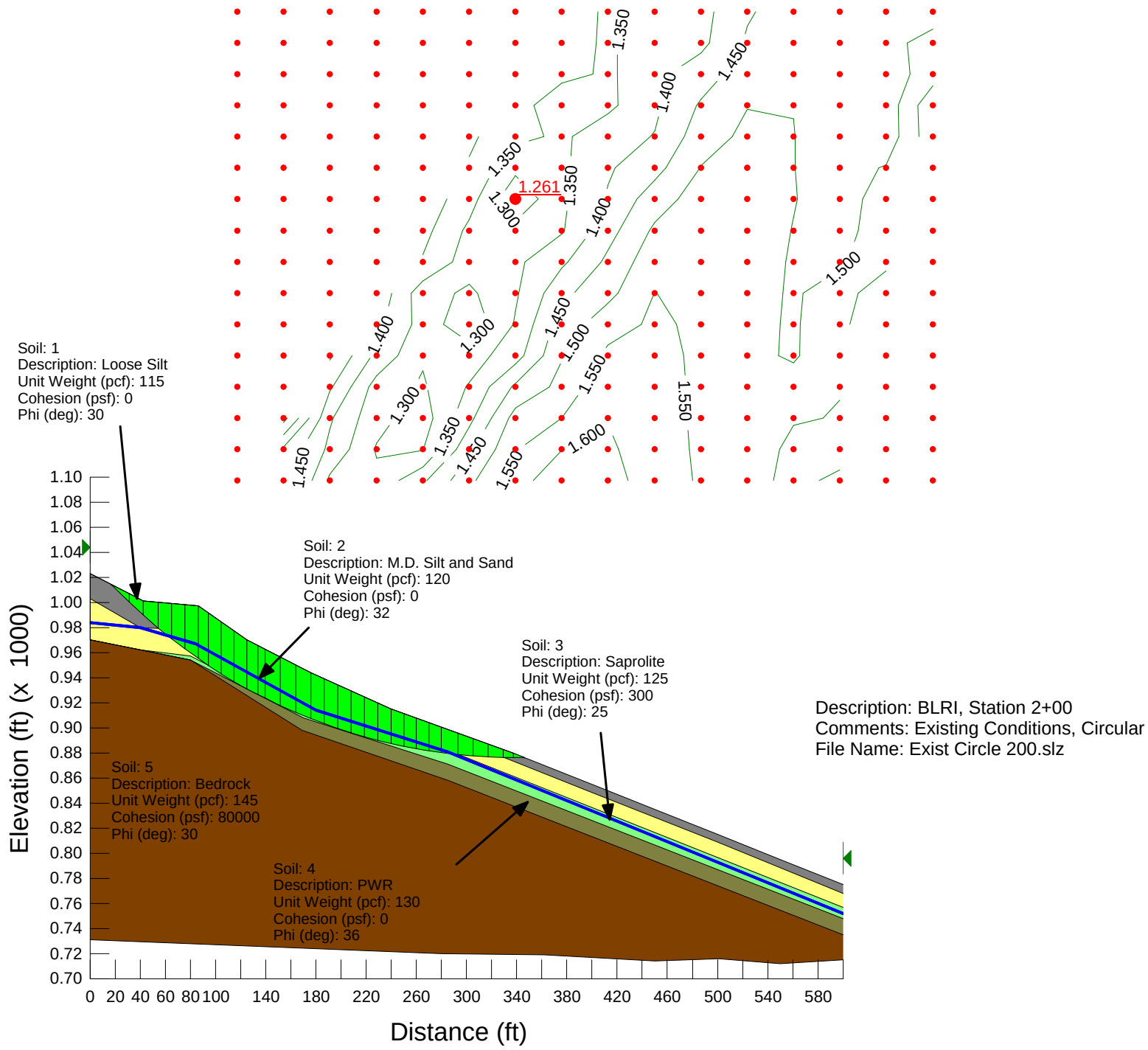
$$\tau_a := 50\text{psi}$$

9.3.2 Wyllie

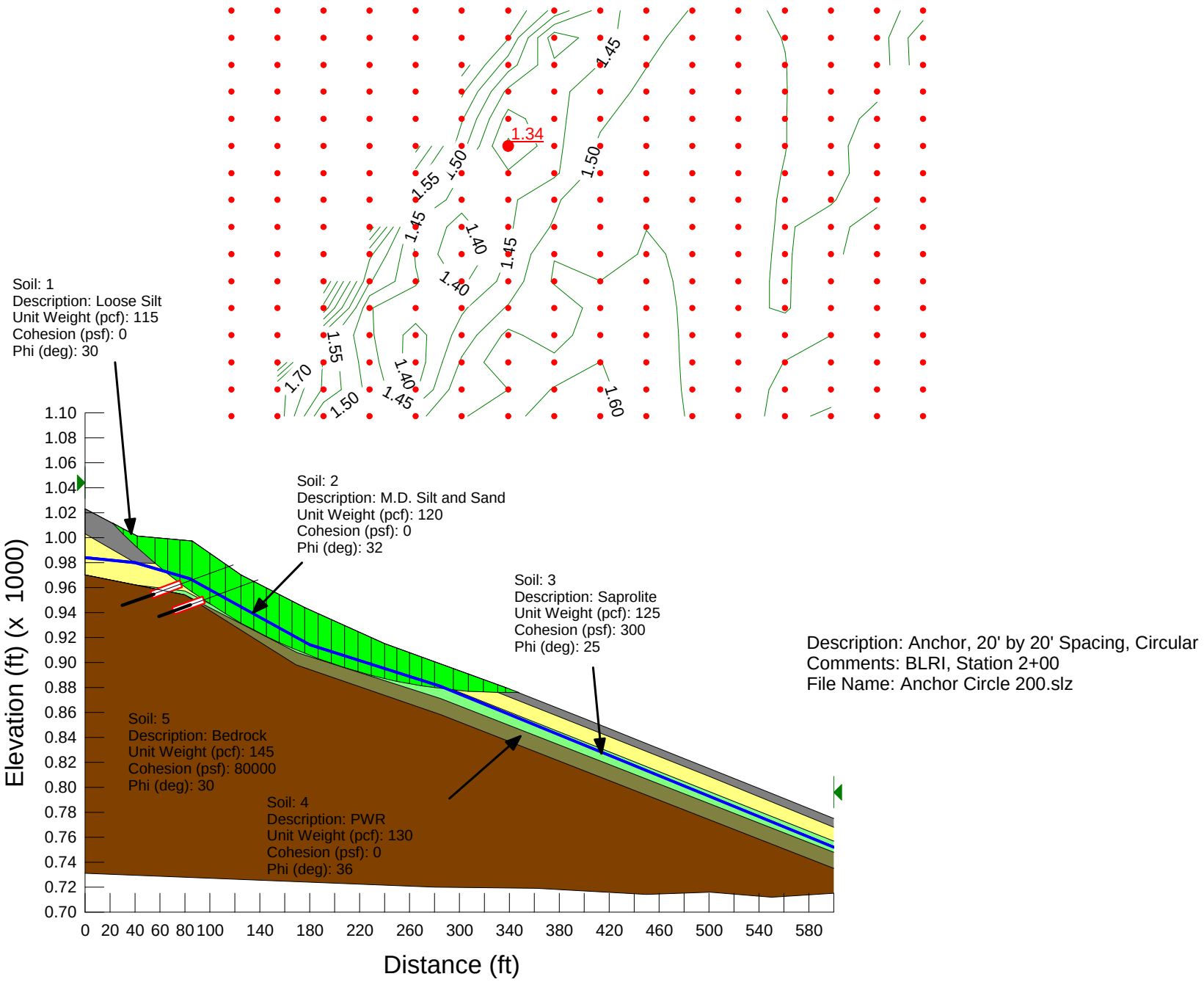
$$l_b := \frac{Q}{\pi d \cdot \tau_a}$$

$$d = \begin{pmatrix} 3 \\ 4 \\ 5 \\ 6 \end{pmatrix} \text{in} \qquad l_b = \begin{pmatrix} 53.1 \\ 39.8 \\ 31.8 \\ 26.5 \end{pmatrix} \text{ft}$$

Wyllie recommends limits of 6 inch maximum drill hole diameter in rock. Practical limit on length of bond zone is 26 to 33 ft.



Description: BLRI, Station 2+00
Comments: Existing Conditions, Circular
File Name: Exist Circle 200.slz



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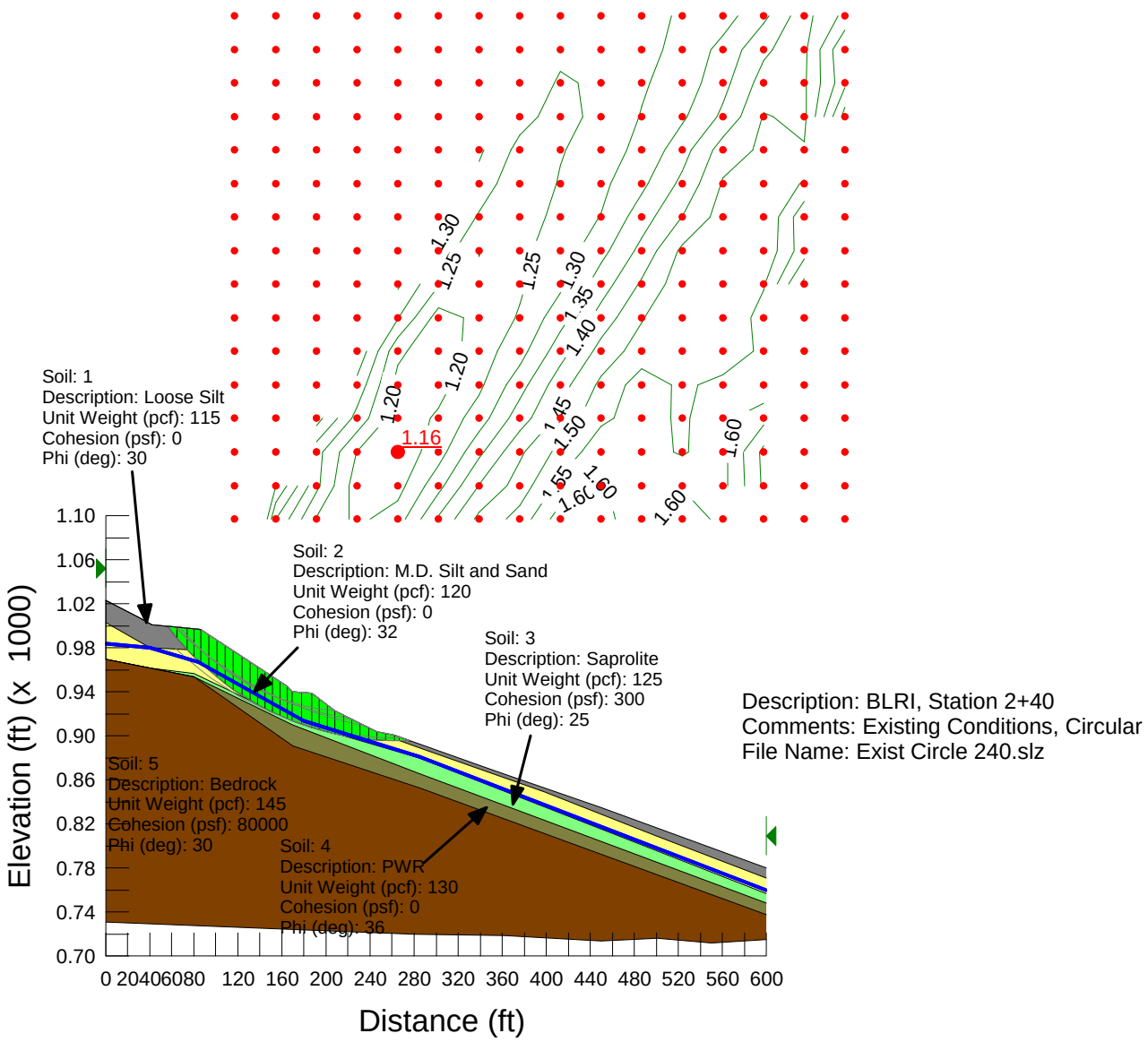
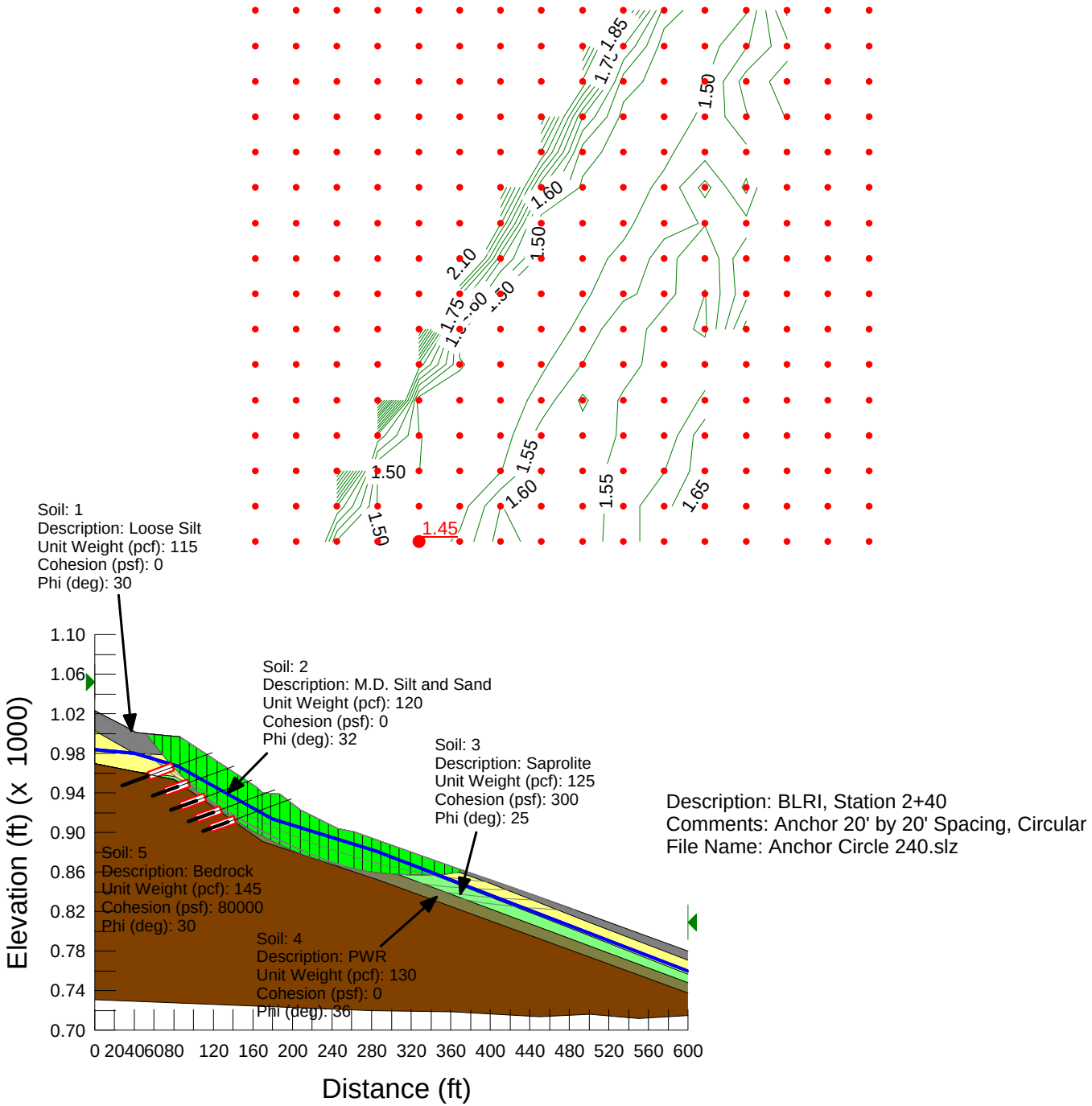
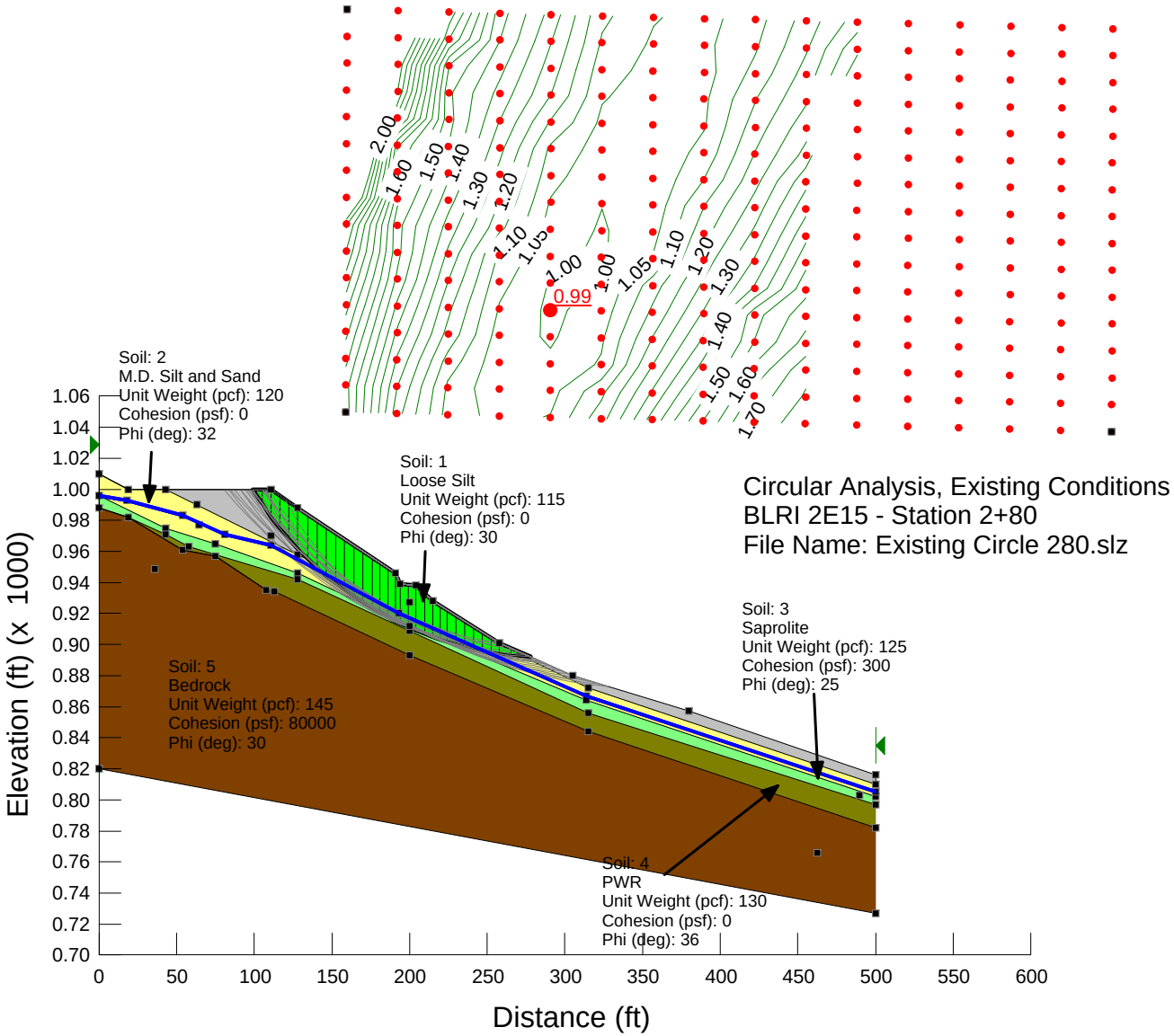
Comments: BLRI, Station 2+00
File Name: Anchor Circle 200.slz

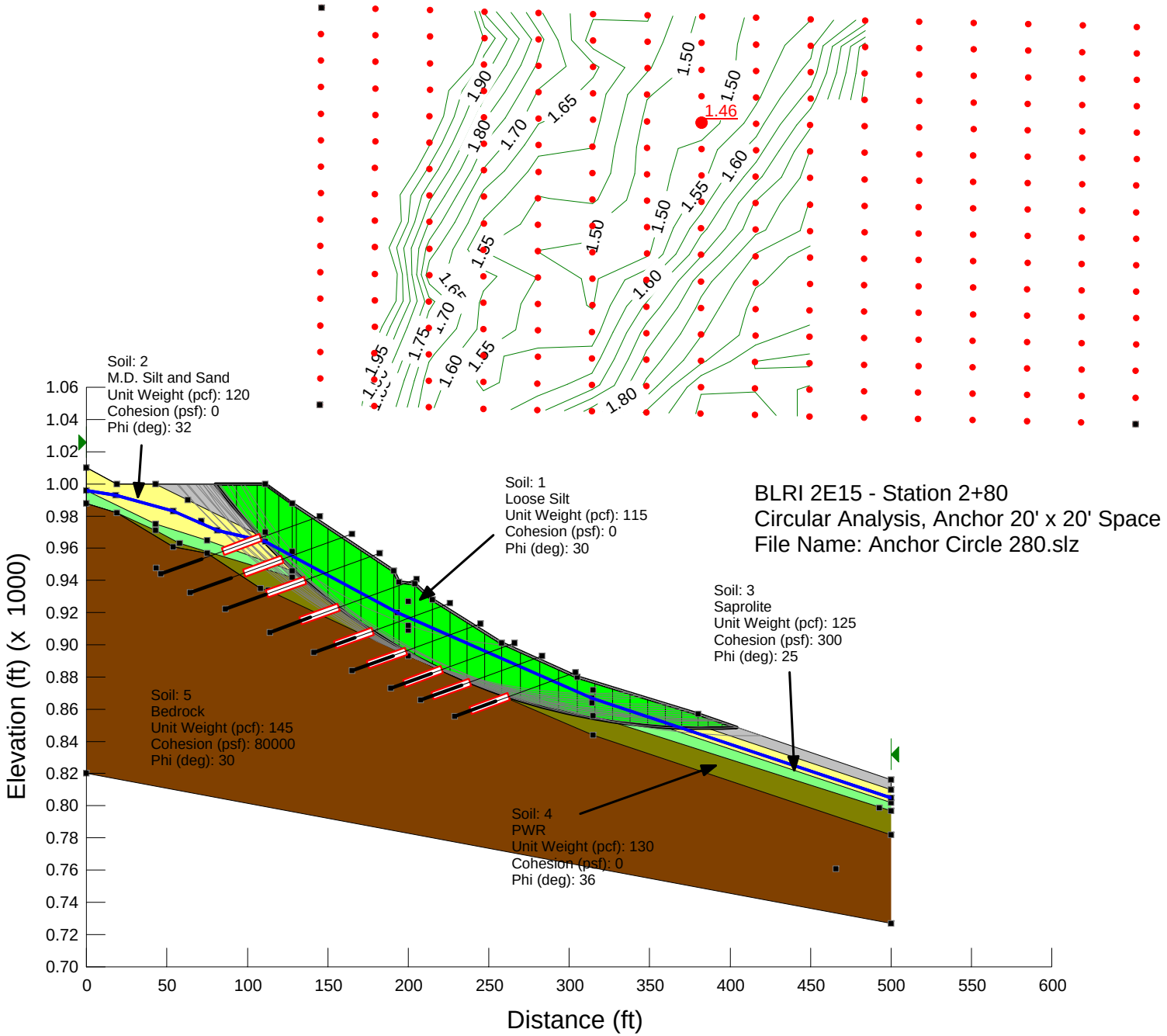


Description: BLRI, Station 2+40
Comments: Existing Conditions, Circular
File Name: Exist Circle 240.slz



Description: BLRI, Station 2+40
Comments: Anchor 20' by 20' Spacing, Circular
File Name: Anchor Circle 240.slz


Soil: 2
M.D. Silt and Sand
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 32
Soil: 1
Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 3
Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
PWR
Unit Weight (pcf): 130
Cohesion (psf): 0
Phi (deg): 36
0.99
Circular Analysis, Existing Conditions
BLRI 2E15 - Station 2+80
File Name: Existing Circle 280.slz
Elevation (ft) (x 1000)
Distance (ft)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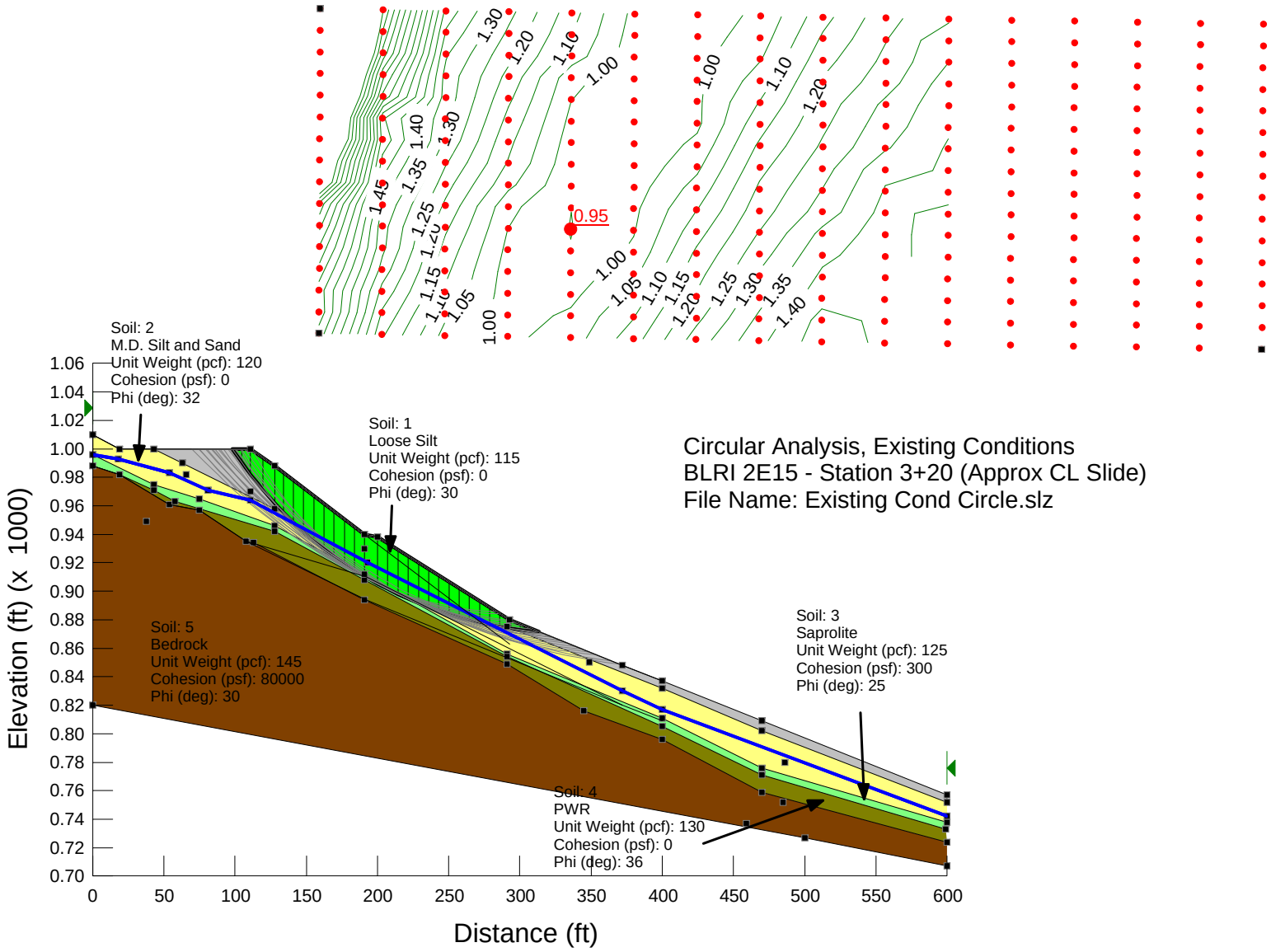
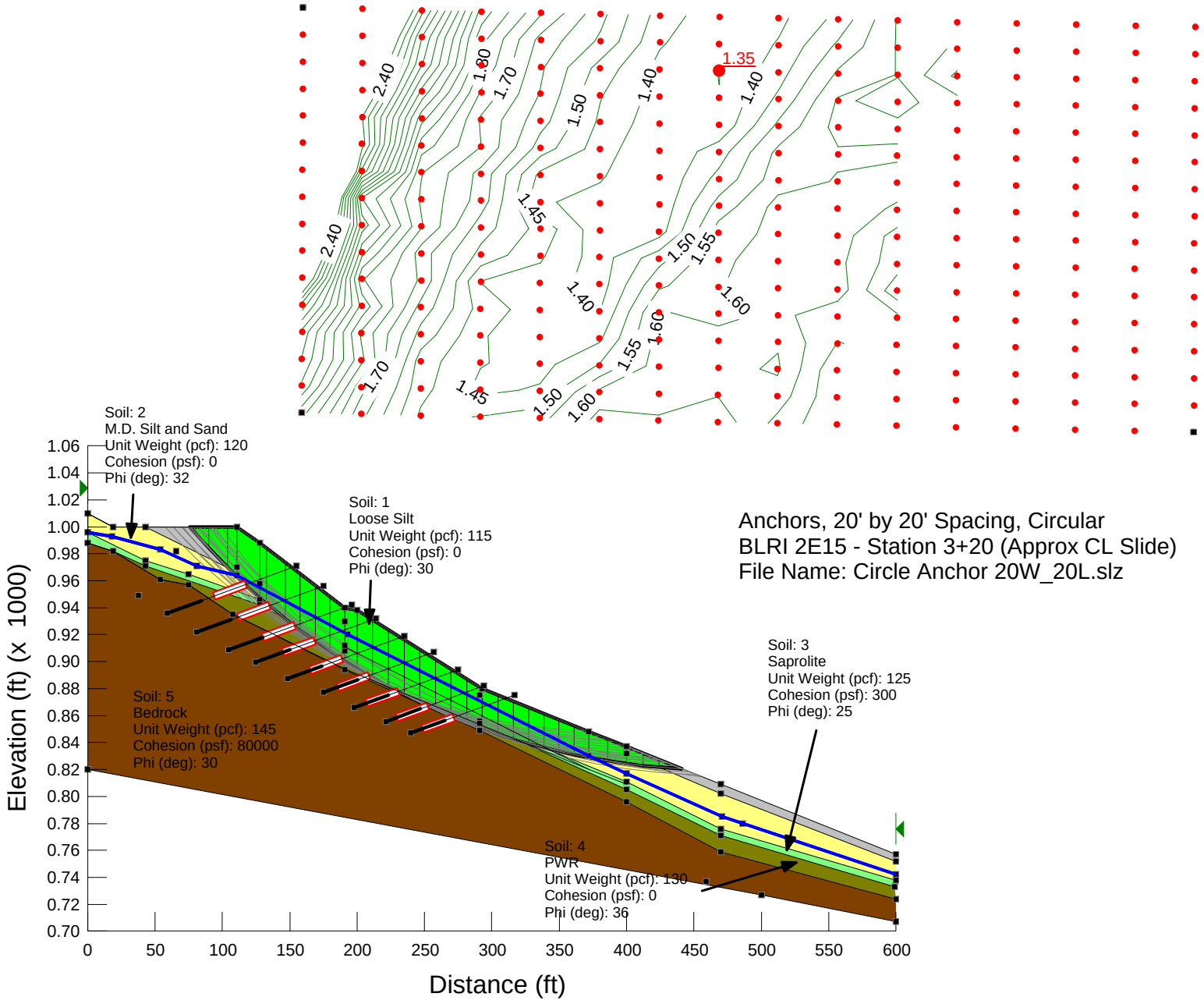
1.50
1.50
1.90
1.80
1.70
1.65
1.55
1.50
1.50
1.55
1.60
1.50
1.60
1.80
1.75
1.60
1.55
Soil: 2
M.D. Silt and Sand
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 32
Soil: 1
Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 3
Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
PWR
Unit Weight (pcf): 130
Cohesion (psf): 0
Phi (deg): 36
BLRI 2E15 - Station 2+80
Circular Analysis, Anchor 20' x 20' Space
File Name: Anchor Circle 280.slz
Elevation (ft) (x 1000)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0.70
0
50
100
150
200
250
300
350
400
450
500
550
600
Distance (ft)



Circular Analysis, Existing Conditions
BLRI 2E15 - Station 3+20 (Approx CL Slide)
File Name: Existing Cond Circle.slz



Anchors, 20' by 20' Spacing, Circular
BLRI 2E15 - Station 3+20 (Approx CL Slide)
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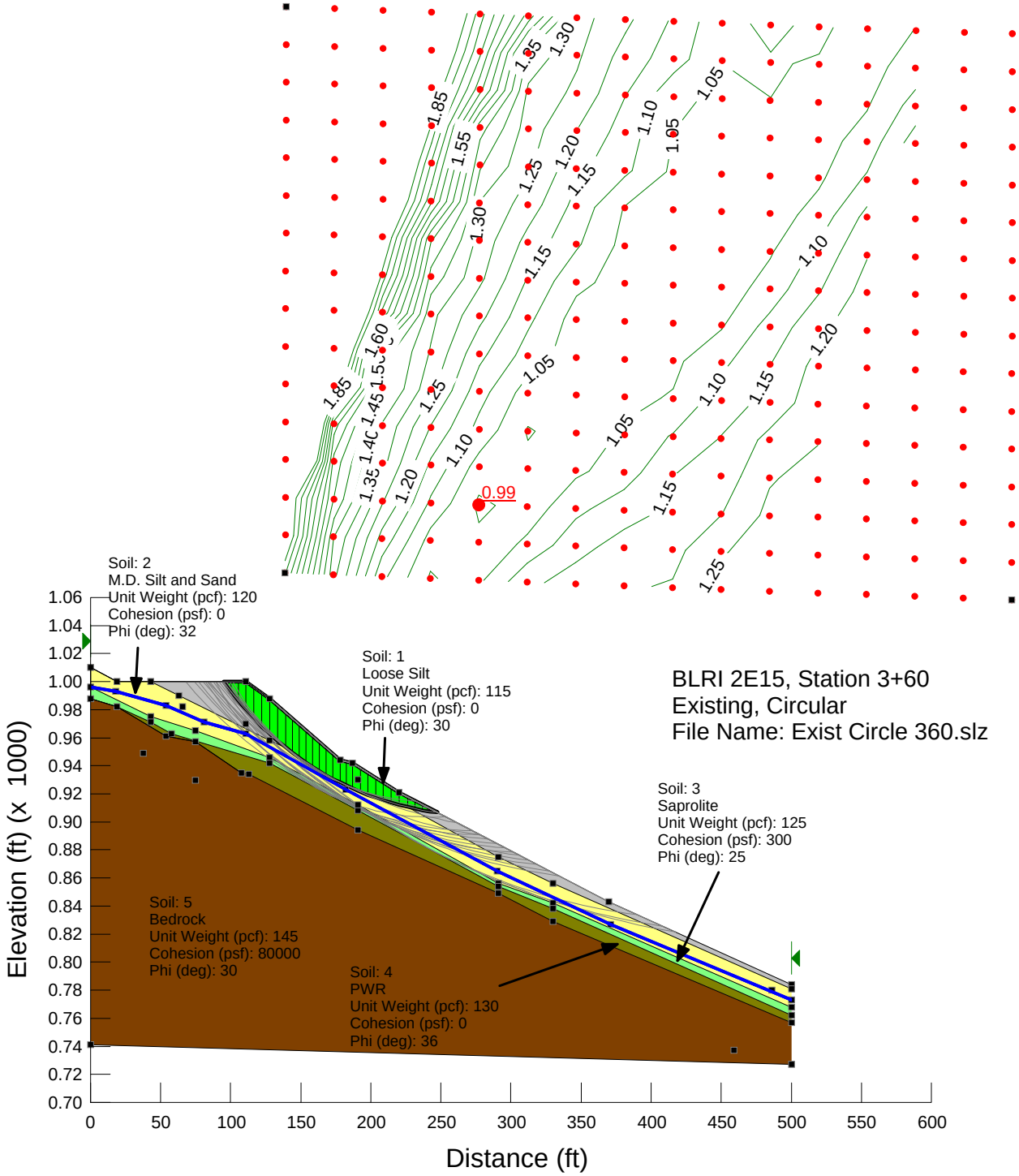
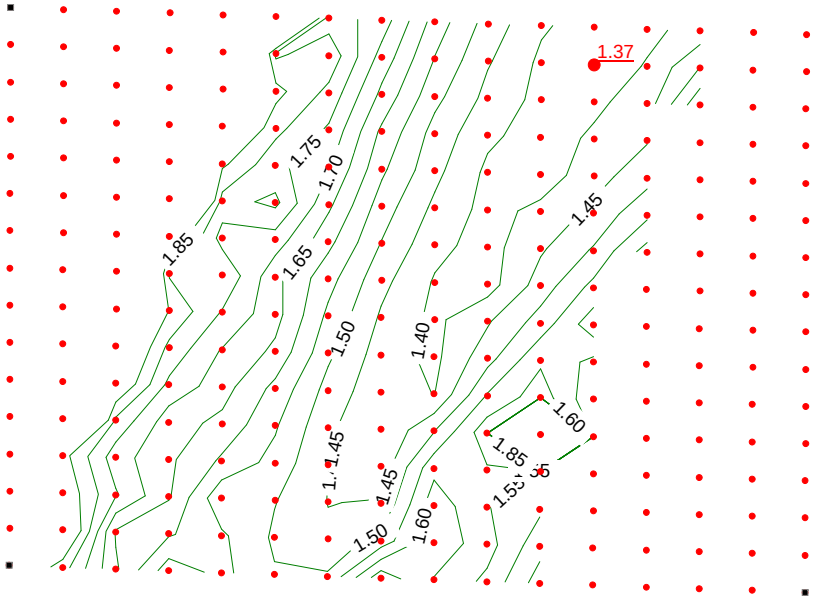

0.99
Soil: 2
M.D. Silt and Sand
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 32
Soil: 1
Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 3
Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
PWR
Unit Weight (pcf): 130
Cohesion (psf): 0
Phi (deg): 36
BLRI 2E15, Station 3+60
Existing, Circular
File Name: Exist Circle 360.slz
Elevation (ft) (x 1000)
Distance (ft)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0.70
0
50
100
150
200
250
300
350
400
450
500
550
600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1.75
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1.65
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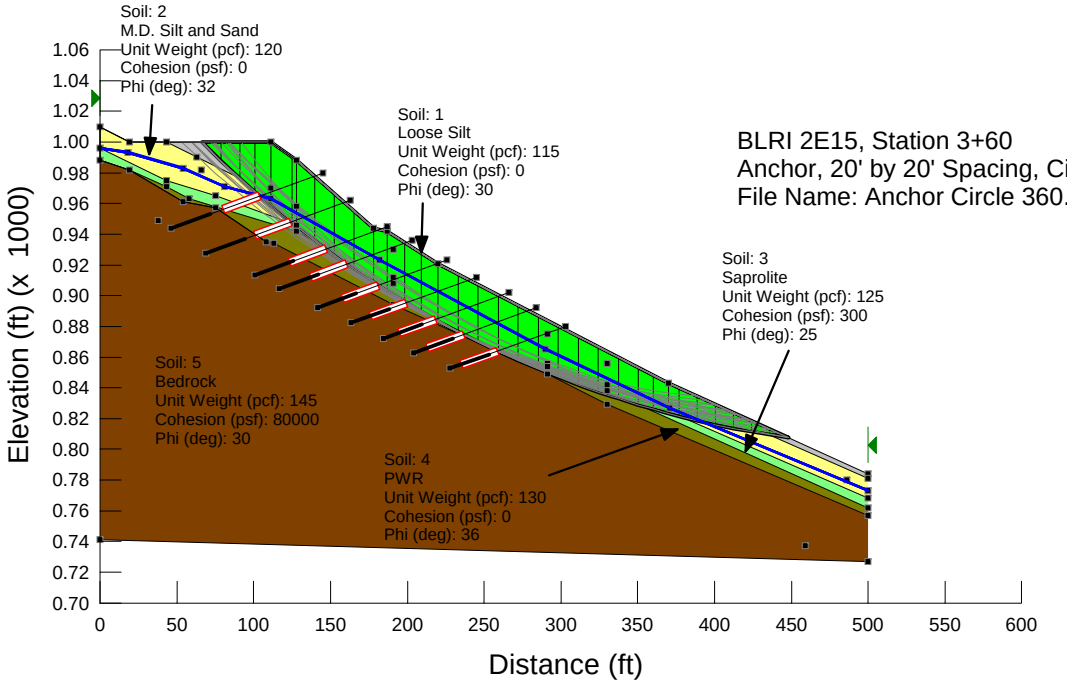
1.50
1.40
1.60
1.45
1.45
1.50
1.60
1.85
1.55
35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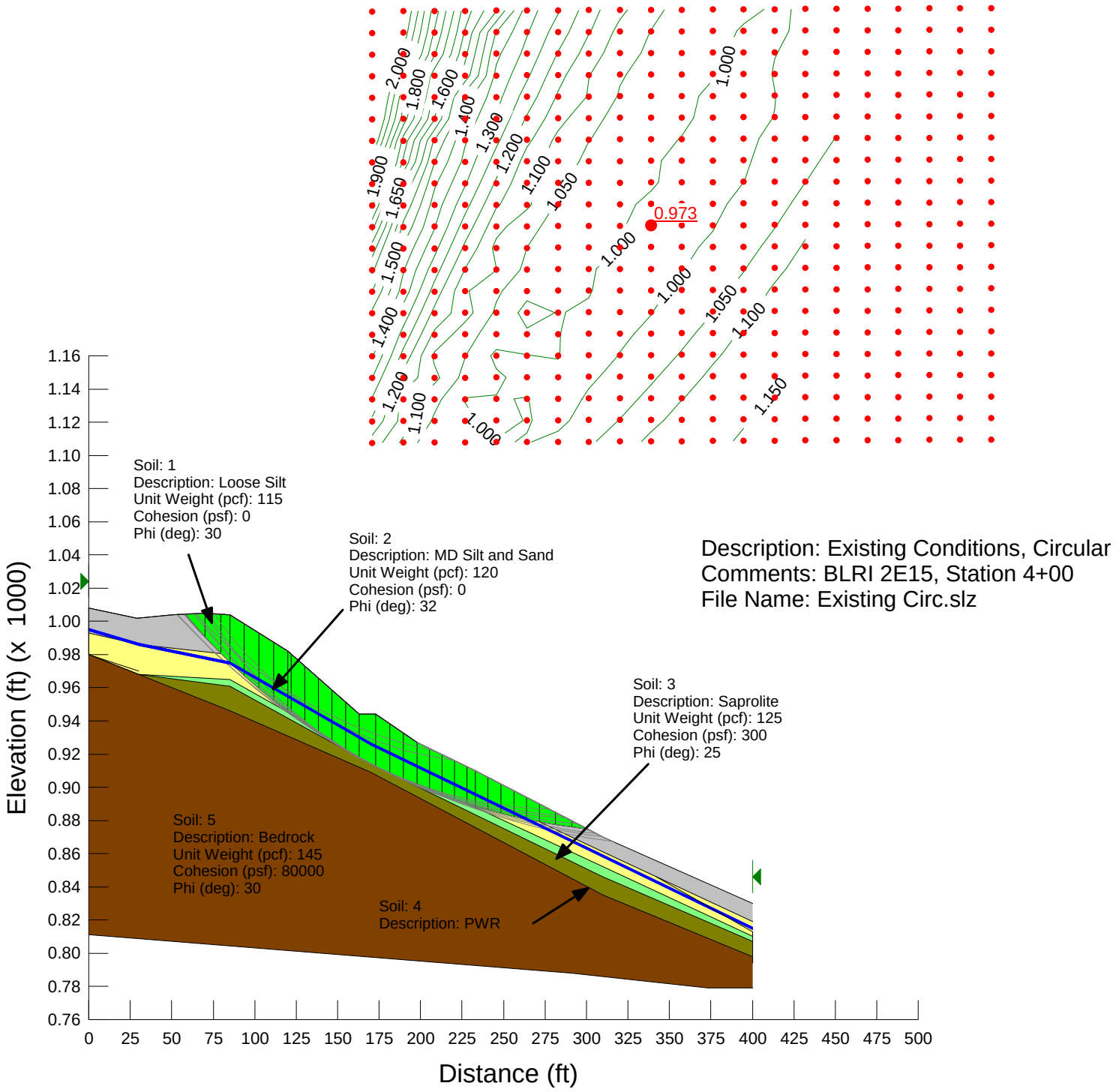
M.D. Silt and Sand
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 32
Soil: 1
Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 3
Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
PWR
Unit Weight (pcf): 130
Cohesion (psf): 0
Phi (deg): 36
BLRI 2E15, Station 3+60
Anchor, 20' by 20' Spacing, Circular
File Name: Anchor Circle 360.slz
Elevation (ft) (x 1000)
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0.70
0
50
100
150
200
250
300
350
400
450
500
550
600
Distance (ft)


2.000
1.800
1.600
1.400
1.300
1.200
1.100
1.050
1.000
1.900
1.650
1.500
1.400
1.200
1.100
1.000
0.973
1.000
1.000
1.050
1.100
1.150
Soil: 1
Description: Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 2
Description: MD Silt and Sand
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 32
Soil: 3
Description: Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Description: Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
Description: PWR
Description: Existing Conditions, Circular
Comments: BLRI 2E15, Station 4+00
File Name: Existing Circ.slz
Elevation (ft) (x 1000)
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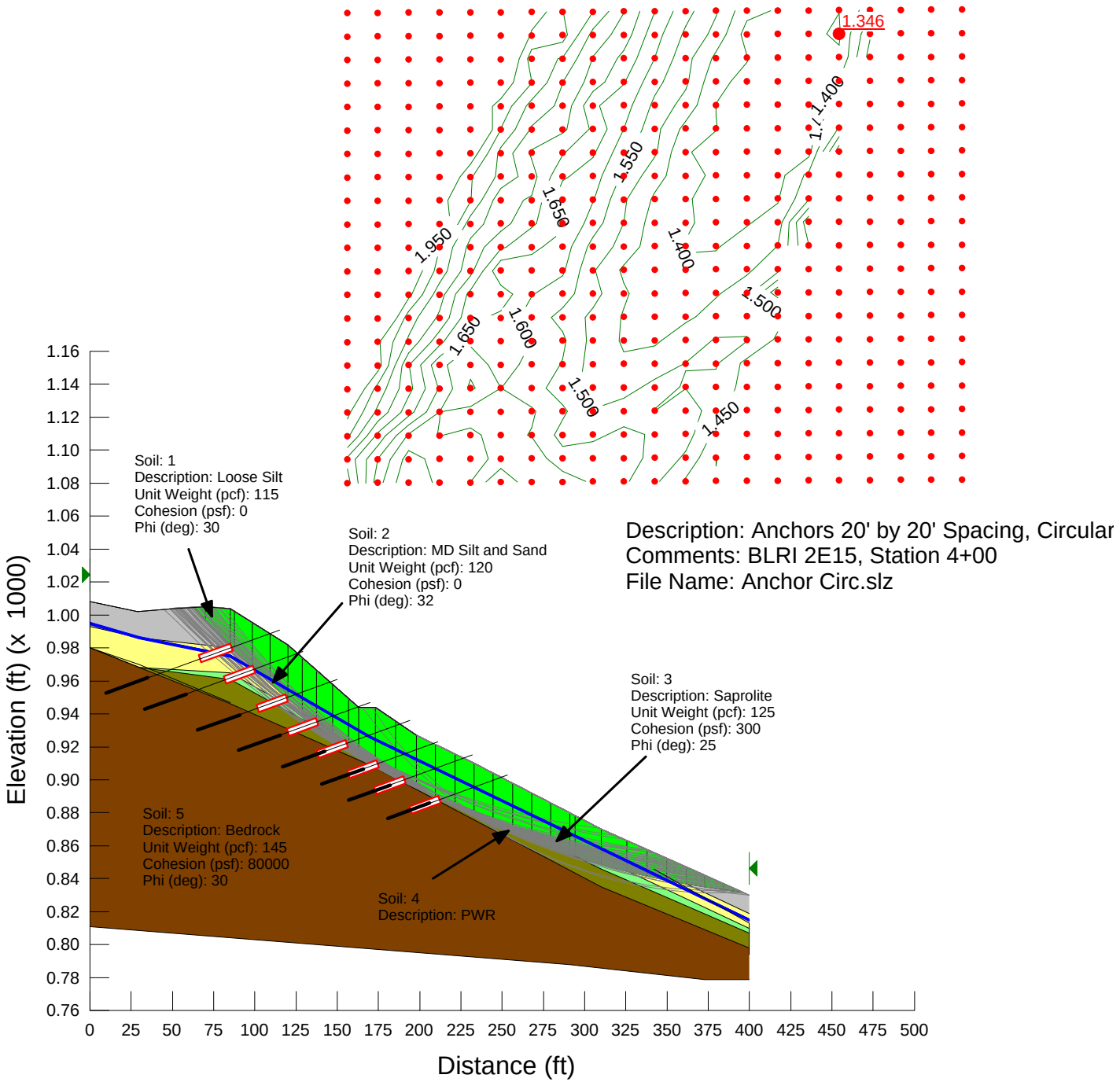
1.14
1.12
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
475
500
Distance (ft)


1.346
1.400
1.550
1.650
1.950
1.400
1.500
1.650
1.600
1.500
1.450
Description: Anchors 20' by 20' Spacing, Circular
Comments: BLRI 2E15, Station 4+00
File Name: Anchor Circ.slz
Soil: 1
Description: Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 2
Description: MD Silt and Sand
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 32
Soil: 3
Description: Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Description: Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
Description: PWR
Elevation (ft) (x 1000)
1.16
1.14
1.12
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0
25
50
75
100
125
150
175
200
225
250
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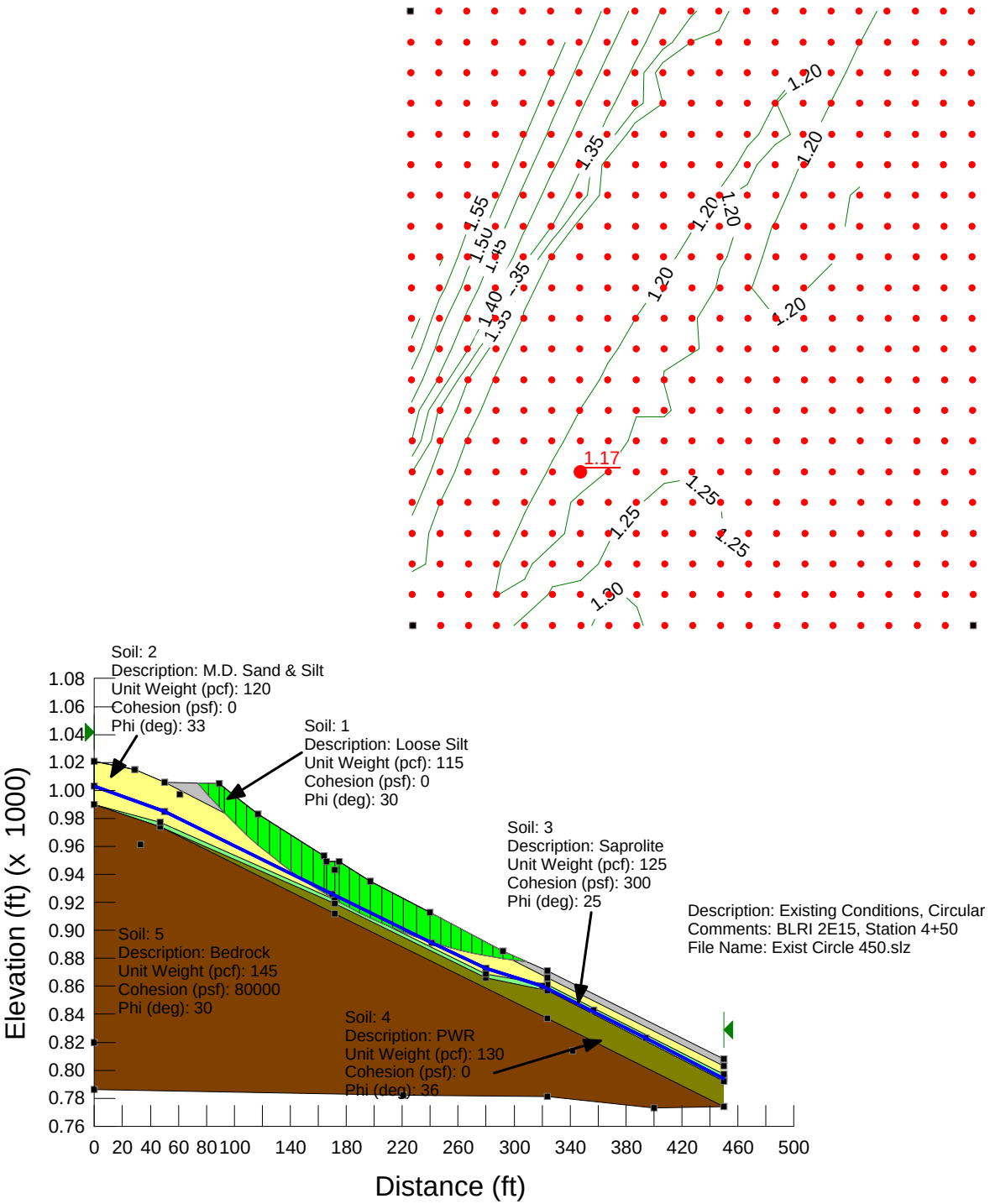
325
350
375
400
425
450
475
500
Distance (ft)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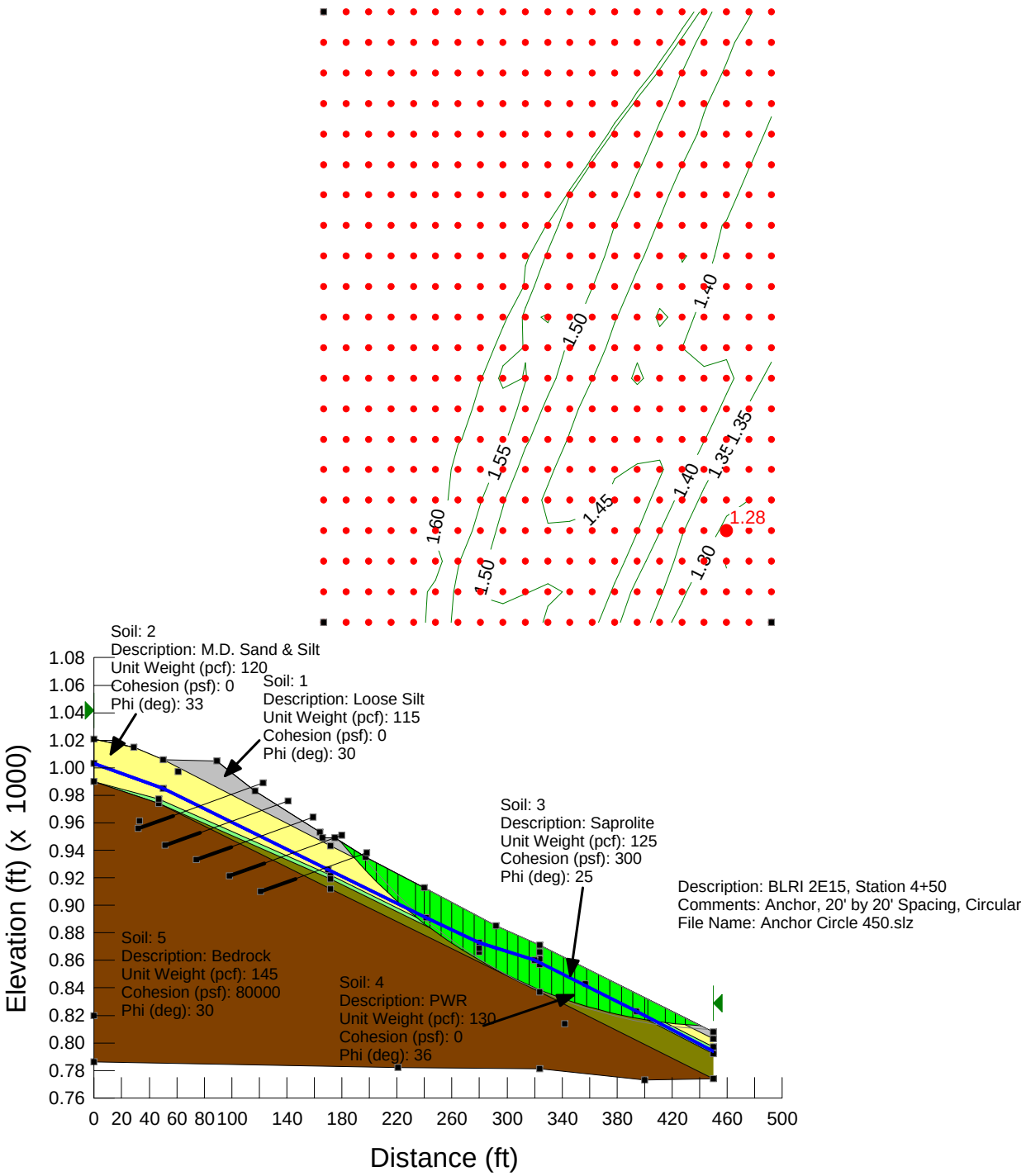
1.50
1.45
1.40
1.35
1.35
1.20
1.20
1.20
1.20
1.20
1.20
1.17
1.25
1.25
1.25
1.30
Soil: 2
Description: M.D. Sand & Silt
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 33
Soil: 1
Description: Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 3
Description: Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Description: Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
Description: PWR
Unit Weight (pcf): 130
Cohesion (psf): 0
Phi (deg): 36
Description: Existing Conditions, Circular
Comments: BLRI 2E15, Station 4+50
File Name: Exist Circle 450.slz
Elevation (ft) (x 1000)
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0 20 40 60 80 100 140 180 220 260 300 340 380 420 460 500
Distance (ft)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1.55
1.50
1.45
1.40
1.35
1.30
1.28
Soil: 2
Description: M.D. Sand & Silt
Unit Weight (pcf): 120
Cohesion (psf): 0
Phi (deg): 33
Soil: 1
Description: Loose Silt
Unit Weight (pcf): 115
Cohesion (psf): 0
Phi (deg): 30
Soil: 3
Description: Saprolite
Unit Weight (pcf): 125
Cohesion (psf): 300
Phi (deg): 25
Soil: 5
Description: Bedrock
Unit Weight (pcf): 145
Cohesion (psf): 80000
Phi (deg): 30
Soil: 4
Description: PWR
Unit Weight (pcf): 130
Cohesion (psf): 0
Phi (deg): 36
Description: BLRI 2E15, Station 4+50
Comments: Anchor, 20' by 20' Spacing, Circular
File Name: Anchor Circle 450.slz
Elevation (ft) (x 1000)
1.08
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0 20 40 60 80 100 140 180 220 260 300 340 380 420 460 500
Distance (ft)

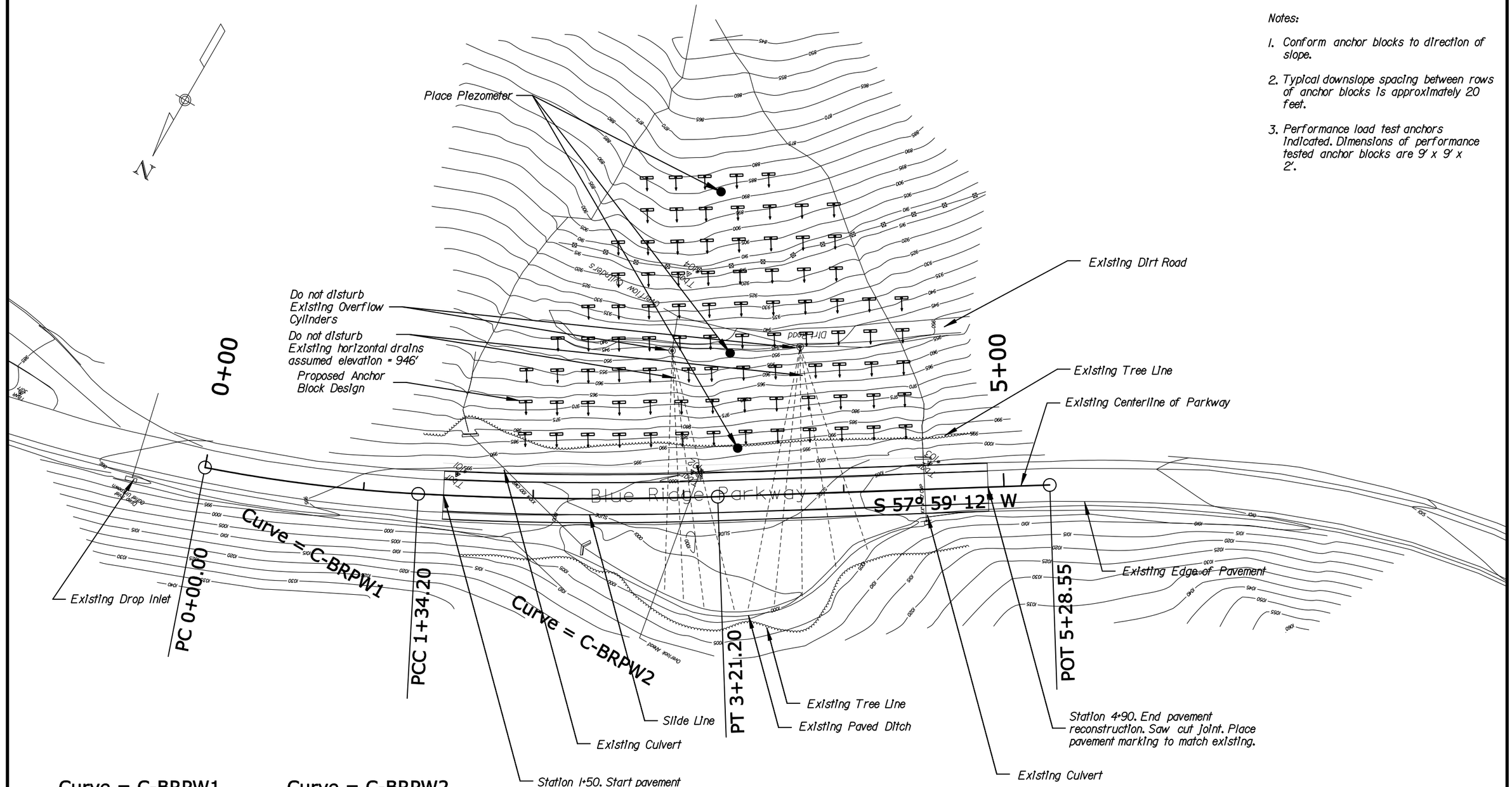
APPENDIX G

Anchor Block Plan

NPS NO.	REG	STATE	PROJECT	SHEET NO.
	SE	NC	PRA-BLRI 2E15	D1

Notes:

1. Conform anchor blocks to direction of slope.
2. Typical downslope spacing between rows of anchor blocks is approximately 20 feet.
3. Performance load test anchors indicated. Dimensions of performance tested anchor blocks are 9' x 9' x 2'.



Curve = C-BRPW1
PI 0+67.20
△= 7° 55' 04" (LT)
R = 971.09'
T = 67.20'
L = 134.20'

Curve = C-BRPW2
PI 2+27.76
△= 5° 06' 08" (LT)
R = 2,099.96'
T = 93.56'
L = 187.01'

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

BLUE RIDGE PARKWAY

PLAN VIEW

0 30 60
SCALE IN FEET

12/18/2007 2:33:54 PM M:\Projects\blri\2e15\proj_dev\CADD\D01-blri2e15_plndgn

APPENDIX H

Representative Photographs

Picture #1 – Looking west (southbound) at Mile 270.3, photo taken Sept 2007

Picture #2 – Looking east (northbound) at Mile 270.3, photo taken September 2007

Picture #3 – Looking east (northbound) at Mile 270.3, photo taken August 2004

Picture #4 – Geophysics Line 1, looking up-slope from midpoint of line

Picture #5 – Geophysics Line 1, looking down-slope from midpoint of line

Picture #6 – Geophysics Line 2, looking east from midpoint of line